PHASE 1 DIAGNOSTIC – FEASIBILITY STUDY OF LAKE CARASAJLO

TOWNSHIP OF LAKewood, OCEAN COUNTY, NEW JERSEY

APRIL 2005

PREPARED FOR:

PREPARED BY:

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1.0 EXECUTIVE SUMMARY

This report has been prepared to document the findings of a Phase 1 Diagnostic-Feasibility Study completed for Lake Carasaljo, which is a shallow 74-acre waterbody located within the municipal boundaries of the Township of Lakewood, Ocean County, New Jersey. The lake, which was created during the early 1800’s to support milling facilities, offers numerous passive recreational opportunities for area residents and visitors. However, in recent years in-lake recreational opportunities have become restricted due to reduced water quality. Swimming within the lake has not been permitted due to elevated fecal coliform levels and a State health advisory has been issued for the consumption of fish caught within the lake. The purpose of this Phase 1 Study is to 1) identify the type and assess the quantity of pollutants entering the lake system; 2) determine the root cause and/or sources of pollutants; and, 3) evaluate and provide recommendations for the most feasible methods for restoring and protecting the lake.

Analysis of water quality data and pollutant loading calculations indicate that the primary sources of water quality impairments within the lake are derived from external sources (i.e. stormwater run-off and waterfowl). As a result, emphasis of restoration and protection efforts for the lake favor watershed management practices that address the external sources of the pollutants rather than “in-lake” restoration methods that primarily address the lake’s response to the pollutants.

“In-lake” restoration methods that are recommended under this study are limited to the continuance of winter drawdowns and chemical treatment for the control of nuisance aquatic species. The control of nuisance aquatics would be desirable to improve water quality (via. reduction in internal phosphorus loading), ecological value (via control of non-native species) and recreational use (i.e. swimming and boating) of the lake. Watershed management practices that are recommended for implementation include: land use management techniques, structural and non-structural stormwater management techniques and waterfowl management practices. Based on the findings of this study, two different approaches to land use management are recommended for the watershed: one approach for the lesser developed upper or “secondary” watershed and one approach for the more densely developed “primary” watershed, which immediately surrounds the lake. As stormwater run-off was identified as a primary contributor to water quality impairments, the implementation of structural and non-structural stormwater management techniques are strongly recommended. In addition to stormwater run-off, waterfowl was identified as a significant contributor to water quality impairments within the lake, as such, the development and implementation of a waterfowl management program is also highly recommended.
2.0 PROJECT DESCRIPTION

This report has been prepared to document the findings of a Phase 1 Diagnostic-Feasibility Study completed for Lake Carasaljo, located in the Township of Lakewood, Ocean County, New Jersey (Figure 2.1). The purpose of this Phase 1 Study was to 1) identify the type and assess the quantity of pollutants entering the lake system; 2) determine the root cause and/or sources of pollutants; and, 3) evaluate and provide recommendations for the most feasible and cost-effective methods and measures for restoring and protecting the lake. The Phase 1 Study was conducted in accordance with procedures outlined under the Clean Lakes Program regulations (40 CFR Part 35, Subpart H). These procedures provide a sound scientific basis for the collection and analysis of limnological data in a manner that enables results to be synthesized with an evaluation of existing watershed conditions in order to develop recommendations for protection and restoration measures.

2.1 BACKGROUND

Lake Carasaljo is an approximately 70 acre man-made lake situated within the Metedeconk Watershed, which discharges into Barnegat Bay (Figure 2.2). The lake, and associated park grounds, provides numerous recreational opportunities and serves as the primary publicly accessible open space area utilized by local residents and area visitors. However, degradation of water quality within the lake has resulted in the lake being closed to swimming and the issuance of a State health advisory for the consumption of fish from within the lake (NJDEP 2004). The lake is included on the State list of 303(d) waters for identified impairments that include algae, macrophytes and mercury within fish tissue (NJDEP 2004). In addition, water quality data, which is regularly obtained from the Ocean County Department of Health, indicates that fecal coliform levels within the lake frequently exceed State standards (personal correspondence).
2.2 SUMMARY OF DIAGNOSTIC STUDY

The diagnostic study portion of this project includes: a characterization of existing watershed conditions; a limnological monitoring program (comprised of detailed geophysical and bio-chemical assessments); and a trophic assessment of the lake. The purpose of the watershed characterization is to establish a base of information that can be utilized in conjunction with liminological data and results of the trophic state assessment to identify potential root causes and sources of pollutants.

2.3 SUMMARY OF FEASIBILITY STUDY

Under the feasibility study portion of this project information and data obtained under the diagnostic study was utilized to evaluate alternatives for restoring and protecting the lake. Alternatives evaluated include: dredging, winter drawdown and sediment consolidation, artificial circulation, macrophyte harvesting, biological controls, chemical treatment, land use management techniques, structural stormwater management techniques, non-structural stormwater management techniques and waterfowl management practices. The purpose of the feasibility study is to provide recommended cost-effective solutions for restoring and protecting water quality within the lake.

2.4 PROJECT FUNDING

Funding for this project has been provided by the New Jersey Department of Environmental Protection (NJDEP), Division of Watershed Management under Federal Clean Water Act Section 319(h) Grant RP03-018. Administration of the grant funds for this project was provided by the Township of Lakewood.
3.0 DIAGNOSTIC STUDY

The diagnostic study of Lake Carasaljo presents information and data gathered to document existing watershed and water quality conditions. The study presents information gathered to characterize the watershed and document existing geophysical conditions. The study also presents analyzed biochemical data collected under a one-year limnological monitoring program and presents the results of a trophic state index assessment conducted to define the physical state of the lake. The purpose of conducting this diagnostic study is to provide a basic understanding of existing watershed and water quality conditions and an understanding of localized physical conditions affecting water quality within the lake.

3.1 Watershed Characterization

The following subsections, which include historical, physical and socio-economic information relative to the watershed, is provided to document existing conditions within the contributory drainage area of Lake Carasaljo and to establish a base of information that can be utilized in conjunction with geophysical and bio-chemical liminological data to identify potential root causes and sources of pollutants entering the lake system.

3.1.1 General Watershed Description

The Lake Carasaljo watershed (Figure 3.1) consists of a 23.6 square mile (sq. mi.) drainage area that encompasses portions of Lakewood and Jackson Townships in Ocean County and Freehold Township in Monmouth County. The configuration of the watershed can be characterized as an 11-mile long linear drainage corridor, which is a component of the larger (70 sq. mi.) Metedeconk watershed, which is a component of the ~668 sq. mi. Barnegat Bay watershed. The Lake Carasaljo watershed supports extensive wetland complexes along the South Branch Metedeconk and its many tributaries. Upland areas within the watershed contain a variety of land uses with the most dominant being undeveloped woodlands and residential development. Extensive woodland areas are more predominant in the upper reaches of the watershed, while residential development is more concentrated in the lower reaches of the watershed, including high-density areas of "downtown" Lakewood immediately surrounding the lake.

Figure 3.1: Lake Carasaljo Watershed
3.1.2 Local History

The Lake Carasaljo watershed first began to experience development during the early to mid 1800’s. The lake itself is a man-made waterbody that was created during the early part of the 1800’s when the feeder stream was damned to support milling facilities and subsequently iron works operations. Settlers gradually cleared land to establish home sites as the industries grew (Figure 3.2). The lake remained without an official name until the mid 1800’s, where upon the passing of a locally successful businessman, Joseph W. Brick who owned the iron works that bordered the lake, a family friend named the bordering lakes, Lake Carasaljo and Lake Manetta, for Mr. Brick’s three daughters Carolina, Sarah, and Josephine and his wife, Manetta.

By 1866, the ironstone market was no longer flourishing and the executor and heirs of the Brick Estate formed the Bricksburg Land and Improvement Company to start marketing the area for development. Land development opportunities were highly publicized in New York newspapers and many bankers started to invest in the area. Over the next decade the area became a very popular resort and many magnificent homes and estates were beginning to appear due to increased settlement by top socialites of the era, which also increased interest that spurred growth in the surrounding area, which was by then known as Lakewood. By the close of World War I, the Township of Lakewood, which encompassed the majority of development within the watershed, had increased to a year round population of 8,000 and winter population of 35,000 residents. Development within Lakewood continued to grow with 90 percent of existing homes being built during the second half of the 1900’s. Since 1970 the Town’s population has nearly doubled to include 60,352 residents and one of the State’s largest industrial park facilities.

3.1.3 Subwatersheds and Drainage Patterns

The 15,115 acre (23.6 sq. mi.) watershed that drains to Lake Carasaljo can be explicitly divided into two distinct drainage areas that can be characterized as “primary and secondary” subwatersheds (Figure 3.3). The “primary” subwatershed consists of a 3,385.84 acre (5.3 sq. mi.) area comprised of land areas that surround the lake and collect water that drains east of Hope Road. The “secondary” subwatershed consists of an 11,729.23 acre (18.3 sq. mi.) area that constitutes the entirety of the upper Metedeconk River drainage basin. A culvert that carries the Metedeconk River across Hope Road provides the only opportunity for water from the “secondary”
(upper) watershed to reach Lake Carasaljo. As such, it behaves as a well-defined input source to the "primary" watershed. A more detailed map of the boundaries of the Lake Carasaljo watershed and the Metedeconk River watershed area are depicted on a plan provided within Appendix A of this report.

Figure 3.3: "Primary" and "Secondary" Subwatersheds of Lake Carasaljo

3.1.4 Topography

The topography within the Lake Carasaljo watershed is comprised of gently sloping plains. The maximum elevation within the watershed is approximately 150 feet mean sea level (msl) and proceeds down to approximately 40 msl along the lake's shores. The general slope of the watershed is northwest to southeast, with the highest elevations existing in the northern reaches of the watershed.

3.1.5 Geology

Lake Carasaljo and the surrounding watershed are situated in the geologic formation known as the Atlantic Coastal Plain. This formation occupies about three-fifths of the State's land area, which is generally described as the land area south and east of a line from Woodbridge to Trenton. Most of the sediments of New Jersey's Coastal Plain range in age from Cretaceous to Miocene (135 to 5.3 million years old) and were deposited in deltaic and marine environments as sea level fluctuated during Cretaceous and Tertiary times (New Jersey Geological Survey 1996; BBEP 2001).
New Jersey’s Coastal Plain can be divided into two distinct parts, the inner and outer coastal plains. The outer coastal plain, which includes the Lake Carasaljo watershed, consists of loosely consolidated sediments that consist mainly of sand, silt and clay and are underlain by sedimentary rock of the Cenozoic, Tertiary age.

3.1.6 Soils

The “General Soil Map” for Ocean County, prepared by the United States Department of Agriculture, National Resource Conservation Service (NRCS), identifies three soil associations within the Lake Carasaljo watershed: Lakehurst-Lakewood-Evesboro association; Downer-Evesboro association; and, Manahawkin-Atsion-Berryland association. This map identifies the land area immediately surrounding the lake as being comprised of soils belong to the Manahawkin-Atsion-Berryland association and the primary and secondary subwatershed areas as being comprised primarily of soils belonging to the Downer-Evesboro association and to a lesser extent the Manahawkin-Atsion-Berryland and Lakehurst-Lakewood-Evesboro associations. A brief characterization of these soil associations as they exist within the watershed is below.

Lakehurst-Lakewood-Evesboro association: Nearly level to sloping, somewhat poorly drained to excessively drained, sandy soils on uplands (NRCS). This soil association is present within the upper portion of the watershed designated as the “secondary” subwatershed. The dominant soil types of this association within the watershed include Lakehurst and Evesboro sands that underlie undeveloped woodlands and agricultural lands.

Downer-Evesboro association: Nearly level and gently sloping, well drained and excessively drained, loamy and sandy soils on uplands (NRCS). This soil association is dominant association through out the lower portion of the watershed designated as the “primary” subwatershed. The dominant soil types of this association include Downer and Evesboro sands that have been extensively developed with commercial and residential land uses.

Manahawkin-Atsion-Berryland association: Nearly level, very poorly drained and poorly drained, organic and sandy soils on lowlands (NRCS). Although this soil association is present within the upper and lower portions of the watershed, the extent of the soils is limited to the narrow riparian corridor associated with the lake’s primary tributary, South Branch Metedeconk River. The dominant soil type consists of Berryland frequently flooded and Atsion soils that support undeveloped forested wetland areas.

3.1.7 Groundwater

Groundwater reserves in the Atlantic Coastal Plain are plentiful and public water supply in Ocean County is obtained from groundwater sources. Groundwater in the Lake Carasaljo watershed is derived from the Kirkwood-Cohansey aquifer system,
which can yield from 500 to 1,000 gallons per minute (gpm). The Kirkwood-Cohansey aquifer system may experience salty or brackish water in coastal areas. This is due to seawater intrusion, which occurs because the aquifer is below sea level in some areas. The Kirkwood-Cohansey aquifer system is unconfined and is becoming an increasingly important source of water supply as the confined aquifers become depleted. This aquifer exceeds 107 m (350 ft) in thickness in some places (U.S. Geological Survey 1985).

### 3.1.8 Applicable State Water Quality Standards

Under New Jersey Administrative Code (N.J.A.C.) 7:9B Surface Water Quality Standards, the State establishes designated uses and acceptable water quality criteria for waters within the State. This document, which is published by the New Jersey Department of Environmental Protection (last revised August 2004) identifies Lake Carasaljo and its tributaries as FW2-NT (C1) waters. A FW2 designation is a general classification applied to waters that are not of an exception resource value. A NT designation is applied to waters, which are generally not suitable for trout because of their physical, chemical, or biological characteristics, but are suitable for a wide variety of other fish species. A C1 designation is a classification that is applied to a waterbody for purposes of implementing the anti-degradation policies that have been established for protection of a waterbody from measurable changes in water quality characteristics. The designated uses for waters with this classification include: maintenance, migration and propagation of the natural and established biota; primary and secondary contact recreation; industrial and agricultural water supply; and public potable water supply after conventional filtration treatment and disinfection. Applicable surface water quality standards for waters with this classification are provided in Table 3.1 below.

**Table 3.1 Applicable Surface Water Quality Standards from 7:9B-1.14(c)**

(Expressed as maximum concentrations unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>APPLICABLE CRITERIA FOR FW2 WATERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal Coliform</td>
<td>Levels shall not exceed a geometric average of 200/100 ml nor should more than 10% of the total samples taken during any 30-day period exceed 400/100 ml</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>24 hour average not less than 5.0 mg/L, but not less than 4.0 mg/L at any time</td>
</tr>
<tr>
<td>pH</td>
<td>6.5 – 8.5</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>Lakes 0.05 mg/L</td>
</tr>
<tr>
<td></td>
<td>Streams 0.1 mg/L</td>
</tr>
<tr>
<td>Nitrate</td>
<td>10,000 µg/L</td>
</tr>
<tr>
<td>Turbidity</td>
<td>30-day average of 15 NTU</td>
</tr>
<tr>
<td></td>
<td>50 NTU at any time</td>
</tr>
</tbody>
</table>

*For the purpose of this report, parameters listed above are limited to those included in both the State Surface Water Quality Standards and the Lake Carasaljo sampling program.
3.1.9 Land Use

As stated previously, the lower portion of the lake’s watershed within Lakewood Township can be characterized as highly developed with a mix of residential and commercial land uses, while the upper portion of the watershed situated within Jackson and Freehold Townships, is significantly less developed and includes vast tracts of undeveloped open space. Table 3.2 describes the general land use categories with their approximate percent coverage within the watershed.

Table 3.2 Percent Coverage within the Lake Carasaljo Watershed by Land Use Type

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Percent Coverage within Watershed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Density Residential</td>
<td>22</td>
</tr>
<tr>
<td>Medium Density Residential</td>
<td>20</td>
</tr>
<tr>
<td>High Density Residential</td>
<td>15</td>
</tr>
<tr>
<td>Commercial</td>
<td>2</td>
</tr>
<tr>
<td>Roadways</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Open Space/Recreational</td>
<td>40</td>
</tr>
</tbody>
</table>

3.1.10 Existing Lake Uses and Public Access

Lake Carasaljo is conveniently located within the “downtown” area of the Township of Lakewood, which provides unlimited access to area residents. Pedestrian paths are located around a majority of the lake, as well as an amphitheatre and viewing platform located on the northern shoreline. Exercise and playground equipment are placed in various locations along the southern shoreline. A free public boat ramp is also located on the southern shoreline for use by non-motorized and electric powered vessels. Boat and paddleboat rentals are also available on the northern shoreline during spring and summer seasons. A bathing beach is located in the central portion of the northern shoreline. However, swimming has not been permitted for the past 2 years and highly restricted during previous years due to elevated fecal coliform counts. Recreational fishing is very prominent at the lake with access along both shorelines and via non-motorized boats. However, a State issued health advisory for the consumption of fish caught within the lake is still in effect.

3.1.11 Population and Socio-Economic Structure

Lake Carasaljo is situated within the boundaries of the Township of Lakewood; however, the lake’s watershed extends into large portions of Jackson Township in Ocean County and a portion of Freehold Township in Monmouth County. A review of U.S. Census data and projections for Lakewood, Jackson, and Freehold Townships and Ocean and Monmouth Counties indicate that towns with the watershed are experiencing a significant amount of growth (Table 3.3). The data shows that
between 1990 and 2000 Lakewood experienced a 34 percent population increase and Jackson and Freehold Townships experienced 29 and 28 percent population increases, respectively. Population projections available for Ocean and Monmouth Counties show that population growth in both Counties is expected to continually increase through 2010.

Table 3.3 Population Data and Projections for the Townships of Lakewood, Jackson, Freehold and Monmouth and Ocean Counties

<table>
<thead>
<tr>
<th>YEAR</th>
<th>1990</th>
<th>2000</th>
<th>2006</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lakewood Twp.</td>
<td>45,048</td>
<td>60,352</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Jackson Twp.</td>
<td>33,233</td>
<td>42,816</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Freehold Twp.</td>
<td>24,710</td>
<td>31,537</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Ocean County</td>
<td>433,203</td>
<td>510,916</td>
<td>520,400</td>
<td>538,200</td>
</tr>
<tr>
<td>Monmouth County</td>
<td>553,124</td>
<td>615,301</td>
<td>637,500</td>
<td>654,700</td>
</tr>
</tbody>
</table>

The distribution of citizens, by race, in 2000 in the Township of Lakewood was 70% white, 11% African American, 13% Hispanic or Latino, and 6% other races. Jackson Township was 88% white, 4% African American, 5% Hispanic or Latino, and 3% other races. Ocean County was 90% white, 3% African American, 5% Hispanic or Latino, and 2% other races. The Township of Freehold was 84% white, 5% African American, 5% Hispanic or Latino, and 6% other races. Monmouth County was 81% white, 8% African American, 6% Hispanic or Latino, and 5% other races.

Per capita income in 1999 was $16,700 for Lakewood, $23,891 for Jackson, and $23,054 for Ocean County. Per capita income was $31,505 for Freehold and $31,149 for Monmouth County. Approximately 15.7% of the Township of Lakewood population is below the poverty level. While only 2.5% and 2.8% are below poverty level in Jackson and Freehold, respectively.

Occupational data for Lakewood Township is presented in Table 3.4. Information from the 2000 U.S. Census indicates that 50.2% of the available working force is employed, which leaves 21,100 persons, age 16 and older, not in the labor force. The data also show that in the Township of Lakewood, as well as Ocean County, occupations vary widely with the exception of farming, fish and forestry.

Table 3.4 Lakewood Township Occupation Data (2000)

<table>
<thead>
<tr>
<th>OCCUPATION</th>
<th>PERCENT OF POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management, professional, and related occupations</td>
<td>33.4</td>
</tr>
<tr>
<td>Service occupations</td>
<td>16.6</td>
</tr>
<tr>
<td>Sales and office occupations</td>
<td>26.2</td>
</tr>
<tr>
<td>Farming, fishing, and forestry occupation</td>
<td>0.2</td>
</tr>
<tr>
<td>Construction, extraction, and maintenance occupations</td>
<td>8.4</td>
</tr>
<tr>
<td>Production, transportation, and material moving occupations</td>
<td>15.2</td>
</tr>
</tbody>
</table>
As per the 2000 U.S. Census, Lakewood maintained 21,214 housing units, Jackson 14,640, and Freehold 11,032. Ocean County maintained 248,711 and Monmouth County 240,884. Therefore, Lakewood, Jackson, and Freehold Townships maintained 8.5%, 5.9%, and 4.6% of the housing units for each county, respectively.

3.1.12 Watershed Characterization Summary

Lake Carasaljo is a 74-acre shallow water lake located in the Township of Lakewood, Ocean County, New Jersey. The lake is a man-made water body that was created during the early part of the 1800's when the feeder stream (North Branch Metedeconk) was dammed to support milling facilities and subsequently iron works operations. The lake was named after the three daughters (Carolina, Sarah, and Josephine) of a local businessman (Joseph W. Brick) who owned the iron works facility that bordered the lake. Lake Carasaljo is conveniently located within the “downtown” area of the Township of Lakewood, which provides unlimited access to area residents. Park grounds surrounding the lake provide numerous passive recreational opportunities, however in-lake recreational opportunities have become restricted due to reduced water quality. Swimming within the lake has not been permitted for the past 2 years and highly restricted during previous years due to elevated fecal coliform counts. Recreational fishing is very popular at the lake, but a State issued health advisory for the consumption of fish caught within the lake is still in effect.

The contributory watershed to Lake Carasaljo is comprised of a 23.6 square mile (sq. mi.) drainage area that encompasses portions of Lakewood and Jackson Townships in Ocean County and Freehold Township in Monmouth County. U.S. Census data and projections for these areas indicate that towns with the watershed are experiencing significant population growth that is expected to continually increase through 2010. The configuration of the watershed can be characterized as an 11-mile long linear drainage corridor, which is a component of the larger (70 sq. mi.) Metedeconk watershed, which is a component of the ~668 sq. mi. Barnegat Bay watershed. The lake’s watershed can be explicitly divided into two distinct drainage areas that can be characterized as “primary” and “secondary” subwatersheds. The “primary” subwatershed consists of 5.3 square mile area within the lower portion of the watershed that includes densely developed portions of Lakewood Township that immediately surround the lake. The “secondary” subwatershed consists of an 18.3 square mile area that constitutes the upper portion of the watershed that includes portions of Jackson and Freehold Townships that are significantly less developed including vast tracts of undeveloped open space.

During the time that this study was conducted State policy changes concerning stormwater management were enacted, resulting in additional water quality protection to Lake Carasaljo. The State Surface Water Quality Standards (N.J.A.C. 7:9B – August 2004) upgraded the lake and its tributaries to Category One (C1) designated status. A C1 designation is a special level of protection that is applied to a waterbody
for purposes of implementing the anti-degradation policies that have been established for protection of a waterbody, particularly waterbodies that are a source of drinking water, from measurable changes in water quality characteristics. The State Surface Water Quality Standards were then subsequently integrated with the recently implemented State Stormwater Management Rule (N.J.A.C. 7:8), which provides, in most cases, a 300-foot buffer to C1 designated waters.

3.2 Geophysical Limnological Assessment

The following subsections, which include physical information relative to the watershed, are provided to document existing environmental conditions within the lake. They provide a foundational base upon which to analyze current conditions and suggest potential sources of pollutants which may impair water quality. This report documents the conditions within the contributory drainage area of Lake Carasaljo and establishes a base of information that can be utilized in conjunction with geophysical and bio-chemical limnological data to identify potential root causes and sources of pollutants entering the lake system.

3.2.1 Lake Bathymetry

A bathymetric survey of Lake Carasaljo was performed in May of 2003 by personnel from LGA Engineering, Inc. Water depths were measured along multiple transects from where the lake meets Route 9, just past Lake Carasaljo Drive. The bathymetric map showing bottom contours of the lake was also prepared by LGA Engineering, Inc. and is included as Appendix B of this report. The deepest reaches of the lake can be found in the eastern portion of the lake. Generally, as the lake travels west the depths become much shallower. The largest percentage of the lake (18.6%) is within the −4 to −3' depth range, where the lowest percentage (0.1%) can be found at both the −12 to −11' and 0 to 1' depth ranges.

3.2.2 Lake Morphology

Lake Carasaljo is a 74 acre shallow lake located in the Township of Lakewood, Ocean County, New Jersey. The Lake Carasaljo watershed covers an approximately 15,115 acre area that is contained within the larger Metedeconk River watershed, which encompasses 2,499,426 acres that includes lands within both Ocean and Monmouth Counties. The one major tributary is the South Branch of the Metedeconk River, which runs through both Monmouth and Ocean Counties through forested areas, such as the Turkey Swamp Wildlife Management Area, cranberry bogs, and residential areas. Of the 15,115 acre watershed serving the lake, only about 530 acres (3.5%) drains directly to the waterbody. The delivery vehicle for the balance of drainage area (96.5%) is via input streamflow (South Branch of Metedeconk River) or groundwater.

Physical characteristics of the lake are listed in Table 3.5. The ratio of drainage area to surface area is 203:1, which explains the current residence time of 3.25 days.
Table 3.5 Existing Physical Characteristics of Lake Carasaljo

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>MEASUREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Area</td>
<td>74.408 acres</td>
</tr>
<tr>
<td>Mean Depth</td>
<td>5.1 feet</td>
</tr>
<tr>
<td>Maximum Depth</td>
<td>11.8 feet</td>
</tr>
<tr>
<td>Lake Volume</td>
<td>585,000 ft³ (4.38 million gallons)</td>
</tr>
<tr>
<td>Hydraulic Residence Time</td>
<td>3.25 days*</td>
</tr>
<tr>
<td>Primary Drainage Basin Area</td>
<td>3,385.84 acres</td>
</tr>
<tr>
<td>Secondary Drainage Basin Area</td>
<td>11,729.23 acres</td>
</tr>
<tr>
<td>Mean Discharge</td>
<td>50 ft³/sec (374 gal/sec)**</td>
</tr>
</tbody>
</table>

* Average dry weather value based upon simplified formula (T=V/Q), where Q (mean discharge) is based upon limited data.
** Average dry weather value based upon limited hydraulic flow data.

3.2.3 Pollutant Source Assessment

This section summarizes the likely sources of pollution entering the lake system and presents results of analytical efforts to quantify the relative magnitude of the sources.

The Lake Carasaljo watershed can be explicitly divided into “primary” and “secondary” components, with Hope Road serving as the boundary between the two (see Figure 3.4). The primary watershed surrounds the Lake and collects water that drains east of Hope Road. The secondary watershed constitutes the entirety of the upper Metedeconk River drainage basin. A culvert that carries the Metedeconk River across Hope Road provides the only opportunity for water from the “secondary” (upper) watershed to reach Lake Carasaljo. As such, it behaves as a well-defined input source to the “primary” watershed.

Based upon the relative characteristics of the “secondary” watershed (relatively undeveloped) and the “primary” watershed (urbanized), it is assumed apriori that the primary source of the lake’s nutrient and bacterial pollution originates east of Hope Road. This assumption requires future confirmation via water sampling at the Hope Road culvert.

Figure 3.4: USGS Map Depicting Primary and Secondary Drainage areas of Lake Carasaljo
Within the "primary" watershed, the following sources of pollution have been identified as the most likely contributors to the existing pollution problem:

- Stormwater runoff
- Septic leachate (groundwater)
- Resident waterfowl

The analysis presented herein is intended to estimate the relative magnitudes of each of these pollutant contributors. The initial step for this analysis is the determination of a hydrologic budget, or mass balance system that estimates the relative magnitude of surface and ground water inflow to the lake.

### 3.2.4 Hydrologic Budget

As illustrated in Figure 3.5, the primary watershed of Lake Carasaljo lends itself toward a simple hydrologic budget analysis due to the fact that surface water enters and leaves the watershed through two distinct points where all surface flow is constrained in culverts (groundwater flow may bypass the lake altogether). Hydrologic sampling locations were established at both of these locations. The first point was located at the inflow of the lake, to the northwest, at the eastern side of the culvert on Hope Chapel Road and the second point was located at Central Avenue and Route 9, at the southernmost edge of the culvert connecting Lake Carasaljo with Lake Manetta (Figure 3.6).

![Figure 3.5: Aerial Photograph of Sampling Points at Lake Carasaljo](image)
A simple mass balance system was used to determine the surface water flow in and out of the lake. At each sampling station, a profile of the creek bed was measured (see Figure 3.7). Subsequently, current velocities and water depths were measured during three dry and two wet events. Using simple geometry, the measured hydrologic data were converted to flow rates at each station. Table 3.6 summarizes the results.

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>Sample Type</th>
<th>Flow, ft³/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/15/03</td>
<td>Dry</td>
<td>34.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>59.31</td>
</tr>
<tr>
<td>10/29/03</td>
<td>Wet</td>
<td>95.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>92.00</td>
</tr>
<tr>
<td>11/26/03</td>
<td>Dry</td>
<td>43.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47.60</td>
</tr>
<tr>
<td>12/5/03</td>
<td>Wet</td>
<td>62.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>93.26</td>
</tr>
<tr>
<td>12/18/03</td>
<td>Dry</td>
<td>60.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63.44</td>
</tr>
</tbody>
</table>
Although the data presented in Table 3.6 are limited, they illustrate that, as expected, there is a trend for net gain in water volume between Stations 1 and 2. The dry events are the most indicative of this gain, because they represent conditions when the only inputs to the Lake are streamflow and groundwater. Assuming that evaporation of lake water is negligible, the data indicate that groundwater inflow accounts for between 5% and 40% of the total flow. Based upon local conditions and data from other streams in the area, the likely range of groundwater input is 5% to 10% of the total flow. Additional sampling would serve to further refine this lake budget.

Although the groundwater flow cannot be accurately quantified as part of this project, the determination that it is a measurable source of water to the lake is of primary importance. This is due to the fact that the area surrounding the lake is the site of a significant number of septic systems that may leach contaminants to the groundwater, which is potentially delivered to the lake. This process will be discussed further in the subsequent subsections.

3.2.5 Point Source Pollutant Loads

Point source pollutants are those defined as distinct sources of pollution, particularly those that are continuous. These sources include sanitary sewer and industrial waste outfalls. At the time of this report there were no known documented point source pollutants within the lake’s watershed.

3.2.6 Nonpoint Source Pollutant Loads

Nonpoint source pollutants are generally defined as a pollutant or group of pollutants that originate from sources that are not associated with identified point sources. These pollutants can accumulate within a watershed over large areas resulting in polluted water that flows over the surface of the land or along natural drainage channels to the nearest water body. Nonpoint source pollutants can also accumulate within surfacewater or groundwater, as is the case with Lake Carasaljo. The nonpoint sources identified for Lake Carasaljo are stormwater runoff, septic leachate, and resident waterfowl populations.

Methodologies for quantifying the above-referenced pollution are not well refined. This section presents the results of an empirical analysis that is intended to quantify the relative magnitude of effect for each of the listed pollutant sources. In this manner, the results can be interpreted to assist decision makers in their allocation of funding and efforts to help reduce the problems.

3.2.7 Stormwater Pollutant Loadings

The relative magnitude of pollutant loading from stormwater can be estimated using a simple methodology based upon land use and hydrologic data. Loading for the Lake Carasaljo watershed was computed to determine relative contributions of pollutants
within subwatersheds based on specific land use areas. These loadings can be used to identify priorities for implementation of best management practices.

Pollutant loadings were estimated using the Simplified Method (Scheuler 1987). This method estimates stormwater runoff pollutant loads for urban areas. The technique requires the following information:

- Drainage Area – The primary watershed was delineated into 17 individual catchment areas using USGS topography, field inspection, and GIS resources. Details are illustrated in Appendices A and C of this report.
- Land Use Classification – Land use classification (commercial, high density residential, etc.) and impervious percentages were computed for each catchment and can be found in Appendix C.
- Stormwater Runoff Pollutant Concentrations – These are empirical values that correlate pollutant concentrations as a function of runoff volume and land use. They are expressed in units of pollutant load (mg/l). Values utilized for this study are listed in Appendix D. They are referenced from the Stormwater Management Resource Center (www.stormwatercenter.net) and are their default values.
- Annual Precipitation – The expected annual precipitation for the Lake Carasaljo watershed is 43 inches. This value is the long-term mean of historical precipitation measurements for Coastal New Jersey from 1895 to 2001.

The Simplified Method indicates the following general findings. Detailed results are presented in Appendix D:

**Watershed Level:** Computed annual pollutant loads for the watershed are as follows:

- Total Nitrogen – 6.94 tons/year
- Total Phosphorous – 370 pounds/year
- Total Suspended Solids – 46 tons/year
- Total Fecal Coliform – 7.86 E+09 billion colonies/year

**Catchment Level:** The pollutant loading analysis is most useful at the catchment level. The results are specified in terms of both gross pollutant loading (pounds per year) and pollutant yield (pounds per year per acre). Each of these values are useful for identifying root causes of pollution and for prioritizing water quality improvement efforts; however, it must be recognized that the results are very simplified and general in nature. In essence, they represent a quantification of the amount of pollution that can potentially reach the lake. Mitigating infrastructure such as detention basins and other water quality improvements are not considered in the model. Likewise, the model does not consider aggravating circumstances such as soil erosion, upland goose populations, illicit sewer connections, high-risk land uses, etc.
Specifically, one can identify those catchments (refer to Appendix D) that produce loads and yields that are above average and likely contribute an extraordinary amount of pollution to the lake. Tables 3.7 and 3.8 illustrate the pollutant yields and loads for each of the catchments, which are ranked according to the following color-coding:

- Red – High Values (typically highest 1/3)
- Yellow – Median Values (typically central 1/3)
- Green – Low Values (typically lowest 1/3)

Note that none of the fecal coliform values are colored. This is due to the fact that prediction of fecal coliform is highly variable and unreliable. The predictions made herein were made using a standard value for “urban areas”; therefore, they are primarily a function of land area not land use.

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Catchment</th>
<th>Total Nitrogen (pounds/acre)</th>
<th>Total Phosphorous (pounds/acre)</th>
<th>Suspended Solids (pounds/acre)</th>
<th>Fecal Coliform (billions of colonies/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>3.8</td>
<td>0.11</td>
<td>28.14</td>
<td>2.41E+06</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>5.44</td>
<td>0.11</td>
<td>28.03</td>
<td>2.38E+06</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3.4</td>
<td>0.1</td>
<td>24.6</td>
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</tr>
<tr>
<td>4</td>
<td></td>
<td>1.82</td>
<td>0.06</td>
<td>13.68</td>
<td>9.07E+05</td>
</tr>
<tr>
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<td></td>
<td>0.55</td>
<td>0.02</td>
<td>4.84</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>1.38</td>
<td>0.05</td>
<td>12.27</td>
<td>7.62E+05</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>3.5</td>
<td>0.1</td>
<td>23.89</td>
<td>1.95E+06</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>4.72</td>
<td>0.15</td>
<td>38.62</td>
<td>3.46E+06</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>5.62</td>
<td>0.16</td>
<td>39.55</td>
<td>3.56E+06</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>7.09</td>
<td>0.16</td>
<td>41.05</td>
<td>3.74E+06</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>4.92</td>
<td>0.1</td>
<td>25.55</td>
<td>2.12E+06</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>1.51</td>
<td>0.04</td>
<td>9.41</td>
<td>4.68E+05</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>0.88</td>
<td>0.04</td>
<td>8.18</td>
<td>3.42E+05</td>
</tr>
<tr>
<td>14</td>
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<td>5.18</td>
<td>0.13</td>
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<td>2.98E+06</td>
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<tr>
<td>15</td>
<td></td>
<td>5.93</td>
<td>0.12</td>
<td>32.04</td>
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</tr>
<tr>
<td>16</td>
<td></td>
<td>5.1</td>
<td>0.12</td>
<td>30.5</td>
<td>2.59E+06</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>4.59</td>
<td>0.11</td>
<td>28.93</td>
<td>2.52E+06</td>
</tr>
</tbody>
</table>
Table 3.8 Computed Pollutant Loads

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Catchment</th>
<th>Total Nitrogen (pounds)</th>
<th>Total Phosphorus (pounds)</th>
<th>Suspended Solids (pounds)</th>
<th>Fecal Coliform (billions of colonies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>3,200.51</td>
<td>95.41</td>
<td>23,698</td>
<td>2.03E+09</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>443.3</td>
<td>9.26</td>
<td>2,283.7</td>
<td>1.94E+08</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>219.8</td>
<td>6.49</td>
<td>1,591.8</td>
<td>1.31E+08</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>110.11</td>
<td>3.48</td>
<td>827.28</td>
<td>5.48E+07</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>89.88</td>
<td>3.81</td>
<td>798.15</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>6</td>
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<td>122.92</td>
<td>4.63</td>
<td>1,091.2</td>
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<tr>
<td>7</td>
<td></td>
<td>710.33</td>
<td>19.79</td>
<td>4,849.5</td>
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<tr>
<td>8</td>
<td></td>
<td>1,095.82</td>
<td>36</td>
<td>8,971.2</td>
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</tr>
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<td>9</td>
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<td>841.17</td>
<td>23.76</td>
<td>5,925.1</td>
<td>5.33E+08</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>1,889.03</td>
<td>43.52</td>
<td>10,936</td>
<td>9.97E+08</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>953.07</td>
<td>20.15</td>
<td>4,952.1</td>
<td>4.11E+08</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>76.73</td>
<td>2.08</td>
<td>478.34</td>
<td>2.38E+07</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>97.74</td>
<td>4.02</td>
<td>910.22</td>
<td>3.80E+07</td>
</tr>
<tr>
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<td></td>
<td>1,299.93</td>
<td>32.38</td>
<td>8,333.6</td>
<td>7.47E+08</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>583.25</td>
<td>12.15</td>
<td>3,152.7</td>
<td>2.83E+08</td>
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<tr>
<td>16</td>
<td></td>
<td>375.84</td>
<td>8.87</td>
<td>2,246.5</td>
<td>1.91E+08</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>1,761.11</td>
<td>43.68</td>
<td>11,095</td>
<td>9.65E+08</td>
</tr>
</tbody>
</table>

3.2.8 Septic Tank Leachate (Groundwater)

As discussed earlier, the results of the Hydrologic Budget illustrated that the likely range of groundwater input into the lake is 5% to 10% of the total flow during dry weather. For purposes of this cursory analysis, the actual volume of groundwater input is relatively unimportant. However, it is important to recognize that groundwater does enter the lake and that this flow may serve as a significant conduit.
for the delivery of septic leachate. Septic system leachate is considered to be one of the potential factors that may contribute pollutants to the lake.

The approximate age of the septic tanks within the primary watershed range from 25-75 years (septic systems installed between 1930 and 1980’s) with an estimated average age of 50 years. For the purpose of this study it is assumed that all of the septic systems within specified radial areas of the lake are in some mode of failure and are leaching to groundwater. In addition to tank condition and age, the distance between a leaching septic tank and the water body in question is a primary factor in determining the amount of polluted groundwater that infiltrates the water body.

Given the previously noted assumptions that 1) groundwater is a source of water to the lake, and 2) septic systems leach into the groundwater table, it is reasonable to assume that septic systems contribute pollutants to the lake. Quantification of their effect is a poorly developed science; however, empirical methods provide for a means of estimation. The first step toward estimating the septic loading is to determine the location of the septic systems relative to the lake. Using aerial photography and utility mapping of the local sanitary system, a Non-Sewer Service Area Map was developed and is attached in Appendix E. The Map indicates that there are only 2 houses that utilize septic systems within a 300’ radial distance from the perimeter of the lake, and 22 houses within a 500’ distance. Within a 1000’ radial distance 162 houses were identified and within the primary watershed 520 houses were identified that utilize septic systems. These septic counts were used as input to EPA guidance, which indicates that the following loading rates can be applied to residential septic systems:

- Fecal Coliform: $2.46 \times 10^{14}$ colonies/year (US EPA 2003)
- Phosphorous: 1.45 kg of Phosphorous/capita/year (US EPA 1988)

Based upon these rates, Figure 3.8 illustrates the computed annual loading to the lake as a function of distance from its perimeter.

---

Figure 3.8 Yearly Fecal Coliform yields at various radial distances from the Lake Perimeter
These results, when compared to other pollutant factors, indicate that septic leachate is a relatively small source of nutrient and bacterial pollutant levels to the lake, compared to the urban stormwater runoff. As indicated in Figure 3.8, one would have to consider all septic systems within 7,000 feet of the lake before the total contribution became notable. This distance is unreasonable, considering it lies outside the limits of the lake’s watershed. It is noted, however, that additional fecal coliform levels in the lake could result from unknown septic tanks that exist adjacent to the lake, as well as residents within the radial area that are in serviced developments that have yet to hook up to the City’s system. Likewise, illicit connections to stormwater pipes and/or leaking sanitary sewer lines could have significant impacts upon the bacterial loading.

3.2.9 Nutrient Loadings from Waterfowl

Lake Carasaljo’s resident goose populations contribute nutrients and bacterial loadings to the lake directly through deposition of feces. The nutrients from these waterfowl populations have the potential to contribute to the process of eutrophication. The degree of contribution depends on factors such as population density, feeding habits, time of year and dilution capacity of the water body. BEI performed population counts on the lake during 2003/2004 and determined that there were spring/summer and fall/winter resident populations of about 40 and 104 waterfowl, respectively. Annual loading was computed for each of these populations assuming loading rates of 78x10^8 fecal coliform colonies/waterfowl/day (F.X. Browne Associates, Inc. 1990), 1.4 grams of Nitrogen/day/waterfowl and 0.4 grams of phosphorous/waterfowl/day (Manny, B.A., R.G. Wetzel, and W.C. Johnson 1975). These results are depicted in Table 3.9 and compared to other sources in the following section.

Table 3.9 Annual Waterfowl Loading

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Goose Population at Lake Carasaljo</th>
<th>Annual Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Goose Population</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summer = 40</td>
<td>Winter = 104</td>
</tr>
<tr>
<td>P</td>
<td>6.44</td>
<td>16.73</td>
</tr>
<tr>
<td>N</td>
<td>22.53</td>
<td>58.56</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>5.69E+4</td>
<td>1.48E+5</td>
</tr>
</tbody>
</table>

3.2.10 Pollutant Budgets for Lake Carasaljo

The results described in Table 3.9 present a theoretical pollutant budget for the lake. The results of the budget are illustrated in Figures 3.9 and 3.10. The most striking result is the overwhelming effect of stormwater runoff and the relative magnitudes of nitrogen/phosphorous loading. As noted previously, the stormwater runoff estimates are typically high, as they do not account for any mitigating measures. The following
section of this report compares the theoretical estimates prepared herein with estimates developed from actual water quality sampling.

![Annual Nutrient Loads for Specific Source Types](image)

**Figure 3.9:** Annual nutrient loads for all non-point sources

![Annual Bacterial Loads for Specific Source Types](image)

**Figure 3.10:** Annual Fecal Loading for all non-point sources
3.2.11 Pollutant Loadings Calculated from Monitoring Data

The theoretical exercises presented above are used as a tool for determination of the source of pollutants; however, actual measurement of the pollutants in the lake provides a more accurate picture. Field measurements of the pollutant constituents in question were measured for this purpose during the latter months of 2003.

This data was then applied to the measured flow rates presented in Section 3.2.4 to estimate total annual loads for purposes of comparison to the theoretical results.

Figures 3.11 through 3.14 illustrate annual loading rates as a function of flow rate for nitrogen, phosphorous, suspended solids, and fecal coliforms. The lines in each graph represent data collected at storm events, dry events and an average of all data collected for that particular constituent. The typical trend shown in all the graphs shows that at a given flow rate, there will be a higher concentration of the constituent during a storm event then during a dry flow event, with the average lying between the two cases. This is indicative of the fact that surface water will collect contaminants during its route towards each particular drainage area, and ultimately enter the lake. These results support our earlier findings that the majority of the pollutants found within the lake are due to stormwater runoff.
Total Annual Phosphorus - Varying Flows

Figure 3.12: Annual Phosphorous Loads – Measured Data

Total Annual Suspended Solids - Varying Flows

Figure 3.13: Annual Suspended Solids Loading – Measured Data
If one assumes an average annual flow rate for the lake, the measured results can be compared with the theoretical results on an annual basis. Table 3.10 presents these results, based upon an average annual lake flow rate of 70 ft³/s.

Table 3.10 Comparison of Measured and Theoretical Loading Results

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Measured</th>
<th>Theoretical</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>70</td>
<td>7</td>
<td>tons</td>
</tr>
<tr>
<td>P</td>
<td>12.7</td>
<td>0.23</td>
<td>tons</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>4.72E+5</td>
<td>7.87E+9</td>
<td>billions of colonies</td>
</tr>
</tbody>
</table>

Given the fact that the theoretical analysis has very little quantitative value, one can draw the following qualitative conclusions from the results.

1) The theoretical results suggest that the nitrogen loading should be approximately 30 times that of phosphorous loading; however, measured results indicate that the N:P ratio is only about 5.5. Given the fact that the measured concentrations of phosphorous are known to be relatively high, this finding suggests that there is a source of phosphorous that is out of the ordinary, or excessive denitrification is occurring in the watershed.

2) The theoretical results suggest that the pollutants produced in the lake’s primary watershed would result in an N:P ratio of 30, which would result in a phosphorous-limited system. However, the measured results indicate an N:P ratio of 5.5, which is closer to a nitrogen limited system. The disparity between the two suggests that the actual phosphorus loading exceeds what would be expected based upon theoretical land use loading values. A more detailed field
investigation of phosphorus generating land uses within the watershed may reveal the source(s) of this disparity.

3) The theoretical fecal coliform load results are heavily dominated by stormwater runoff. The comparison of measured results suggests that this theoretical dominance does not occur to the degree predicted. Therefore, it is reasonable to expect that alternative sources, such as waterfowl and septic systems, play a more significant role.

3.2.12 Internal Nutrient Loading

Internal loading is the process that occurs in lakes when nutrients are introduced into the water from the lake sediment. As with external loading, internal loading can lead to eutrophication and cause chemicals and nutrients to leach into the water and cause odor and water quality issues. Because of the lake's high levels of fecal coliform and nutrient levels, it is expected that internal loading from the contaminated bottom sediment does occur during optimal conditions, and contributes to the nutrient levels within the lake.

3.2.13 Bacterial Sources

Bacterial sources, as shown in the results stated above, are the result of urbanized land uses, the presence and migration of waterfowl in the vicinity of the lake and of structurally compromised septic tanks.

3.2.14 Waterfowl

Bacteria and pathogen content of waterfowl feces also contribute to the detrimental effects of the lake. Common bacteria found in waterfowl include *E. coli*, *Cryptosporidium*, and *Salmonellae*. These bacteria strains can be harmful to human health and the health of the water body. As stated earlier in this report, the presence of fecal coliform in the water body promotes the presence of these bacterial strains.

3.2.15 Geophysical Limnological Assessment Summary

The Lake Carasaljo watershed receives contaminants from stormwater runoff and resident goose populations. Septic systems are also suspected as a source. The theoretical and measured results presented in this Section revealed the following conclusions:

- Stormwater runoff appears to be the primary source of pollutants to the Lake.
- Waterfowl are a significant source of bacterial pollution.
- The effect of septic systems is likely less than that which was originally suspected, due to the relatively small number of systems located in close proximity to the lake.
Phosphorous pollution in the lake is atypically high. The source of the extra phosphorous is unknown, however the theoretical analysis suggests that it does not originate from standard land use patterns.

Given the fact that stormwater has been identified as a primary pollutant source, the prioritization of mitigation projects should be oriented toward the most damaging components of the watershed. Prioritization efforts can make use of the catchment level stormwater pollutant analysis (Section 3.2.7) to more effectively utilize limited funding.

It must be emphasized that the results presented herein are of a cursory nature due to budgetary constraints. Future efforts to refine these results would require a rigorous hydrologic analysis as well as additional water quality sampling.

### 3.3 Bio-chemical Limnological Assessment

Based on our theoretical loading rate calculations, a series of water quality assessment activities were conducted for Lake Carasaljo. These assessment activities include:

- Collection of in-lake water quality samples obtained monthly during May and September and biweekly during June, July and August.
- Analysis of water quality samples for total and soluble reactive phosphorus, nitrite, nitrate, pH, temperature, dissolved oxygen, turbidity, representative alkalinitities and chlorophyll a.
- Analysis of fecal coliform data obtained from the Ocean County Health Department and the Lakewood Township Public Works Department.
- Performance of a macrophyte survey to identify problem species and estimate the percent coverages.
- Assessment of phosphorus and nitrogen inflows and outflow associated with the lake.

#### 3.3.1 In-lake Water Quality Monitoring Program

The following parameters were monitored between May and October of 2003 within Lake Carasaljo: temperature, pH, alkalinity, turbidity, total phosphorus, nitrate, nitrite, dissolved oxygen (DO), chlorophyll a, and fecal coliform. Three (3) sample locations were positioned throughout the lake where water quality was measured and testing was performed. The following water quality parameters were recorded in the field using a YSI Model 556 water quality meter: pH, temperature, and DO. Water samples were also taken at each location throughout the summer and sent to Blue Marsh Laboratories for testing of the following parameters: DO, pH, nitrate, nitrite, phosphorus, alkalinity, and total nitrogen. Turbidity and chlorophyll a were measured in the field using an Aquafluor Flurometer. Two (2) additional sites, located between these three main sites, were assessed using the water quality meter and the turbidimeter. Approximate depths and secchi readings were also recorded for all five (5) sampling locations.
At each of the three primary water quality stations, water was sampled from the surface, middle layer and bottom to record any variations in the water column. These samples were taken using a Kemmer bottle. Sampling took place on the following dates: 5/29, 6/11, 6/27, 7/24, 7/30, 8/14, and 8/27. Data obtained during the sampling events is provided as Appendix F of this report. A summary of the sampling results is provided below in the following subsections.

Water quality was also tested on three additional dates, 9/17, 10/15, and 10/29, in support of the pollutant load analysis, which was addressed in Section 3.0 of this report. However, sample locations were altered to support proper analysis of drainage and flow to and within the lake. Therefore, this information has not been included within this section.

Fecal coliform water sampling was performed by the Township of Lakewood Health Department on a weekly basis between June 3 and August 28, 2003. Analysis of these samples was performed by the Ocean County Health Department. Results of their analysis are included within Appendix F and a discussion of the results is included under section 3.3.8 of this report.

3.3.2 Temperature and Dissolved Oxygen

The EPA’s Volunteer Lake Monitoring Manual lists temperature as an important component to lake water quality and ecology because rates of biological and chemical processes are temperature dependent. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Temperature also affects the oxygen content of the water, the rate of photosynthesis by aquatic plants, the metabolic rates of aquatic organisms, and the sensitivity of organisms to toxic wastes, parasites, and diseases. Causes of temperature change include weather, removal of shading by stream-bank vegetation, impoundments, discharge of cooling water, urban storm water, and groundwater inflows to waterbodies.

Surface temperatures throughout the lake ranged from 61.7°F in May to 81.9°F in June. The average surface temperatures were 76° at Site 1, 75° at Site 2 and 73° at Site 3. Mid-lake temperatures throughout the lake ranged from 60.4° in May to 81.9° in June. The average mid-lake temperatures are 73° at Site 1, 75° at Site 2 and 72.5° at Site 3. Bottom temperatures throughout the lake ranged from 55.9° in May to 76.6° in August. The average bottom temperatures are 68° at Site 1, 68.5° at Site 2 and 69° at Site 3.
Figure 3.15: Surface Temperature Data

Figure 3.16: Mid Depth Temperature Data

Figure 3.17: Lake Bottom Temperature Data
The amount of dissolved oxygen in the water is an important indicator of overall lake health. Oxygen plays a crucial role in determining the type of organisms that live in a lake. When oxygen is significantly reduced, organisms can become stressed and when oxygen becomes absent (hypoxia), all oxygen-breathing organisms must either move to an oxygenated zone or they will die. Lake systems produce oxygen through photosynthesis and diffusion from the atmosphere, but they also consume oxygen through metabolic and respiratory pathways by all living organisms in the system. A system gains oxygen from the diffusion of atmospheric oxygen into the water and from plants as a result of photosynthesis. Vertical mixing of the water, aided by winds, distributes the oxygen within the lake. Oxygen is measured in its dissolved form as dissolved oxygen (DO). If more oxygen is consumed than is produced, dissolved oxygen levels decline and some sensitive organisms may migrate away, become stressed, or die. DO levels fluctuate seasonally and over a 24-hour time period. They also vary with water temperature and altitude. Cold water holds more oxygen than warm water.

Surface levels of dissolved oxygen throughout the lake ranged from 4.7 mg/L in June to 8.4 mg/L in July. Site 1 had the highest average level of DO at 7 mg/L followed by Site 2 at 6.8 mg/L and Site 3 at 6.4 mg/L. Mid-lake levels of DO throughout the lake ranged from 4.3 mg/L in June to 8.3 mg/L in July. There was a lower level of DO recorded during the July 24 sampling event although we believe this recording to be erroneous and therefore was not used for analysis. Site 3 had the highest average level of DO at 6.9 mg/L followed by Site 1 at 6.7 mg/L and Site 2 at 6.2 mg/L. Bottom levels of DO throughout the lake ranged from 2.2 mg/L in June to 8.2 mg/L recorded in both May and August. Site 3 had the highest average level of DO at 6.3 mg/L followed by Site 1 at 5.2 mg/L and Site 2 at 4.8 mg/L. Surface and mid lake levels during all sampling events exceeded the State Water Quality Standards for DO which is 4 mg/L.
Summary

The interrelationship between water temperature and dissolved oxygen is important in determining whether or not a lake is functioning within the normal range of acceptable levels. Based on the data collected, Lake Carasaljo exhibits a typical seasonal thermocline developing between our mid-depth and bottom water samples. This is evident from the dramatic temperature differences seen from June 12th and throughout the summer. In fact, a 4-6 degree difference existed between these layers. The implication of this thermocline is the possibility of limited mixing of water between these layers. As such, the diffusive interaction of the lake and the atmosphere is most likely limited to the surficial water layer and minimal exchange of dissolved oxygen from the atmosphere can get through the thermocline. As a result
of the thermocline, the mid and surface waters of Lake Carasaljo exhibit dissolved oxygen concentrations above the state's threshold levels. However, dissolved oxygen minimums occur just before dawn when organismsal respiration has occurred for the greatest length of time. Consequently, oxygen minima at this critical hour may in fact be below the State's threshold. Without continuous water quality assessment on the site, these minima are often difficult to detect. However, the substantial dip in dissolved oxygen seen in the bottom waters reflect the lack of mixing with surficial waters and is an issue of concern. If these minimal values were to last for a sufficient time frame, they could cause large-scale hypoxia and potentially fish kills might occur. However, based on the presented data, Lake Carasaljo exhibits typical temperature and dissolved oxygen traits for a lake which is undergoing eutrophication. In general, care must be taken to ensure that significant hypoxia does not occur and disrupt the living organisms in the lake.

3.3.3 Alkalinity and pH

Alkalinity is a measure of the capacity of water to neutralize acids. Without this acid-neutralizing capacity, significant changes in pH may occur due to the addition of acidified water. According to the EPA's Volunteer Lake Monitoring Manual, measuring alkalinity is important in determining a lake's ability to neutralize acidic pollution from rainfall or wastewater. Lakes with low alkalinity are generally not well buffered and as a result, are often adversely affected by acid inputs. After a short time, their pH levels will drop to a point that eliminates acid-intolerant forms of aquatic life. Alkalinity is influenced by rocks and soils, salts, certain plant activities, and certain industrial wastewater discharges.

Surface levels of alkalinity ranged from 2 mg/L in May and June to 24 mg/L in July. Site 1 had the highest average alkalinity at 9.9 mg/L followed by Site 3 at 9.7 mg/L and Site 2 at 8.9 mg/L. Mid lake alkalinity ranged from 2 mg/L in June to 20 mg/L in July. Site 1 had the highest average alkalinity at 12.5 mg/L followed by Site 3 at 9.7 mg/L and Site 2 at 7.7 mg/L. Bottom alkalinity ranged from 2 mg/L in June to 22 mg/L in July. Site 2 had the highest average alkalinity at 11.7 mg/L followed by Site 3 at 7.7 mg/L and Site 1 at 7.4 mg/L.
Figure 3.21: Surface Alkalinity Data

Figure 3.22: Mid-Depth Alkalinity Data

Figure 3.23: Lake Bottom Alkalinity Data
Quantification of the acidic or basic nature of a water body is generally categorized as pH. pH values range from 0-14, with 7 being neutral, and is the characteristic value of pure water. pH values relate to the concentration of hydrogen ions present in the water. pH affects many chemical and biological processes in the water. The EPA's Volunteer Lake Monitoring Manual mentions that the largest varieties of aquatic animals prefer a range of 6.5-8.0. pH outside this range reduces the diversity in the water body because it stresses the physiological systems of most organisms and can reduce reproduction. Low pH can also allow toxic elements and compounds to become mobile and "available" for uptake by aquatic plants and animals. This can produce conditions that are toxic to aquatic life, particularly to sensitive species. Changes in acidity can be caused by atmospheric deposition (acid rain), surrounding rock, and certain wastewater discharges.

Surface pH readings ranged from 4.69 in May to 8.84 in August. Mid-lake pH readings ranged from 5.82 in May to 8.29 in August. Bottom pH readings ranged from 5.56 in June to 7.85 in August. The acceptable range of pH readings, according to the Surface Water Quality Standards, is 6.5 to 8.5. Unacceptable pH readings were more commonly observed during the May 29, June 11 and June 27 monitoring events.
Characteristic data of pH and alkalinity were gathered and suggest a moderately buffered system, especially during the end of the summer. The increase in both alkalinity and pH is most likely the result of substantial photosynthesis occurring in the lake during this time frame. This results from excess carbon dioxide being taken up by the plants during photosynthesis and subsequently, driving the equilibrium to a more basic state. This is a natural condition for fresh water lakes which undergo high rates of photosynthesis during the summer. However, pH values were below the State Water Quality Standards early in the spring and may reflect problems associated with acidified rainfall, storm-water runoff and other potential non-point sources. It also may reflect a generalized low pH or acidic waterbodies characteristic of this geologic region. The low pH readings identified in this study may not be a problem, but potentially a natural condition based on regional geologic features as well as
dominant regional vegetation. Low pH may become problematic if significant reductions occur in the future and may impact the flora and fauna residing in Lake Caralsaljo.

3.3.4 Turbidity

Turbidity is a measure of water clarity, how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. The EPA’s Volunteer Lake Monitoring Manual explains that higher turbidity increases water temperatures because suspended particles absorb more heat. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the lake bottom and smother benthic macroinvertebrates. Sources of turbidity include soil erosion, waste discharge, urban runoff, eroding stream banks, and excessive algal growth.

Turbidity at Site 1 ranged from 20.47 NTU in August to 457.6 NTU in October. Turbidity at Site 2 ranged from 39.37 NTU in July to 436.6 NTU in October. At Site 3 turbidity readings ranged from 27.23 during July to 301.5 in October. The Surface Water Quality Standard for turbidity is 50 NTU. All of the sites during the September and October monitoring events exceeded the Surface Water Quality Standard. Site 3 exceeded the Surface Water Quality Standard during all monitoring events except the July event.

![Surface Turbidity Data](image)

Figure 3.27: Surface Turbidity Data

Summary

Results from the turbidity data suggest a major problem with excess turbidity within the water. There are several likely sources including run-off induced turbidity from particulate material, but also phytoplankton can cause elevated turbidity. Given that
the chlorophyll \( a \) concentrations peak in late August (see Figure 3.36), the elevated turbidity seen during September through October may be related to erosion and suspended particles brought in through storm water run-off.

### 3.3.5 Phosphorus

Both phosphorus and nitrogen are essential nutrients for the plants and animals that make up the aquatic food web. Since phosphorus is the nutrient in short supply in most fresh waters, even a modest increase in phosphorus can, under the right conditions, set off a chain of undesirable events in a stream including accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals according to the EPA's Volunteer Lake Monitoring Manual. There are many sources of phosphorus, both natural and human including soil and rocks, wastewater treatment plants, runoff from fertilized lawns and cropland, failing septic systems, disturbed land areas, and drained wetlands.

The Surface Water Quality Standard for phosphorus is 0.05 mg/L. Surface phosphorus levels ranged from 0.04 mg/L in most monitoring events to 0.1 mg/L in August. Site 3 had the lowest average phosphorus readings at 0.038 mg/L. Mid-lake phosphorus levels ranged from 0.04 mg/L in most events to 0.1 mg/L at all three sites in August. Average bottom phosphorus levels were significantly higher at all three sites than surface and mid-lake average readings. All three sites average bottom phosphorus levels were over the Surface Water Quality Standard of 0.05 mg/L.

![SURFACE PHOSPHORUS](image)

Figure 3.28: Surface Phosphorus Data
Summary

Surface and mid-water samples show very low concentrations of phosphorous, although they were above the State water quality standards. These concentration patterns were significantly different when compared to the bottom phosphorous concentrations. The bottom concentrations substantially exceeded the states water quality standards during the late spring and late summer (Figure 3.30). The late summer peak in phosphorous is most likely due to internal nutrient recycling following the summer plant production. The late spring peak for sites one and three may have several potential causes. It may be due to internal nutrient cycling following the development of water stratification between the bottom and surface/mid water layers.
3.3.6 Nitrogen

Nitrogen is an essential element necessary for life on the planet. Nitrogen is a primary component of all proteins in living organisms and is considered to be one of the two primary limiting nutrients for plants (phosphorus being the other). Nitrogen occurs in several forms including ammonia (NH₃), nitrates (NO₃), and nitrites (NO₂). In general, nitrogen’s most abundant form (N₂) is not biologically available. Nitrogen must be converted to one of the biologically available forms before it is readily available to organisms in the community. This can be done naturally by nitrogen fixing bacteria, but a great proportion of nitrogen now comes from anthropogenic sources. These sources include wastewater treatment facilities and septic systems, excess fertilizers placed on land and transported as run-off and also as a by-product of combustion engines producing various NOx chemicals, which get into aquatic habitats via rainfall and atmospheric deposition.

Nitrogen is an essential plant nutrient, but in excess amounts it can cause significant water quality problems. Together with phosphorus, ammonia, nitrates, and nitrites in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in an aquatic habitat.

Nitrate

Surface, mid, and bottom nitrate levels at all three sites for all sampling events except the June 11 (1.2 mg/L) and August 27 (1.1 mg/L) sampling events were 1.0 mg/L, which is the minimum detected level for the analyses conducted. As such, nitrates were at extremely low levels in the lake. This was true for all samples except for a single spike in nitrate concentration recorded during the July 24 sampling event (8.2 mg/L) at site One. Given this unusual spike relative to all other samples, we are suspect of this data point and believe that there may have been contamination in the sample. Future water quality measurements can resolve the potential nitrate spike.

![Surface Nitrate Data](image-url)
Surface nitrite levels at all three sites for all sampling events were 0.01 mg/L (minimum detectable level). Samples collected from the mid-depth and the bottom of the water column showed some variation in their concentration values. Specifically Mid-lake nitrite levels were at minimum detectable levels (0.01 mg/L) for all sampling dates except Site 1 during the June 11 sampling event (0.02 mg/L) and Site 3 at the July 24 sampling event (0.04 mg/L). Bottom nitrate levels at all three sites
were at minimum detectable levels (0.01 mg/L) for all sampling dates except Site 2 during the June 11 sampling event (0.02 mg/L).

**Figure 3.34: Surface Nitrite Data**

**Figure 3.35: Mid-Depth Nitrite Data**
Figure 3.36: Lake Bottom Nitrite Data
Summary

Based on the data collected, Lake Carasaljo maintains relatively low concentrations of nitrate and nitrite. These low values indicate that either inputs to the lake are minimal relative to other nutrients, nitrogen is rapidly being assimilated into living plant tissue or significant denitrification is occurring within the system. While denitrification naturally occurs in all environments, the theoretical and measured nitrogen loadings to this system are substantial (Table 3.10) and the majority of these loading sources occur from surface run-off. As nitrogen is rarely the limiting nutrient in freshwater systems, the elevated phosphorous levels in Lake Carasaljo suggest that nitrogen may be limiting and that eutrophication is occurring within the lake. It is important to recognize that ammonia concentration was not measured for the lake. As a component of both fertilizer and animal waste (urea), ammonia concentrations may play an important role in nitrogen dynamics and cycling in Lake Carasaljo.

3.3.7 Chlorophyll $a$

Chlorophyll $a$ is the green photosynthetic pigment found in the cells of all algae. Extracted from the algal cells present in the water, chlorophyll $a$ is a reliable indicator of algal quantity. The amount of chlorophyll $a$ found in living cells varies among algal species. Therefore, two lakes can have identical densities of algae yet have significantly different concentrations of chlorophyll $a$ because they are dominated by different species. Even within a single lake comparison is further complicated by the fact that the amount of chlorophyll $a$ in an algal cell varies with light conditions. Healthy algal cells constantly try to maintain chlorophyll concentrations at a level for maximum photosynthetic efficiency. Chlorophyll in a cell usually decreases during high light conditions and increases during low light conditions. Similarly, a cell that is sinking down into the water column (away from the sun) may also produce more chlorophyll to compensate for the lower light levels found at greater depths.

According to the EPA’s Volunteer Lake Monitoring Manual, chlorophyll $a$ should not be used alone, but when measured together with total phosphorus and secchi disk transparency, chlorophyll $a$ can provide valuable information about the relationship between water fertility and algal growth.
Summary

Site 1 chlorophyll $a$ levels range from 0.007 ug/L in June to 3.675 ug/L in August. Site 2 levels range from 0.007 ug/L in June to 2.282 ug/L in August. Site 3 levels range from 0.008 ug/L in June to 2.239 in July. Chlorophyll $a$ levels were highest at Site 1. These results suggest that phytoplankton bloom conditions existed during the late summer and early fall in Lake Carasaljo. Because our sampling began during June, we most likely missed the typical spring phytoplankton blooms which generally occurs somewhere between April and June in temperate regions of the globe. The phytoplankton bloom observed in the late summer may likely be the result of phosphorous recycling during this time frame. Water analysis of phosphorous showed increasing concentrations during August (Figures 2.28 through 3.30), which could provide the necessary nutrients for initiation of a phytoplankton bloom.

3.3.8 Fecal Coliform

A wide variety of disease-causing organisms can be transmitted to humans at bathing beaches. Sources of these pathogens include failing septic systems, sewage, runoff from animal or waterfowl, and even swimmers themselves. As a measure of public health and safety, local agencies test and monitor beaches periodically during the swimming season for the presence of one or more indicator organisms. The EPA’s Volunteer Lake Monitoring Manual explains that the indicator organisms most often used to indicate sanitary conditions at bathing beaches are fecal coliform bacteria and enterococcus bacteria. Coliforms belong to the enteric bacteria group, Enterobacteriaceae, which consists of various species found in the environment and in the intestinal tract of warm-blooded animals. Fecal coliforms are the part of the coliform group that is derived from the feces of warm-blooded animals.
The Surface Water Quality Standards state that for all FW2 water bodies, fecal coliform levels shall not exceed a geometric average of 200 colonies/100ml. The Ocean County Health Department's fecal coliform sampling took place at three locations during 2003: Route 9, North Beach and South Beach. Sampling at the Route 9 location took place during 8 of the 35 sampling events. The fecal coliform levels identified at the Route 9 location ranged from 120 colonies/100ml during the June 25 sampling event to 4,200 colonies/100ml during the July 2 sampling event. The average fecal coliform level is 1,718.25 colonies/100ml. Sampling at the North Beach location took place during 29 of the 35 sampling events. The fecal coliform levels identified at the North Beach location ranged from 10 colonies/100ml during the June 3 sampling event to 1,783 colonies/100ml during the July 22 sampling event. The average fecal coliform level at North Beach during 2003 is 542.48 colonies/100ml. Sampling at the South Beach location took place during 22 of the 35 sampling events. The fecal coliform levels identified at the South Beach location ranged from 40 colonies/100ml during the June 3 sampling event to 4,000 colonies/100ml during the June 18 sampling event. The average fecal coliform level at South Beach during 2003 is 790.9 colonies/100ml.

Summary

Results from these samples indicate that during the summer of 2003, fecal coliform levels exceeded the State Water Quality Standards on most dates. As such, the beaches were closed for human swimming and recreation. Results of the theoretical pollutant load analysis conducted under preceding sections identify stormwater runoff (7.86 E+09 billion colonies/year) and waterfowl (2.05E+05 billions of colonies/year) as the primary sources for fecal coliform contributions to the lake. Please refer to Sections 2.2.3 through 3.2.14 and Appendices C and D of this report for detailed discussions regarding the methodologies and results of the pollutant load analysis.
3.3.9 Macrophyte Survey

As Lake Carasaljo has had a known history of extensive aquatic plant growth, as part of the diagnostic portion of this study a macrophyte survey was conducted to identify species of concern and to quantify the extent of aquatic plant coverage. The macrophyte survey was conducted during late summer (August 28 and 29, 2003) to correlate the sampling events with a time period where plant growth is most extensive. As part of the sampling plan, nineteen sampling sites were established within the lake. Using a 1m$^2$ grid, which was divided into sixteen 25cm by 25cm squares, the percent surface cover of aquatic vegetation was determined for each sampling site. Percent coverage was determined by dividing the number of squares with vegetation present by total squares of the grid. Species present were then identified and were recorded. Aquatic plant species identified during the survey include the following: fanwort (Cabomba caroliniana), pondweed (Potamogenton sp.), purple loosestrife (Lythrum salicaria), tape grass (Vallisneria americana), Eurasian watermilfoil (Myriophyllum spicatum) and waterlily (Nymphaea sp.).

The following table identifies percent cover at each of the nineteen sites:

<table>
<thead>
<tr>
<th>Site Number</th>
<th>% Surface Cover</th>
<th>Species Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>56.25</td>
<td>Fanwort, Pond Weed, Purple Loosestrife</td>
</tr>
<tr>
<td>2</td>
<td>18.75</td>
<td>Fanwort</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>Fanwort, Tape grass</td>
</tr>
<tr>
<td>4</td>
<td>6.25</td>
<td>Fanwort, Tape grass</td>
</tr>
<tr>
<td>5</td>
<td>37.5</td>
<td>Fanwort</td>
</tr>
<tr>
<td>6</td>
<td>37.5</td>
<td>Fanwort, Milfoil</td>
</tr>
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<td>15</td>
<td>12.5</td>
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<tr>
<td>16</td>
<td>0</td>
<td>Green algae below surface</td>
</tr>
<tr>
<td>17</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>18</td>
<td>37.5</td>
<td>Fanwort</td>
</tr>
<tr>
<td>19</td>
<td>0</td>
<td>--</td>
</tr>
</tbody>
</table>
It should be noted that as you travel east along the lake, water depths increase. For example, site 1 had a water depth of approximately 1' where site 19 was approximately 6' deep. This could be one of the determining factors in percent coverage since vegetation growth depends on sunlight. As the water depths increase the amount of sunlight decreases. Therefore, as the water depths increase the percent of surface cover by macrophytes also decreases. A total lake coverage assessment, based on observations and the results of the 19 surveyed locations, reveals that approximately 75 to 80 percent of the lake bottom is vegetated by varied combinations of the identified species.

3.3.10 Trophic State Index

The trophic state of a waterbody refers to a lake’s productivity or total weight of living biological material (biomass). For the purpose of defining a lake’s trophic state, a classification system as determined in terms of water clarity, algal biomass and phosphorus concentration is often used. Typically three trophic identifiers are used to classify a lake’s trophic state: oligotrophic, mesotrophic and eutrophic, although modifiers such as hyper- or ultra- oligotrophic and eutrophic are also commonly used. The term oligotrophic is applied to waterbodies where overall productivity and concentrations of phosphorus and nitrogen are low. Oligotrophic waterbodies typically have limited plant growth and highly transparent waters. The term mesotrophic is applied to waterbodies with moderate levels of productivity and nutrients. Mesotrophic waterbodies typically exhibit moderate levels of plant growth and water clarity. The term eutrophic is applied to waterbodies with high productivity and nutrient levels and typically exhibit extensive plant growth and limited water clarity.

A frequently used method for determining a lake’s trophic state is the trophic state index (TSI) of Carlson (1977). The Carlson index uses algal biomass as the basis for trophic state classification through independent analysis of three variables: chlorophyll $a$, total phosphorus and Secchi depth. Carlson provides a numerical index for each variable on a scale of approximately 0 to 100. Table 3.12, below, identifies the general TSI limits to trophic state classification.

<table>
<thead>
<tr>
<th>Trophic State</th>
<th>TSI Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra-Oligotrophy</td>
<td>&lt; 20</td>
</tr>
<tr>
<td>Oligotrophy</td>
<td>20 – 40</td>
</tr>
<tr>
<td>Mesotrophy</td>
<td>40 – 50</td>
</tr>
<tr>
<td>Eutrophy</td>
<td>50 – 70</td>
</tr>
<tr>
<td>Hypereutrophy</td>
<td>&gt; 70</td>
</tr>
</tbody>
</table>

Evaluation of water quality data obtained under the Lake Carasaljo sampling program indicates that the lake would be classified as eutrophic using the Carlson TSI. Chlorophyll $a$ is often considered to be the priority variable for assessing the trophic
I state of a lake because it is the most accurate at predicting algal biomass. However, the TSI does not account for macrophyte biomass and Carlson suggests that total phosphorus may be a more accurate variable for summer sampling. Therefore, as Lake Carasaljo is a macrophyte dominated system rather than an algal dominated system and as a majority of the sampling was conducted during summer months, phosphorus may be the more appropriate variable for assessing the trophic state of Lake Carasaljo. As presented under Section 3.3.5, concentrations of total phosphorus within the lake typically ranged between 0.04 mg/l and 0.09 mg/l (refer to Figures 3.28 thru 3.30), which translate to TSI values within the 50 to 70 eutrophic range. Secchi depths recorded during the sampling program typically ranged between 0.5m and 1.0m, which also translates to TSI values within the 50 to 70 eutrophic range. Interestingly, Chlorophyll a data obtained under the sampling program ranged between 0.007 ug/L in June to 3.675 ug/L in August (refer to Figure 3.37), which indicates a low overall algal biomass and translates to TSI values within the oligotrophy and mesotrophy range. Our interpretation of these combined data sets is that Lake Carasaljo is a nutrient rich, macrophyte dominated system in a eutrophic state. While chlorophyll a concentrations were generally low, the elevated nutrient concentrations and the relatively high spatial coverage of macrophytes indicates a lake undergoing eutrophy.

3.3.11 Bio-Chemical Limnological Assessment Summary

Based on the data collected during this project, a few generalizations can be made regarding the Lake’s current state. Lake Carasaljo exhibits characteristics of a typical temperate lake undergoing eutrophication. This is evident from the relative concentrations of nutrients such as phosphorous and nitrogen, but also reflects the abundance of submerged aquatic vegetation and chlorophyll a. Lake Carasaljo also shows typical water column stratification, but essentially only two layers exist. A surface layer of warmer water covers a deeper layer of cooler water. This single stratification is likely the result of the shallow nature of the lake. This stratification of the lake is most likely responsible for the low oxygen values encountered in the bottom (Figure 3.20). Without substantial mixing between these two layers, oxygen diffusion to deeper parts of the lake are minimal and can allow these bottom waters to go hypoxic. The only way to assess this potential would be to set up continuous monitoring of bottom dissolved oxygen concentration and determine whether the deep portions of the lake undergo night-time hypoxia. The alkalinity and pH of the lake suggest that it is reasonably buffered. However, pH values observed in the surface and mid-water samples (both part of the overall surface layer of the lake) had elevated pH values most likely due to high level of photosynthesis by both phytoplankton and submerged aquatic vegetation during the summer. The high level of photosynthesis disrupts the buffering capacity of freshwater systems by active uptake of CO₂ and HCO₃⁻ by the plants and altering water pH.

Based on the very low concentrations of phosphorous levels present in Lake Carasaljo, and the relatively high concentrations of nitrogen sources, phosphorous is most likely the limiting nutrient. As such, it would be rapidly assimilated by both
phytoplankton species (Figure 3.37) and by the dense submerged aquatic vegetation. However, the substantial loading values calculated and observed during the pollutant load assessment, suggests that significant phosphorous is entering the lake from storm water run-off. As a result, reductions in phosphorous loadings to the watershed could improve water quality in the lake and reduce the substantial submerged aquatic vegetation in the lake.
4.0 Feasibility Study

The feasibility portion of this study defines and evaluates various “in-lake” restoration/management options and appropriate watershed best management practices. The purpose of this evaluation is to determine which methods and practices could be most applicable and beneficial to actual lake conditions in order to assist in the prioritization of future lake restoration and protection efforts. As one reads the following subsections, it is important to note that as analysis completed under the diagnostic portion of the study found that the primary sources of water quality impairments are from external sources (i.e. stormwater run-off and waterfowl). As a result, emphasis of restoration and protection efforts favor Watershed Management Practices that address the external sources of the pollutants rather than “In-lake” Restoration Methods, which primarily address the lake’s response to the pollutants.

4.1 Evaluation of In-lake Restoration Methods

The following subsections provide a description and evaluation of available “in-lake” restoration/management options that are conducted at or below the lake surface for the purpose of restoring and protecting the lake system.

4.1.1 Dredging

The removal of accumulated sediment through the performance of dredging activities can restore shallow lakes to the original depths. Dredging can be used for removing sediment laden with toxic substances, increasing the depth of the lake and therefore limiting the potential for macrophyte habitat, and removing large quantities of nutrients.

Relative to other impacted lakes, Lake Carasaljo is not particularly shallow and based upon land use evaluation, the lake’s contaminants of concern (phosphorous, fecal coliform) are believed to be primarily generated from external sources and delivered via stormwater. Internal loading via resuspension of sediment is not believed to be a significant source of these pollutants.

It is believed that dredging of the lake’s western portions would be beneficial from an ecological and recreational perspective; however, the dredging would not address the root cause of the observed lake water quality impairments because it would not reduce the source input of pollutants. Further, dredging is typically one of the most costly lake management options to implement. Factors contributing to the high cost include limited dredge disposal options, dredge transportation costs, tipping fees, and specialty contractor costs. Regulatory approval can also be difficult, depending upon impacts to existing habitats.
Recommendation

Dredging of Lake Carasaljo is not currently a recommended alternative due to the high costs and anticipated marginal benefits to water quality. Dredging should be considered in the future if shoaling of the western portions of the Lake progresses to a point where lake stratification is significantly reduced.

4.1.2 Winter Drawdown and Sediment Consolidation

The practice of winter drawdown involves reducing water levels within a lake or pond to a predetermined level that would expose a certain percentage of the lake bottom. This practice is useful in controlling aquatic nuisance plants and is an inexpensive method if an appropriate water control device is present. Exposure to dry or freezing conditions for a specific time can cause aquatic macrophyte die off. However, if a drawdown does not occur on a regular basis plants may reestablish within the lake. Drawdowns can also have significant impacts to fish and aquatic wildlife by exposing sediments and reducing lake volume.

Recommendation

The Township of Lakewood has performed winter drawdowns on Lake Carasaljo for the past 10 years to control macrophyte populations. The lake is lowered 5' for 48 hours after which the lake remains lowered only 3'. Generally the lake drawdown occurs the first week of January until the first good frost, after which the lake is raised to its preexisting elevation. Although the practice of winter drawdown has not proven to be a solely adequate control for nuisance aquatics, the practice has proved to be an inexpensive alternative that the Township can conduct through existing resources. It is suspected that the winter drawdown activities do assist in the control nuisance aquatics and that coverage would be more extensive without the implementation of the annual winter drawdown. Therefore, it is recommended that the Township of Lakewood continue the annual winter drawdown activities until such time that it is determined that the extent of nuisance aquatics is reduced to an acceptable level.

4.1.3 Artificial Circulation

Artificial circulation, or destratification, increases a lake’s oxygen content by exposing more of it to the atmosphere. Destratification includes air injection and mechanical mixing devices. The use of pumps, bubbled air or jets destratifies the lake and increases water temperatures. Artificial circulation can reduce phosphorus loading and decrease algal biomass. Costs are variable depending on equipment costs and power rates.

Recommendation

While increasing oxygen content of the water column is a desirable outcome, artificial circulation may have serious consequences. Lake Carasaljo exhibits typical
stratification with a well-oxygenated surface layer and a deeper less oxygenated layer. This deep layer, however, is currently not exhibiting anoxic or hypoxic conditions (refer to Figure 3.20). As such, there is no need to increase the deep circulation of the lake for this purpose. Additionally, by circulating this deep layer, the stored nutrients within the layer and those accumulating in the sediments of the lake during the summer, will become biologically available to the plants in the upper portion of the lake. This is extremely important given the results of the phosphorous concentration monitoring. Data showed that as the summer progressed, phosphorous concentrations increased in the deeper portions of the lake (refer to Figures 2.28 thru 3.30). The release of this phosphorous into the surface waters through artificial circulation may cause unwanted results. In fact, the release of these nutrients may cause and increase in nuisance algal blooms (e.g., cyanobacteria) and aquatic weed production during the summer. As such, minimizing this internal nutrient cycling into surface waters (i.e., no artificial circulation) is recommended at this time. If conditions in the lake worsen and the deeper portions of the lake undergo frequent or persistent hypoxia, then artificial circulation may be a useful tool for reducing oxygen stress for the organisms in the lake.

4.1.4 Macrophyte Harvesting

Removing macrophytes from a lake can reduce the internal productivity of the lake by removing phosphorus that is stored in the plants. Macrophyte harvesting involves use of a machine that cuts the plants underwater and carries the cut macrophytes to the surface for collection. This method provides instant visual results however plants will grow back and may need to be harvested several times during the growing season.

Recommendation

Mechanical macrophyte harvesting is not a recommendable option for the following reasons: an adequate level of control would require multiple harvests per year; a large quantity of plant material would be generated during each harvesting creating significant disposal issues; contract services for mechanical harvesting would be a considerable expense that would outweigh the benefits; and, one of the dominant aquatic plants within the lake is watermilfoil, which can become re-established via plant fragments and roots that are not completely extracted from the lake during harvesting potentially exacerbating the problem.

4.1.5 Biological Controls

The introduction of certain fish, insects or plant pathogens has been used as a method for controlling targeted macrophytes. This method is used not for species elimination but to establish an acceptable plant biomass. Currently, the only approved biological control agent approved by the State of New Jersey is Triploid grass carp (Ctenopharyngodon idella), for which a permit for release can be obtained under certain conditions. Triploid grass carp, or white amur, can effectively control
nuisance aquatic vegetation in lakes. The use of grass carp for aquatic weed control can be advantageous since it is a low cost alternative that can provide long-term results (although periodic stocking is required). Grass carp cannot be used to control all aquatic plants as they have a preference for specific species of plants. Grass carp do not prefer such species as filamentous algae, cattail (Typha sp.), bulrush (Scirpus sp.), arrowhead (Sagittaria sp.), watershield (Brasenia sp.) or waterlily (Nymphaea sp.). Species preferred by grass carp include pondweeds (Potamogentos sp.), American Elodea (Elodea Canadensis), coontail (Ceratophyllum demersum), naiads (Najas sp.), muskgrass (Chara sp.), watermilfoil (Myriophyllum sp.), and water starwort (Callitriche sp.). Studies show that it may take approximately 2 to 5 years for the stocked carp to control the nuisance species.

Recommendation

The macrophyte survey conducted under the diagnostic study portion of this project documented extensive coverage by the nuisance aquatic plant fanwort. Although fanwort is not listed as a preferred species on most lists, grass carp can still be used as a control for this plant species. However, State permitting requirements for the use of grass carp as a biological control agent limit release to waterbodies less than 10-acres in size. Therefore, the use of grass carp as a biological control for Lake Carasaljo cannot be recommended.

4.1.6 Chemical Treatment

Various herbicides can be used to control aquatic vegetation. These herbicides are sprayed directly onto aquatic plants or applied to the water in a liquid or pellet form. There are many herbicides on the market including Rodeo®, Sonar®, AVAST!®, AquaKleen®, Aquathol® and Reward®. Aquatic herbicides are easily applied and are relatively less expensive than other lake management methods, such as dredging or harvesting. However, many herbicides may control or kill non-targeted plants and may require several applications before the control or killing of treated plants takes place.

As part of this study, an on-site meeting with a State certified aquatic herbicide applicator (Allied Biological) was held to discuss the feasibility and potential cost of chemical treatment for Lake Carasaljo. In summary, it was determined that due to the lake’s low hydraulic residence time, control of nuisance aquatics would require an aggressive treatment plan using the herbicide AVAST!®, applied at a rate between 50 and 75 parts per billion (ppb). This chemical treatment plan would target Eurasian watermilfoil (Myriophyllum spicatum) and fanwort (Cabomba caroliniana) both of which are non-native species that inhibit more desirable native plant growth and present safety concerns to swimmers and boaters.
Recommendation

The control of nuisance aquatics via a chemical treatment plan would be desirable to improve both the ecological value (i.e. habitat quality) and recreational use (i.e. swimming and boating) of the lake. Control of the non-native nuisance aquatics would allow the opportunity for the growth of native species that provide a more suitable fisheries habitat. The chemical treatment plan would also assist in controlling the extent coverage of aquatic plant growth, which is currently so severe that it impacts swimming and boating activities. However, it is important to realize that chemical treatment will only address the result of existing water quality impairments (extensive aquatic plant growth) and will not address the source of the impairments (elevated nutrient levels). Therefore, any efforts to control aquatic plant growth should also include external lake management activities discussed under Section 4.2 of this report.

4.2 Evaluation of Watershed Management Practices

The following subsections provide a description and evaluation of practical watershed management practices that have been developed to address upland sources of pollutants that are ultimately discharged into a lake system.

4.2.1 Land Use Management Techniques

A critical component of lake management efforts is proper management of land uses within the watershed. Methods commonly available for managing land uses include such techniques as master planning that includes low impact development strategies, ordinance development, erosion and sediment control enforcement, open space preservation, development and implementation of watershed restoration and protection plans as well as development and implementation of stormwater management plans.

During the completion of this study, the State of New Jersey adopted more stringent stormwater management regulations. The State Stormwater Management Rule (N.J.A.C. 7:8) and Municipal Stormwater Regulation Program (N.J.A.C. 7:14A) regulate both government and private sectors. Although the regulations require municipalities to use land use management techniques to address water quality, adequate protection and restoration of water quality within Lake Carasaljo will require Townships within the watershed to exceed State requirements.

Recommendation

As discussed under Section 3 of this report, the Lake Carasaljo watershed can be divided into “primary” and “secondary” subwatersheds. As previously stated, the primary subwatershed includes densely developed land areas immediately surrounding the lake, while the secondary subwatershed is significantly less developed and includes large areas of undeveloped land. Therefore, as the land uses
within the primary and secondary subwatersheds are very different, land use management techniques employed within the two subwatersheds require different approaches.

As land areas within the primary subwatershed were largely developed prior to the development of modern stormwater management practices, large quantities of stormwater are discharged into the lake without pretreatment. In addition, the diagnostic study portion of this project identified stormwater run-off as a primary source of pollutant loading to the lake. Therefore, land use management strategies within the primary subwatershed should focus on techniques that address the quality of stormwater. Such techniques that can be readily employed by municipalities include: adherence of State guidance for roadway de-icing, implementation of an aggressive street sweeping program conducted in accordance with NJDEP’s Guidance Document for the Management of Street Sweepings and Other Road Cleanup Materials (2004); judicial use of pesticides and fertilizers on publicly owned lands (i.e. athletic fields); adoption of ordinances along with other related structural and non-structural methods discussed under Sections 4.2.2 and 4.2.3. Additional ordinances, beyond those, which are required under the State Municipal Stormwater Regulation Program, include: stream corridor protection ordinances, stormwater management ordinances, tree protection ordinances and erosion control ordinances. To assist planners and municipal officials in implementing such ordinances, samples of the above ordinances are included as Appendix G of this report.

Land areas within the secondary subwatershed are significantly less developed and include vast tracts of undeveloped open space. However, population projections indicate that this area will continue to experience increasing trends in population growth. As such, land use management techniques within these areas should focus on open space preservation and environmentally sensitive master planning that utilizes low impact development strategies that minimize potential water quality impairments from future growth. It is recommended that the municipalities within the watershed implement a coordinated open space acquisition plan that seeks to preserve undeveloped land to form a contiguous open space corridor along the South Branch Metedeconk and its tributaries in order to preserve a natural buffer to the lake’s feeder streams. It is also recommended that municipalities within the watershed incorporate low impact development strategies into their existing municipal master plans to the maximum extent feasible.

4.2.2 Structural Stormwater Management Techniques

Structural stormwater management techniques consist of stormwater pre-treatment facilities that have been developed to reduce pollutant loadings and/or promote the infiltration of stormwater run-off. The State of New Jersey has developed a document entitled New Jersey Stormwater Best Management Practices Manual (2004), which outlines design criteria and site considerations for the employment of various structural options. These options include: bioretention systems, constructed stormwater wetlands, dry wells, extended detention basins, infiltration basins,
manufactured treatment devices, pervious paving systems, sand filters, vegetative filters and wet ponds.

Recommendation

As the pollutant source assessment conducted under the diagnostic phase of this project (Section 3.2) identified stormwater run-off as the primary contributor of pollutants to the lake, the use of structural stormwater management techniques is strongly recommended. Employment of the techniques within the lake's primary subwatershed is of particular importance as this portion of the watershed had been densely developed with a mix of residential and commercial land uses prior to the development of modern stormwater practices. As such, large quantities of stormwater run-off are collected and discharged into the lake without any form of pretreatment. A shoreline survey of the lake identified a total of thirty (30) outfalls that discharge directly to the lake and an additional eight (8) outfalls that discharge to the wetlands and the feeder stream immediately upstream of the lake. The stormwater pollutant loading analysis also found a disparity between theoretical and measured N:P ratios that suggested that actual phosphorus loading exceeds what would be expected based upon theoretical land use loading values. As such, additional emphasis should be placed on structural facilities that are most efficient at phosphorus removal.

Table 4-2 of the State stormwater BMP manual provides information regarding estimated nutrient removal rates by facility type. This table attributes bioretention basins, infiltration basins and pervious paving as being the most efficient methods for phosphorus removal. However, this table does not provide estimated reduction rates for manufactured treatment devices as removal rates will differ by manufacturer and results provided by the manufacturers must be independently verified. A limited amount of publicly owned land exists in the primary subwatershed, therefore, opportunities for the installation/construction of structural facilities within this portion of the watershed may be limited. The identification of specific suitable locations, however, should be a priority. Although the State stormwater manual does not provide removal rates for manufactured treatment devices, use of the units to pretreat stormwater at the thirty-eight (38) outfalls that discharge into the lake and immediately upstream of the lake should be emphasized due to the feasibility of their use (the majority of the outfalls are situated within publicly owned park lands, which renders installation and maintenance of the units reasonably practical).

4.2.3 Non-structural Stormwater Management Techniques

Non-structural stormwater management techniques consist of pollution prevention methods developed to reduce pollutant generating activities/practices through regulation and efforts undertaken to adjust human behavior. Such methods include land use management techniques discussed under Section 4.2.1 of this report along with techniques that range between those that can be easily employed to those that are more complex. Easily employed techniques can be conducted by various entities
such as municipal public works departments, environmental commissions or boy/girl scout troops. Such techniques include: storm drain stenciling programs that help residents identify their connection to the water; public education and outreach programs that inform residents within the watershed of how their activities can affect water quality; and, organization of activities that promote watershed stewardship (i.e. stream corridor clean-ups, school poster contests). The more complex techniques consist of long-term programs that are implemented indefinitely such as a watershed restoration and protection plan; regional stormwater management plan; formation of a lake management committee or watershed association tasked with organizing protection and restoration efforts and obtaining and administering grants to fund such activities; and, volunteer water quality monitoring program, which would allow managing entities to continually adjust and prioritize restoration and protection efforts based on the sampling results.

**Recommendation**

Depending on the level of effort provided by volunteers participating in various programs, non-structural stormwater management techniques could be a very cost effective method for addressing water quality. As such, all of the non-structural methods discussed above are recommended for implementation within the Lake Carasaljo watershed and municipalities and local residents within the watershed are urged to participate in the programs. The formation of a lake management committee or watershed association is particularly recommended to organize future efforts with particular emphasis placed on: the implementation of public education and outreach programs to foster public participation; and, the implementation of a volunteer water quality sampling program in order to monitor for any improvements or degradation to water quality.

As the diagnostic phase of this study identified stormwater as a primary source of pollutants to the lake, the development of a regional stormwater management plan is strongly recommended. NJDEP defines a Regional Stormwater Management Plan (RSWMP) as a participatory process that requires the creation of a broadly representative regional planning committee assembled to address stormwater related water quality, groundwater recharge and/or water quantity impacts of new and existing land uses in a regional stormwater management planning area. The goals of a RSWMP are to develop drainage area specific water quality, groundwater recharge, and water quantity objectives; develop drainage area specific design and performance standards; select stormwater measures to be implemented; develop a strategy for implementation and evaluation of measures identified in the plan; and, identify the entity responsible for coordination and tracking the implementation of the measures. A RSWMP may also include innovative stormwater strategies such as pollutant trading, mitigation strategies, or special protection measures like a stream corridor protection plan to address the protection of areas adjacent to waterbodies. Once a RSWMP is completed, each municipality must incorporate the requirements of the RSWMP into their municipal stormwater management plan and ordinances and the lead planning agency submits the plan to NJDEP for adoption under the Water
Quality Management Planning Rules at N.J.A.C. 7:15-3.4 as a request to amend the Areawide Water Quality Management (WQM) plan(s). Once approved, the specific requirements of the plan will then supersede any stormwater management requirements of the Stormwater Management Rules for new development and NJDEP will use the RSWMP for stormwater review under the Coastal Permit Program, Freshwater Wetlands, CAFRA, Stream Encroachment, NJPDES, and Dam Safety and will not issue a permit that conflicts with the RSWMP under the amended Areawide Water Quality Management Plan. In addition, the State Residential Site Improvement Standards, which are the requirements for stormwater review of residential developments, states that stormwater management plans regulated under RSIS must conform to the RSWMP (N.J.A.C. 5:21-7.5(d)4).

4.2.4 Waterfowl Management Practices

Dense populations of resident waterfowl can contribute significantly to in-lake concentrations of nutrients and bacteria through the deposition of feces. The degree of contribution depends on factors such as population density, feeding habits, time of year and dilution capacity of the waterbody. There are various methods available for managing resident populations. These include indirect population control measures such as hazing and habitat alteration and direct population control measures such as removal/relocation, nest removal, harvesting, reproductive control, and egg management (i.e. addling, puncturing).

Recommendation

Waterfowl population counts obtained during the diagnostic phase of this project identified a significant resident waterfowl population at Lake Carasaljo (Section 3.2.9). Calculation of theoretical pollutant loads generated based on the population counts indicate that resident waterfowl do contribute a considerable amount of pollutants to the lake (refer to Table 3.9). Although the theoretical pollutant loadings attributed to resident waterfowl is not as significant as that attributed to stormwater (refer to Figures 3.9 and 3.10), the development and implementation of a waterfowl management program is highly recommended.

It is important to note that a waterfowl management plan developed for the lake should not be limited to the lake itself but rather consist of a community based plan that is implemented on a watershed scale. It is recommended that the developed plan be modeled after the program employed by GeesePeace, a not-for-profit organization that utilizes humane solutions to resolve wildlife conflicts. Their program generally consists of three strategies that work in concert to provide effective, economic and humane solutions to waterfowl issues (particularly, Canada geese). The strategies are:

- Implementation of a population stabilization program that reduces increasing numbers of resident geese on each site as well as geese loyalty to the area.
- Implementation of a nuisance abatement/site aversion program that targets nuisance issues at sites throughout the watershed.
Public education and outreach efforts that inform about impacts associated with the feeding of wildlife.

Population stabilization is a necessary component of successful long-term waterfowl management programs. Population control for Lake Carasaljo should be accomplished via an egg addling program, which requires trained personnel or volunteers and a federal permit. Addling activities should begin in late March and continue until early May and should cover as large an area as possible, including other lakes within the watershed. Population stabilization activities serve three purposes which are critical for a waterfowl management program:

- Slow/reverse population growth at the lake and surrounding areas,
- Reduce loyalty for future nesting and molting, and
- Break biological necessity for adult geese to stay at the lake by eliminating the presence of goslings, which require adult care.

Nuisance abatement/site aversion activities include both harassment and habitat modification measures. Nuisance abatement typically consists of waterfowl harassment using a trained Border collie to drive waterfowl out of a given area and recondition the waterfowl to view the lake as an unsafe, undesirable area. Habitat modification consists of altering preferred shoreline habitat features such as low-cut lawn areas adjacent to open water, which are typical of the park grounds surrounding Lake Carasaljo, with vegetative barriers that are less hospitable. Altering habitat by changing the landscape has proven to be an effective long-term management technique. A vegetative buffer designed in accordance with NJDEP’s draft guidance document entitled: Management of Canada Geese in Suburban Areas: A Guide to the Basics (2001) is strongly recommended. As outlined in the guidance manual, a vegetative buffer with a minimum of a 25 ft. width should be maintained along the entire lake perimeter. The buffer should consist of dense combination of native grasses and shrubs at least 24 inches in height. A sample planting plan and associated planting list is provided as Figure 4.1 and Table 4.1, respectively.
The final component of the recommended waterfowl management plan is the implementation of a public education and outreach program. There appears to be a problem of recreational feeding of waterfowl at the lake. Feeding of waterfowl causes them to congregate in areas resulting in a concentration of fecal droppings, which ultimately get transfer to the lake. As such, it is recommended that information be provided to the community through appropriate signage, via local papers or mass mailers to discourage recreational feeding of geese and ducks.

4.3 Summary of Recommendations

Analysis completed under the diagnostic portion of the study found that the primary sources of water quality impairments are from external sources (i.e. stormwater run-off and waterfowl). As a result, emphasis of restoration and protection efforts favor Watershed Management Practices that address the external sources of the pollutants rather than “In-lake” Restoration Methods, which primarily address the lake’s response to the pollutants.

“In-lake” restoration methods that are recommended under this study are limited to the continuance of winter drawdowns and chemical treatment for the control of nuisance aquatic species. A macrophyte survey conducted under the diagnostic portion of the study documented extensive coverage by nuisance aquatics, which cover approximately 75 to 80 percent of the lake bottom. The control of nuisance aquatics would be desirable to improve water quality (via. reduction in internal phosphorus loading), ecological value (via control of non-native species) and recreational use (i.e. swimming and boating) of the lake. It is important to realize however that control of the nuisance aquatics will only address the result of existing water quality impairments (extensive aquatic plant growth) and will not address the source of the impairments (elevated nutrient levels). Therefore, efforts to control
aquatic plant growth should also be coupled with external watershed management activities.

Under this study numerous watershed management practices have been recommended for implementation in order to address upland sources of pollutants that are ultimately discharged into a lake system. These practices included: land use management techniques, structural and non-structural stormwater management techniques and waterfowl management practices. Based on the findings of this study, two different approaches to land use management are recommended for the watershed: one approach for the lesser developed upper or "secondary" watershed and one approach for the more densely developed "primary" watershed, which immediately surrounds the lake. As stormwater run-off was identified as a primary contributor to water quality impairments, the implementation of structural and non-structural stormwater management techniques are strongly recommended. Various types of structural and non-structural methods that are available for use are discussed in detail under Sections 4.2.2 and 4.2.3 of this report. In addition to stormwater run-off, waterfowl was identified as a significant contributor to water quality impairments within Lake Carasaljo. Waterfowl population counts obtained under the diagnostic phase of this project identified a significant resident waterfowl population at the lake and calculation of theoretical pollutant loads generated based on the population counts indicate that resident waterfowl do contribute a considerable amount of pollutants to the lake. As such, the development and implementation of a waterfowl management program is highly recommended. It is important to note that the recommended waterfowl management plan should not be limited to the lake itself but rather consist of a community based plan that is implemented on a watershed scale in order to effectively manage the population.
APPENDIX A

WATERSHED DELINEATION MAP
APPENDIX B

BATHYMETRIC SURVEY MAP
The water surface elevation at the time of the survey was determined to be 39.16" NAVD 88 datum. All elevations have been reduced by 39.16" creating a Lake Datum.
NOTE: THE WATER SURFACE ELEVATION AT THE TIME OF THE SURVEY WAS DETERMINED TO BE 39.16' (NAVD 88 DATUM). ALL ELEVATIONS HAVE BEEN REDUCED BY 39.16' CREATING A LAKE DATUM.
APPENDIX C

LAND USE CHARACTERIZATION
APPENDIX C

Land Use Characterization

Land use within an urban watershed such as Lake Carasaljo's is typically a dominant physical feature when considering sources of pollutants. This section provides an assessment of the land use of the watershed.

As stormwater flows across a basin and into a lake, it carries pollutants with it. The characteristics of the basins' land is a useful indicator for determining the quality of the attendant lake water and its likely pollutant constituents.

C.1 Impervious Coverage

The most influential land use feature in terms of watershed health is impervious cover. The conversion of farmland, forests, wetlands, and meadows to rooftops, roads, and lawns creates a layer of impervious surface in the urban landscape, which has a profound influence upon the hydrology, morphology, water quality, and ecology of surface waters (Horner et al., 1996). Research has shown that waterbodies in urban watersheds such as Lake Carasaljo possess a fundamentally different character than streams in forested, rural, or even agricultural watersheds. The amount of impervious cover in the watershed can be used as an indicator to predict how severe these differences can be. In many regions of the country, as little as ten percent watershed impervious coverage has been linked to water quality degradation, with the degradation becoming more severe as imperviousness increases (Schueler, 1994).

The primary impact of impervious coverage upon urban waterbodies is a dramatic increase in surface runoff during storm events, with a proportional reduction in groundwater recharge (Schueler, 1994). In natural settings, very little annual rainfall is converted to runoff and about half is infiltrated into the underlying soils and water table. This water is filtered by the soils, supplies deep water aquifers, and helps support adjacent surface waters with clean water during dry periods. In urbanized areas such as the Lake Carasaljo Watershed this phenomenon causes less water to be available to the lake during dry periods and greater flow volumes during storms.

An example of the profound effects that impervious coverage has is illustrated by Maxted and Shaver, 1996. Their research suggests that watershed impervious levels of 10% to 15% result in a loss of about 90% of all sensitive aquatic insects.

The Center for Watershed Protection (CWP) has produced a manual entitled the “Rapid Watershed Planning Handbook” (CWP, 1998). This manual, produced for the USEPA, contains a simple model that defines a relationship between impervious cover and subwatershed quality. Considering a broad range of existing research, the CWP classified urban streams based upon impervious coverage percentage (see Table D.1).
Table C.1 Center for Watershed Protection Simple Impervious Coverage Model

<table>
<thead>
<tr>
<th>Stream Classification</th>
<th>Typical Impervious Coverage</th>
<th>Stream Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitive</td>
<td>0 – 10%</td>
<td>High quality streams typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and insects. Low impervious coverage limits frequency of flooding and other hydrological changes that typically accompany urbanization.</td>
</tr>
<tr>
<td>Impacted</td>
<td>11% - 25%</td>
<td>Obvious signs of degradation, including alteration of stream geometry (erosion and channel widening), unstable stream banks, noticeable habitat degradation, improvement of water quality during dry weather and storm periods, loss of most sensitive fish and aquatic insects.</td>
</tr>
<tr>
<td>Non-Supporting</td>
<td>&gt;25%</td>
<td>Stream essentially becomes a conduit for conveying stormwater flow. Highly unstable stream channel, poor water quality, high bacteria levels, pollution-tolerant fish and insects species, and high nutrient loads.</td>
</tr>
</tbody>
</table>

C.2 Land Use Classifications

Analysis of land use within the Lake Carasaljo Watershed was made manageable by classifying development into six general categories. Each of the categories is representative of both a land use and a typical impervious coverage percentage. The typical impervious coverage percentages were determined through analysis of NJDEP 1997 aerial photography. Several examples of each land use category were analyzed to determine the typical impervious coverage.

Descriptions and examples of each of the categories are presented in Figure C.1. Summary tables of the land use types and total impervious coverage, delineated by drainage area (as defined in Appendix A), are presented in Tables C.2 and C.3.
Figure C.1: Examples of Land Use Classifications within Lake Carasaljo watershed

- Typical Medium/High Density Residential
  - Total Impervious: 35%
  - Road Surface: 15%
  - Other: 20%

- Typical Low Density Residential
  - Total Impervious: 20%
  - Road Surface: 7%
  - Other: 13%

- Typical Forested Open Space Areas
  - Total Impervious: 0%

- Typical Medium Density Residential
  - Total Impervious: 30%
  - Road Surface: 10%
  - Other: 20%

- Typical Commercial
  - Total Impervious: 90%

- Typical Primary Roadway
  - Total Impervious: 100%
  - Road Surface: 100%
  - Other: 0%
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<thead>
<tr>
<th>AREA #</th>
<th>LOW DENSITY RESIDENTIAL</th>
<th>MED. DENSITY RESIDENTIAL</th>
<th>MED./HIGH DENSITY RESIDENTIAL</th>
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<td>384</td>
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</table>
Based upon the information presented in the attached Tables, the following data are evident:

- 60% of the primary watershed is developed. The primary type of development is residential (57% of the watershed)
- 18% of the overall watershed is impervious. Individual drainage areas have impervious percentages as high as 30%. Based upon the Center for Watershed Protection’s Simple Impervious Coverage Model, the 18% coverage qualifies the stream/waterbody as “impacted” (see Table C.1).
APPENDIX D

THEORETICAL POLLUTANT LOADING ANALYSIS
APPENDIX D
Theoretical Pollutant Loading Analysis

The relative magnitude of pollutant loading from non-point sources in the Lake Carasaljo Primary Watershed was estimated using a simple methodology based upon land use and hydrologic data. Loading was computed to determine relative contributions at multiple management levels (i.e. subwatershed and catchment).

D.1 Methodology

Pollutant loadings were estimated using the Simplified Method (Scheuler, 1987). This method estimates stormwater runoff pollutant loads for urban areas. The technique requires the following information:

- **Drainage Area** – This information was compiled as part of the subwatershed and catchment delineation summarized in Appendix C. See Tables C.1 & C.2 as well as Figure C.1.
- **Land Use Classification** – Land use classification and impervious percentages were computed as part of the Land Use Characterization portion of this study (see Appendix C).
- **Stormwater Runoff Pollutant Concentrations** – These are empirical values that correlate pollutant concentrations as a function of runoff volume and land use. They are expressed in units of mg/l. Values utilized for this study referenced from the Stormwater Management Resource Center (www.stormwatercenter.net) and are their default values.
- **Annual Precipitation** – The expected annual precipitation for the Lake Carasaljo watershed is 43 inches. This value is the long-term mean of historical precipitation measurements for Coastal New Jersey from 1895-2001.

The Simple Method expresses pollutant loads of chemical constituents and TSS as follows:

\[ L = 0.226 \times R \times C \times A \]

Where
- \( L \) = Annual Load (lbs.)
- \( R \) = Annual Runoff (inches) – see below.
- \( C \) = Pollutant Concentration (mg/l) see Table D-1
- \( A \) = Area (acres)

Likewise, the Simple Method for bacteria is as follows, to account for a change in units:
\[ L = 1.03 \times 10^{-3} \times R \times C \times A \]

Where \( L \) = Annual Load (billions of colonies)
\( R \) = Annual Runoff (inches) – see below.
\( C \) = Pollutant Concentration (no./100 ml) Table D-1
\( A \) = Area (acres)

The Annual Runoff, \( R \), is computed as follows:

\[ R = P \times P_j \times R_v \]

Where
\( R \) = Annual Runoff (inches)
\( P \) = Annual Rainfall = 43 inches
\( P_j \) = Fraction of annual rainfall events that produce runoff = 0.9
\( R_v \) = Runoff coefficient = 0.05 + 0.9 * \( I_a \)

Where
\( I_a \) = Impervious Fraction

<table>
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<tr>
<th>Constituent</th>
<th>Land Use</th>
<th>Concentration</th>
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</thead>
<tbody>
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<td>Commercial</td>
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<tr>
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<td>Roadway</td>
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<tr>
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<td>Open Space</td>
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<td>Total Phosphorous</td>
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D.2 Results

The loading equations summarized above were evaluated for each of the catchments. The results are summarized in Table D-2 (yields) and Table D-3 (loads).

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<th>Watershed</th>
<th>Catchment</th>
<th>Total Nitrogen (pounds/acre)</th>
<th>Total Phosphorus (pounds/acre)</th>
<th>Suspended Solids (pounds/acre)</th>
<th>Fecal Coliform (billions of colonies/acre)</th>
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APPENDIX E

NON-SEWER SERVICE AREA MAP
APPENDIX F

DATA TABLES
### APPENDIX F
Data Tables

**WATER QUALITY DATA FOR LAKE CARASALJO**
**Lakewood Township, Ocean County, NJ**
**SAMPLING PERIOD: MAY 2003 THROUGH OCTOBER 2003**

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APPENDIX G

SAMPLE ORDINANCES
STREAM CORRIDOR PROTECTION ORDINANCE
ROCKAWAY RIVER WATERSHED CABINET
STREAM BUFFER CONSERVATION AREA
MODEL ORDINANCE

I. PURPOSE

In recognition of the fact that natural features contribute to the welfare of residents, the following regulations have been enacted to provide reasonable controls governing the restoration, conservation, disturbance, and management of existing stream buffers for all perennial and intermittent streams and all lakes and ponds in the municipality by establishing designated Stream Buffer Conservation Areas. In addition, the specific purposes and intent of this article are to:

A. Reduce the amount of nutrients, sediment, organic matter pesticides, and other harmful substances that reach watercourses, wetlands, subsurface, and surface water bodies by using scientifically-proven processes including filtration, deposition, absorption, adsorption, plant uptake, biodegradation, denitrification and by improving infiltration, encouraging sheet flow, and stabilizing concentrated flows.

B. Improve and maintain the safety, reliability and adequacy of the water supply for domestic, agricultural, commercial, industrial and recreational uses along with sustaining diverse populations of aquatic flora and fauna.

C. Regulate the land use, siting and engineering of all development to be consistent with the intent and objectives of this ordinance, accepted conservation practices, and to work within the carrying capacity of existing natural resources.

D. Assist in the implementation of pertinent state laws concerning erosion and sediment control practices.

E. Conserve the natural features important to land and water resources (e.g., headwater areas, groundwater recharge zones, floodway, floodplain, springs, streams, wetlands, woodlands, prime wildlife habitats) and other features constituting high recreational value or containing amenities that exist on developed and undeveloped land.

F. Work with floodplain, steep slope, and other ordinances that regulate environmentally sensitive areas to minimize hazards to life, property, and stream features.

G. Conserve natural, scenic, and recreation areas within and adjacent to stream areas for the community's benefit.
II. DEFINITIONS, APPLICABILITY, WIDTH DETERMINATION OF THE STREAM BUFFER CONSERVATION AREA AND ESTABLISHMENT OF A STREAM BUFFER CONSERVATION EASEMENT

A. DEFINITIONS – As used in this subsection, the following terms shall have the meanings set forth below:

1. STREAM shall mean a natural watercourse or surface water body that contains water for at least part of the year, has a drainage area of 50 acres or greater, or is portrayed as a dashed line on a USGA Soil Survey Map of the most recent edition.

2. STREAM BUFFER CONSERVATION ZONE shall mean an area adjacent to a Stream that intercepts surface water runoff, subsurface flow and/or deep groundwater flows from upland sources and functions to remove or buffer the effects of associated nutrients, sediments, organic matter, pesticides or other pollutants prior to entry into the Stream. This area may also provide wildlife habitat, control water temperature, attenuate flood flow, and provide opportunities for passive recreation. This buffer area may or may not contain trees and other native vegetation at the time of ordinance enactment.

3. STREAM BUFFER CONSERVATION EASEMENT shall mean an easement running to the municipality subject to all restrictions applicable to the Stream Buffer Conservation Area.

4. STREAM BUFFER MANAGEMENT PLAN shall mean a plan approved by the municipal engineer or the appointed representative. The plan shall be prepared by a landscape architect, professional engineer or other qualified professional and shall fully evaluate the effects of any proposed activity/uses on a Stream Buffer Conservation Area. The plan shall identify existing conditions (vegetation, 100 year floodplain, soils, slopes, etc.), all proposed activities and all proposed management techniques, including any measures necessary to offset disturbances to the Stream Buffer Conservation Area.

B. APPLICABILITY - The regulations outlined in this subsection shall be applicable to all properties containing a Stream Buffer Conservation Area.

C. WIDTH DETERMINATION - The measurement of the Stream Buffer Conservation Area shall extend a minimum of 75 feet from each defined edge of an identified Stream at bankfull flow, or shall equal the extent of the 100 year floodplain, whichever is greater. A Stream Buffer Conservation Area shall consist of two distinct zones designated as follows:
1. Zone One
   a. This zone will begin at each defined edge of a Stream and shall occupy a margin of land with a minimum width of 25 feet measured horizontally on a line perpendicular to the edge of the Stream at bankfull flow.
   b. Where steep slopes (in excess of 25 percent) are located within 25 feet of a Stream, Zone One shall extend the entire distance of this sloped area. If the distance of this sloped area is greater than 75 feet, there will be no requirement for the establishment of Zone Two. If the distance is less than 75 feet, the width of Zone Two will be adjusted so that the total buffer width (Zone One and Zone Two) will be 75 feet, except where a greater width is required in order to include the 100 year floodplain.

2. Zone Two
   a. This zone will begin at the outer edge of Zone One and shall occupy a minimum width of 50 feet in addition to Zone One.
   b. Where the 100-year floodplain extends greater than 75 feet from the waterway, Zone One shall remain a minimum of 25 feet wide, and Zone Two shall extend from the outer edge of Zone One to the outer edge of the 100-year floodplain.

3. Responsibility for Width Determination. The applicant, or designated representative shall be responsible for the initial width determination of the Stream Buffer Conservation Area and for identifying this area on any plan that is submitted to the municipality in conjunction with an application for a construction permit or development plan approval for subdivision, land development, or other improvements that require plan submissions or permits. This initial determination shall be subject to review and approval by the municipal engineer, or appointed representative.

4. Zone Two Waiver. If the applicant submits a Stream Buffer Management Plan that proves to the satisfaction of the municipal engineer that a proposed vegetative or other enhancement to Zone One will eliminate the need for a Zone Two, or a portion of Zone Two, the municipal engineer may waive the requirement for a Zone Two, or portion of Zone Two, provided that the approved Stream Buffer Management Plan is implemented by the applicant.
D. ESTABLISHMENT OF A STREAM BUFFER CONSERVATION EASEMENT – When any of the following circumstances occur, the applicant shall establish a Stream Buffer Conservation Easement containing the Stream Buffer Conservation Area. The Stream Buffer Conservation Easement shall be recorded prior to the municipality issuing any permits or approving any uses relating to the applicable use or activity.

1. When the applicant applies to the Construction Code Office for a construction permit that encroaches into Zone One or Zone Two, excluding a construction permit application that involves only a fence.

2. When the applicant applies to the Planning Board or Board of Adjustment for approval of a development plan, excluding a development plan that involves only a fence.

III. USES PERMITTED IN THE STREAM BUFFER CONSERVATION AREA

The following uses are permitted, either by right or after review and approval by the municipality in the Stream Buffer Conservation Area. Any existing impervious structures or features currently within the Stream Buffer Conservation Area may continue to remain and will not have to be removed.

A. Zone One

1. Uses Permitted by Right – The following uses shall be permitted by right in Zone One and do not require approval by the municipality or compliance with an approved Stream Buffer Management Plan.

   a. Open space uses that are primarily passive in character, including shall be permitted to extend into Zone One, including wildlife sanctuaries, nature preserves, forest preserves, fishing areas, passive areas of public and private parklands.

   b. Fences for which a permit has been issued by the Construction Code Office.

   c. On residential lots, new or expansion of accessory uses and structures not exceeding 100 square feet of impervious area.

2. Uses Requiring Municipal Review and Approval. The following uses shall be permitted in Zone One subject to approval by the municipality and subject to compliance with an approved Stream Buffer Management Plan.

   a. Buffer crossings by farm vehicles and livestock, recreational trails,
roads, railroads, centralized sewer and/or water lines, and public utility transmission lines, and public utility transmission lines provided that the land disturbance is the minimum required to accomplish the permitted use.

b. Reforestation and streambank stabilization.

B. Zone Two

1. Uses Permitted By Right - The following uses shall be permitted by right in Zone Two and do not require approval by the municipality or compliance with an approved Stream Buffer Management Plan.

a. Open space uses that are primarily passive in character, including shall be permitted to extend into Zone One, including wildlife sanctuaries, nature preserves, forest preserves, fishing areas, passive areas of public and private parklands.

b. Fences for which a permit has been issued by the Construction Code Office.

c. On residential lots, new or expansion of accessory uses and structures not exceeding 100 square feet of impervious area.

d. Minimum required front, side, and rear yards on private lots, provided that no minimum required yard may extend into Zone Two more than half the distance between the outer boundaries of Zone One and Zone Two.

e. Agricultural uses existing at the time of adoption of this ordinance.

2. Uses Requiring Municipal Review and Approval - The following uses shall be permitted in Zone Two subject to approval by the municipality and subject to compliance with an approved Stream Buffer Management Plan.

a. New agricultural uses.

b. Buffer crossings by farm vehicles and livestock, roads, railroads, centralized sewer and/or water lines, and public utility transmission lines provided that the land disturbance is the minimum required to accomplish the permitted use.

c. Centralized sewer and/or water lines and public utility transmission lines running along the buffer, provided that any disturbance is, at minimum, offset by buffer improvements identified in the Stream Buffer Management Plan. These lines shall be located as far
d. Selective cutting of trees when removal is consistent with approved standards in the Stream Buffer Management Plan.

e. Recreation areas such as camps, campgrounds, picnic areas and golf courses. Active recreation areas such as ballfields, playgrounds, and courts provided these uses are designed in a manner that will not permit concentrated flow of stormwater.

e. Naturalized stormwater basins, provided the entire basin is located a minimum of 50 feet from the defined edge of the Stream.

f. Reforestation and Streambank stabilization.

IV. USES SPECIFICALLY PROHIBITED IN THE STREAM BUFFER CONSERVATION AREAS

Any use or activity not permitted herein shall be prohibited within the Stream Buffer Conservation Area. By way of example, the following activities and facilities are specifically prohibited:

A. Clear-cutting of trees and other vegetation.

B. Selective cutting of trees and/or the clearing of other vegetation within Zone One or Zone Two, except where such clearing is necessary to prepare land for a permitted use and where the effects of these actions are mitigated by revegetation, in compliance with an approved Stream Buffer Management Plan.

C. Removal of trees in excess of selective cutting, except where such removal is necessary as a means to eliminate dead, diseased, or hazardous tree stands that jeopardize public safety or as part of a reforestation project, provided that the removal is in compliance with a Stream Buffer Management Plan.

D. Removal or disturbance of vegetation in a manner that is inconsistent with erosion control and buffer protection.

E. Storage of any hazardous or noxious materials

F. Use of fertilizers, pesticides, herbicides, and/or other chemicals in excess of prescribed industry standards or the recommendations of the Morris County Conservation District.

G. Roads or driveways, except where permitted as buffer crossings.
H. Motor or wheeled vehicle traffic in any area that in the opinion of the municipal engineer, is not designed to adequately accommodate the type and volume.

I. Parking lots.

J. Any type of permanent structure, including fences, except structures needed for a permitted use.

K. Subsurface sewage disposal areas.

L. Sod farming.

V. BOUNDARY INTERPRETATION AND APPEALS PROCEDURE

A. When a landowner or applicant disputes the Zone (One or Two) boundaries of the stream buffer or the defined edge of a Stream, the landowner or applicant shall submit evidence to the municipality that describes the boundary, presents the landowner or applicant's proposed boundary, and presents all justification for the proposed boundary change. The evidence supporting a proposed Stream designation must be provided by a New Jersey licensed professional engineer.

B. The municipal engineer or appointed representative shall evaluate all material submitted and shall make a written determination within 45 days of a complete submission.

C. Any party aggrieved by any such determination or other decision or determination under this section may appeal to the (governing body) under the provisions this ordinance. The party contesting the location of the district boundary shall have the burden of proof in case of any such appeal.

VI. INSPECTION OF STREAM BUFFER CONSERVATION AREA

A. Lands within or adjacent to an identified Stream Buffer Conservation Area will be inspected by a municipal representative when:

1. A construction permit application affecting the Stream Buffer Conservation Area is submitted to the Construction Code Office.

2. A development plan application affecting the Stream Buffer Conservation Area is submitted to the Planning Board or Board of Adjustment.

3. A change or resumption of a nonconforming use within the Stream Buffer Conservation Area is proposed.

4. A proposed Stream Buffer Management Plan is submitted to the municipality.
B. A Stream Buffer Conservation Area may also be inspected periodically by the municipal representatives for compliance with an approved Stream Buffer Management Plan, excessive or potentially problematic erosion or at any time when the presence of an unauthorized activity or structure is brought to the attention of municipal officials.

VII. MANAGEMENT OF THE STREAM BUFFER CONSERVATION AREA

A. Stream Buffer Management Plan – With the exception of uses permitted by right, no construction, development, use, activity, encroachment or structure shall be permitted within any Stream Buffer Conservation Area unless the effects of such development are mitigated by the implementation of an approved Stream Buffer Management Plan.

1. At the time of submission of an application to the Construction Code Office for a construction permit or to the Planning Board or Board of Adjustment for approval of a development plan, or prior to commencing any use/activity that does not require a construction permit or development plan approval, the landowner or developer shall submit to the municipal engineer, or appointed representative, a proposed Stream Buffer Management Plan prepared by a landscape architect, professional engineer or other qualified professional. The proposed plan shall fully evaluate the effects of all proposed uses/activities on the Stream Buffer Conservation Area. The Stream Buffer Management Plan shall identify the existing conditions (vegetation, 100-year floodplain, soils, slopes, etc.), all proposed uses/activities, and all proposed management techniques, including proposed vegetation and any other measures necessary to offset disturbances to the Stream Buffer Conservation Area. The plan shall be approved by the municipal engineer, or appointed representative.

2. Vegetation Selection. Dominant vegetation in the Stream Buffer Management Plan shall consist of plant species that are suited to the stream buffer environment. The municipality may require species suitability to be verified by qualified experts in the Morris County Conservation District, Natural Resources Conservation Service, NJ Department of Environmental Protection, the U.S. Fish and Wildlife Service, or state and federal forest agencies.

   a. In Zone One, dominant vegetation shall be composed of a variety of native stream trees, shrubs, and tall grasses and shall include species that will provide streambank stabilization.

   b. In Zone Two, dominant vegetation shall be composed of stream trees and shrubs, with an emphasis on native species and appropriate plantings necessary for water filtration.
c. Disturbed areas shall be revegetated with stream buffer plants, in compliance with an approved Stream Buffer Management Plan.

d. Areas that cannot be revegetated shall be restored in compliance with an approved Stream Buffer Management Plan.

3. Performance Guarantee. Performance of the Stream Buffer Management Plan shall be guaranteed by a surety, such as a bond, cash or letter of credit, which shall be provided to the municipality prior to the issuing of any permits or approving any uses relating to the applicable use or activity.
STORMWATER MANAGEMENT ORDINANCE
Stormwater Management and Discharge Control Ordinance
Manasquan Watershed Management Group

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10/18/01
Stormwater Management and Discharge Control Ordinance

ARTICLE I

TITLE, AUTHORITY, PURPOSE AND APPLICABILITY

Section 1. Title. This ordinance shall be known as the Stormwater Management and Discharge Control Ordinance and may be so cited.


Section 3. Purpose and Intent. The purpose of this ordinance is to reduce the volume of surface water flowing into the Manasquan River. To accomplish this goal, infiltration techniques that direct clean water runoff into the ground will be deployed using a variety of methods. Runoff from areas not capable of supporting infiltration because of soil conditions and runoff from land uses with contaminants present, like vehicle salvage yards for instance, will be treated by traditional stormwater management practices and good housekeeping practices. This ordinance will ensure the future health, safety, and general welfare of Manasquan watershed citizens by:

A. Reducing pollutants in stormwater discharges to the maximum extent practicable;
B. Reducing the volume of water discharged to the Manasquan River from development;
C. Reducing the potential for increases in stream flooding and erosion from stormwater;
D. Eliminating illicit connections and discharges to the storm drain system; and
E. Regulating non-stormwater discharges to the storm drain system.

The intent of this ordinance is also to protect and enhance the ecological health and water quality of the Manasquan River, tributaries, water bodies, ground water, and wetlands in a manner pursuant to and consistent with the Federal Clean Water Act (33 U.S.C. §1342) and the 1981 Municipal Stormwater Management Act (P.L. 1981, c.32).

Section 4. Applicability. This ordinance shall be applicable to any major subdivision or site plan application, as defined in the Municipal Land Use Law, located within the municipality, which involves the disturbance of 1,000 square feet or more. Provisions of this ordinance pertaining to runoff from roof areas and requirements for drywells shall also apply to all applications for building permits except as otherwise provided for herein. The ordinance shall be applied to achieve its purposes to the extent reasonable and practical with respect to modifications of previously developed sites consistent with the nature and extent of such modifications.
ARTICLE II
FINDINGS AND GENERAL PROVISIONS

Section 1. Findings
A. The Manasquan River and its tributaries are experiencing severe erosion and sedimentation due to the increasing rate and volume of rain water being directed to streams.

B. The development of roadways, buildings, parking areas and lawn areas on lands once either forested or used for agricultural purposes change the patterns of stormwater runoff.

C. Impervious surfaces associated with development prevent the infiltration of rainfall into the ground and increase surface runoff of rainfall.

D. The installation of drainage pipes and drainage ditches exacerbate stormwater flow by changing runoff patterns from one of overland flow and ground infiltration to one of point source discharge to streams.

E. The increase in stream flow results in severe stream bank and channel scour that deposits sediments throughout the river system.

F. Sediment is made up of particulate matter derived from soil and rocks that settle and fill in the bottom of streams, rivers, and wetlands.

G. Sediment accumulation promotes shoaling and impedes navigation. Significant costs are associated with dredging and disposal of dredged material.

H. Suspended sediment makes the water cloudy and turbid and threatens the survival of filter-feeding organisms such as shellfish and aquatic organisms important to fish and wildlife, and increases the cost of water supply treatment.

I. Deposited sediments can change the physical nature of the river bottom, thus affecting fish habitat.

J. Pollutants such as metals, nutrients, and bacteria bond to sediments and are then carried further downstream resulting in greater distribution of pollutants.

K. Several Manasquan streams and the river’s mainstem have been listed by NJDEP as either impaired or severely impaired and preliminary evidence suggests that contamination is associated with sediment disturbance.

Section 2. Definitions. The terms as used in this ordinance shall have the following meanings:
A. Best Management Practice (BMPs) shall mean any activities, prohibitions, practices, procedures, programs, or other measures designed to prevent or reduce the discharge of pollutants directly or indirectly into waters of the United States. BMPs shall include, but are not limited to, those measures specified in Standards for Soil Erosion and Sediment Control in New Jersey Adopted July 1999 by the New Jersey State Soil Conservation Committee and the NJDEP/SCC BMP Manual.

B. Bioretention area shall mean retention of stormwater through the use of vegetated depressions engineered to collect, store, and infiltrate runoff.
C. Cistern shall mean an engineered reservoir for storing roof water runoff for reuse.

D. Detention Basin shall mean any facility that accepts stormwater runoff and detains water for a period of time while releasing it at a slow rate.

E. Dry Wells shall mean any small sub-surface areas that are backfilled with gravel and/or porous material to store and slowly release stormwater runoff into the ground. Dry wells are typically used for roof runoff and small paved areas.

F. Erosion shall mean the process of soil detachment and movement by the forces of water.

G. Illicit Discharge shall mean any discharge to the storm drain system that is not composed entirely of stormwater runoff except discharges made pursuant to a New Jersey Pollutant Discharge Elimination System (NJPDES) permit or as otherwise authorized by the State or this municipality.

H. Illicit Connection shall mean any physical connection to a storm drain system that has not been permitted by this municipality or New Jersey Department of Environmental Protection.

I. Infiltration shall mean the absorption of rainfall into the ground either naturally or by diverting rainfall to areas where it can infiltrate into the ground.

J. Infiltration Systems shall mean sub-surface areas that are filled with gravel and porous material to store and slowly release stormwater runoff into the ground.

K. New Jersey Pollutant Discharge Elimination System (NJPDES) Permit shall mean a stormwater discharge permit issued by New Jersey Department of Environmental Protection in compliance with the Clean Water Act and the New Jersey Water Pollution Control Act.

L. Municipal NJPDES Permit shall mean an area-wide NJPDES permit issued to a government agency or agencies for the discharge of stormwater from a stormwater system.

M. Non-Stormwater Discharge shall mean any discharge to the storm drain system that is not entirely composed of stormwater.

N. Person shall mean any natural person, firm, association, club, organization, corporation, partnership, business trust, company or other entity that is recognized by law as the subject of rights or duties.

O. Pollutant shall mean anything that causes the deterioration of water quality such that it impairs subsequent and/or competing uses of the water. Pollutants may include but are not limited to paints, oil and other automotive fluids, soil, rock, sand, cellar dirt, dredged material, rubbish, trash, garbage, debris, refuse, waste, thermal waste, sewage, sewage sludge, fecal coliform, fecal streptococcus, enterococcus, biological materials, medical waste, heavy metals, hazardous waste, radioactive substance, solid waste, incinerator residue, chemicals, munitions, fresh concrete, yard waste from commercial landscaping operations, animal waste, materials that result from the process of constructing a building or structure, wrecked or discarded equipment, industrial waste, municipal waste, agricultural waste, nauseous or offensive matter of any kind. "Pollutant" includes both hazardous and nonhazardous pollutants.

P. Porous Pavement shall mean paved surfaces that allow rainwater to infiltrate through the material. Porous pavement can be pervious interlocking concrete paving blocks, concrete grid pavers, perforated brick pavers, and compacted gravel. Note: The use of porous asphalt pavement and bituminous concrete is discouraged due to the problems
associated with continued maintenance and functioning of these types of systems, unless long-term maintenance is assumed by the applicant.

Q. Premises shall mean any building, lot, parcel of land, land or portion of land whether improved or unimproved.

R. Rain barrel shall mean a container designed to collect and store rooftop runoff for reuse.

S. Retention Basin shall mean a facility that accepts stormwater runoff and stores it while it slowly discharges from the basin through an outlet control structure. The retention basin stores water on a continuous basis and therefore does not run dry.

T. Storm Drain System shall mean any facility within the municipality by which stormwater may be conveyed to waters of New Jersey. Storm drain system includes but is not limited to any roads with drainage systems, streets, curbs, gutters, catch basins, natural and artificial channels, ditches, aqueducts, storm drains, inlets, detention basins, retention basins, infiltration basins, conduit or other drainage structure.

U. Stormwater Runoff shall mean surface runoff and drainage associated with rainstorm events and snowmelt.

V. Vegetated Swales shall mean drainage swales that slow water velocities and encourage infiltration. Vegetation in the swales is used to reduce velocities and improve water quality through biofiltration of the water.

W. Water Quality Storm shall mean a design storm that is a one-year frequency 24-hour storm using the rainfall distribution recommended for New Jersey by the U.S. Department of Agriculture, Soil Conservation Service, or a storm of 1.25 inches of rainfall in two hours.

Section 3. Responsibility for Administration. This ordinance shall be administered by municipalities that have entered into a Memorandum of Agreement with NJDEP.

Section 4. Regulatory Consistency. This ordinance shall be construed to assure consistency with the requirements of New Jersey laws and acts amendatory thereof or supplementary thereto, applicable implementing regulations, and any existing or future municipal NJPDES Permits and any amendments or revisions thereto or reissuance thereof. This ordinance is not intended to interfere with, abrogate, or annul any other ordinance, rule or regulation, statute, or other provision of law. Where any provision of this ordinance imposes restrictions different from those imposed by any other ordinance, rule or regulation, or other provision of law, whichever provisions are more restrictive or impose higher standards shall control.

Section 5. Severability. If any provision, clause, sentence, paragraph, section, or subsection of this ordinance or the application thereof to any person, establishment, or circumstances shall be held invalid by a court of competent jurisdiction, such order of judgment shall not affect or invalidate the other provisions or application of this ordinance which can be given effect without the invalid provision or application, and to this end, the provisions of this ordinance are hereby declared to be severable.

ARTICLE III
MANAGEMENT AND DISCHARGE CONTROLS
Traditionally, stormwater runoff has been viewed as undesirable and must therefore be removed from the site as quickly as possible to achieve good drainage. This philosophy has resulted in extremely efficient stormwater runoff conveyance systems that do not adequately control runoff.
volumes. The goal of this ordinance is to creatively design sites that replicate predevelopment hydrology by expanding rainwater infiltration opportunities that will result in improving stream stability, habitat structure, base flows, and water quality. These methods follow a hierarchy of prevention, infiltration, and detention/retention. Methods may include reducing impervious surfaces, maintaining natural drainage courses, minimizing clearing and grading, dispersing runoff uniformly throughout a site, encouraging sheet flow through vegetated areas, and strategically routing flows to increase travel time. Benefits include decreasing the use of storm drain piping and inlet structures, reducing the size of stormwater ponds, lowering infrastructure and maintenance costs, improving water quality, and increasing base flow yields to receiving waters.

Section 1. Reduction of Pollutants in Stormwater.

A. General. It is a violation of this ordinance to throw, deposit, leave, maintain, keep, or permit to be thrown, deposited, placed, left or maintained, any pollutant in or upon any street, alley, sidewalk, storm drain, inlet, catch basin, conduit or other drainage structures, business place, or upon any public or private plot of land. The only exception being where a pollutant is temporarily placed in an appropriate container with a spill containment system for later collection and removal. It is a violation of this ordinance to cause or permit any dumpster, solid waste bin, or similar container to leak such that any pollutant is discharged into any street, alley, sidewalk, storm drain, inlet, catch basin, conduit or other drainage structures, business place, or upon any public or private plot of land.

B. New Development and Redevelopment. New development or redevelopment projects shall control stormwater runoff so as to prevent any deterioration of water quality that would impair subsequent or competing uses of the water. The Standards for Soil Erosion and Sediment Control in New Jersey (adopted July 1999) identifies BMPs that may be implemented to prevent such deterioration, establishes criteria for selecting BMPs appropriate for a particular site, and identifies the manner of implementation. Stormwater management strategies shall follow a hierarchy from prevention, to infiltration, and then detention/retention.

1. Stormwater Prevention. Prevention methods shall be employed that minimize site disturbance and mimic predevelopment hydrology by using site designs that retain the natural features of the landscape. All sensitive areas that affect hydrology like streams, riparian buffers, floodplains, wetlands, steep slopes, high-permeability soils, low lying areas, open space, and woodland conservation zones shall be identified in order to preserve the natural hydrologic functions of the site. Riparian areas shall not be disturbed and shall support a buffer protection zone of at least 75 feet. Trout maintenance streams identified by NJDEP must have a buffer protection zone of at least 150 feet. Properties located along drainage ways or watercourses that do not have vegetated buffers must be restored by planting native plant material within a buffer protection zone of at least 75 feet. The Natural Resource Conservation Service offers publications that provide guidance on riparian restoration such as Stream Corridor Restoration: Principles, Processes, and Practices (10/1998). Buffer protection zones shall be identified and protected by conservation easements. Specific hydrologic features that will remain undisturbed shall be mapped and marked in the field by property monuments. Hydrologic features that will be altered shall be identified on the site plan and include an assessment of their environmental impact to the receiving water body.

2. Stormwater Infiltration. Once prevention methods have been deployed, infiltration structures shall be the second method of protection when developing the site and shall accompany disturbed areas as a control strategy. Infiltration structures shall be incorporated into the site plan when suitable conditions exist. Suitable conditions include all of the following:
1. Suitable soils include sand, sandy loam and loamy sand, as defined by the U.S. Department of Agriculture,

2. the soil infiltration rate is .50 inches/hour or greater, and

3. the minimum depth to the seasonal groundwater table or bedrock is at least three (3) feet from the bottom of the infiltration structure.

If the above criteria are met, infiltration facilities shall be used with the following land uses and activities: residential streets and rural highways, residential development, institutional development, office developments, non-industrial rooftops, and pervious areas, except golf courses and nurseries.

A. Golf courses and nurseries shall be designed to drain internally where ponds capture irrigation runoff that can then be used for nutrient and water recycling.

B. Infiltration basins shall have an adequate back-up drainage system in the event that the infiltration capacity of the infiltration basin fails.

C. Infiltration basins shall include pre-treatment controls such as vegetative filter strips that prevent suspended solids from reaching the basin.

In addition to large infiltration systems designed for development projects, additional stormwater controls can assist in reducing runoff volumes.

A. Regardless of the above soil criteria, runoff shall be directed to permeable areas, by orienting it away from impermeable areas and towards swales, berms, vegetative filter strips, bioretention areas, gravel beds, sand filters, or french drains; by installing rain-gutters oriented towards permeable areas; by modifying the grade of the property to divert flow to permeable areas and minimize the amount of stormwater runoff leaving the property; and by designing curbs, berms or other structures such that they do not isolate permeable or landscaped areas.

B. Stormwater storage facilities shall be deployed on a lot-by-lot basis for buildings greater than 500 square feet, by using retention structures, dry wells, cisterns, rain barrels, or other structures to store stormwater runoff for reuse or slow release.

Infiltration facilities shall not be used with the following land uses and activities: vehicle salvage yards and recycling facilities, vehicle fuelling stations, vehicle service and maintenance facilities, vehicle and equipment cleaning facilities, fleet storage areas (bus, truck, etc.), industrial sites, marinas (service and maintenance), outdoor liquid container storage, outdoor loading/unloading facilities, public works storage areas, facilities that generate or store hazardous materials, commercial container nursery, and other land uses and activities as designated by this municipality. If applicants can demonstrate that pollutants will not contaminate stormwater runoff, then variances may be granted.

3. **Stormwater Reduction Goals and Technical Standards.**

a. **No net increase in nonpoint source pollution** - Stormwater control systems shall be designed to prevent the degradation of water quality in receiving watercourses from nonpoint source pollution associated with stormwater runoff. NJDEP's Surface Water Quality Standards, NJAC 7:9B, shall be used for this determination.
b. **No net increase in sediment loadings** - Stormwater control systems shall be designed to reduce to the maximum extent possible, the total suspended solids (TSS) from stormwater runoff for storm events with magnitudes as high as the Water Quality Storm and to retain, as closely as possible, the pre-development hydrologic response of the site and the watershed.

c. **No net increase in stormwater runoff rates and stream channel erosion** - Stormwater control systems shall be designed so that, to the maximum extent possible, the post-development stormwater runoff rates from the site and at any point in the watershed between the site are no greater than pre-development rates, in order to retain as closely as possible the pre-development hydrologic response of the site and the watershed.

d. **No net increase in stormwater runoff volumes** - Wherever suitable infiltration, soil permeability, and favorable geological conditions exist, stormwater control systems shall be designed so that stormwater runoff from impervious surfaces is infiltrated into the soil for the first 1.25 inch, 2-hour storm, using the Type III rainfall distribution recommended for New Jersey by the U.S. Soil Conservation Service.

C. **Procedures for Measuring Compliance with the No Net Increase Goals of the Ordinance**

1. Hydrologic/hydraulic analyses shall be prepared and submitted demonstrating that the post-development stormwater runoff rates do not exceed the standards set forth in this ordinance for the water quality storm and the 2, 10, 25, 50 and 100-year storms. In the absence of a regional stormwater management plan, post-project construction peaks shall be 50 percent of the pre-project construction peak runoff for the two year storm, 75 percent for the 10 year storm, and 80 percent for the 100 year storm as called for in the Residential Site Improvement Standards (5:21-7.5(d)3).

   a. The hydrologic and hydraulic analyses shall generally conform to methods developed by the Natural Resources Conservation Service and published in National Engineering Handbook, Section 4 - Hydrology, Technical Release No. 55 and Technical Release No. 20. Other approved methods may be utilized if pre-approved by the Township engineer.

   b. Standards and procedures for developing hydrographs and calculating peak rates of runoff shall be as shown in the Stormwater and Nonpoint Source Pollution Control Best Management Practices Manual, dated December 1994.


2. For infiltration facilities proposed to meet the no net increase goals of this ordinance, the results of a subsurface investigation and soil tests demonstrating the suitability of the area's soils and groundwater table for infiltration and treatment of runoff shall be provided.

3. A nonpoint source pollutant loading analysis shall be prepared and submitted, demonstrating that the nonpoint source pollutant and sediment loadings resulting from the proposed land development or construction project do not exceed the standards set forth in this ordinance.
4. In preparing the required analysis it shall be acceptable to utilize the average removal efficiency statistics provided in the Stormwater and Nonpoint Source Pollution Control Best Management Practices Manual, dated December 1994, and any subsequent revisions thereto, prepared by the N.J.D.E.P. and the New Jersey Department of Agriculture.

D. Existing Development. Existing development shall control stormwater runoff so as to prevent any deterioration of water quality that would impair subsequent or competing uses of the water. The municipality shall identify the BMPs that may be implemented to prevent such deterioration and shall identify the manner of implementation.

Section 2. Illicit Connections/Discharges. It is a violation of this ordinance to establish, use, maintain, or continue illicit connections to the storm drain system, or to commence or continue any illicit discharges to the storm drain system. This prohibition against illicit connections and discharges is expressly retroactive and applies to connections and discharges made in the past, regardless of whether permissible under the law or practices applicable or prevailing at the time of the connection or discharge.

Section 3. Non-Stormwater Discharges. The discharge of non-stormwater into the storm drain system is a violation of this ordinance except as specified below.

A. The discharge prohibition shall not apply to any discharge regulated under a NJPDES Permit or Waiver issued to the discharger by the State of New Jersey, provided that the discharger is in full compliance with all requirements of the permit or waiver and other applicable laws or regulations.

B. Discharges from the following activities will not be considered a violation of this ordinance when properly managed: water line flushing and other discharges from potable water sources, landscape irrigation and lawn watering, irrigation water, diverted stream flows, rising ground waters, infiltration to separate storm drains, uncontaminated pumped ground water, foundation and footing drains, water from crawl space or basement sump pumps, air conditioning condensation, springs, individual residential car washing, flows from riparian habitats and wetlands, swimming pool discharges or flows from fire fighting. When possible, controlled discharges shall be directed over vegetated areas, such as lawns, before reaching a street or storm drain.

Section 4. Discharges in violation of Permit.

A. Municipal NJPDES Permit. Any discharge that would result in or contribute to a violation of an existing or future Municipal NJPDES Permit(s) or any amendment or revision thereto or reissuance thereof, either separately considered or when combined with other discharges, is a violation of this ordinance and is prohibited. Liability for any such discharge shall be the responsibility of the person(s) causing or responsible for the discharge, and such persons shall defend, indemnify and hold harmless the municipality in any administrative or judicial enforcement action relating to such discharge.

B. NJPDES Permit for Industrial/Commercial and Construction Activity. Any industrial discharger, discharger associated with construction activity, or other discharger subject to any NJPDES permit issued by the New Jersey Department of Environmental Protection shall comply with all requirements of such permit. Such dischargers shall specifically comply with the following permits: the Industrial Stormwater General Permit, the Construction Activity Stormwater General Permit, and the Dewatering General Permit. Proof of compliance with said NJPDES General Permits may be required in a form acceptable to the New Jersey Department of Environmental Protection, Freehold Soil Conservation District, or this municipality prior to issuance of any grading, building, or occupancy permits.
ARTICLE IV

OPERATION, INSPECTION, MAINTENANCE, REPAIR AND SAFETY

Section 1. Responsibility for Operation, Inspection, Maintenance, Repair, and Safety

A. Responsibility for operation, inspection, maintenance, repair, and safety of stormwater management facilities, including periodic removal and disposal of accumulated particulate material and debris, shall remain with the property owner and all successors in title unless assumed by a governmental agency.

B. Prior to granting approval or as a condition of final subdivision or site plan approval to any project subject to review under this ordinance, the applicant shall develop a stormwater BMP maintenance plan and enter into an agreement with the municipality to ensure the long term/perpetual operation, maintenance, repair, and safety of the stormwater management facility. In cases where property is subdivided and sold separately, a homeowner’s association or similar permanent entity, or an individual shall be established as the responsible person absent an agreement by a governmental agency to assume responsibility. It shall be demonstrated to the municipality that any proposed new responsible entity or individual has the capability to perform the required maintenance.

C. In the event that the stormwater management facility becomes a danger to public safety or public health, or if it is in need of maintenance, the municipality shall so notify the responsible person in writing. Upon receipt of that notice the responsible person shall have fourteen (14) days to effect maintenance and repair of the facility in a manner that is approved by the municipal engineer or a designee. If for reasons of safety there is need for immediate action, the responsible person shall act forthwith to remove the danger. If the responsible person fails or refuses to perform such maintenance and repair, the municipality may immediately proceed to do so and shall be reimbursed for the cost thereof by the responsible person or entity.

Section 2. Inspection, Maintenance and Repair Procedures

A. Inspection and maintenance procedures are required to maintain the intended operation and safe condition of the stormwater management facility by reducing the occurrence of problems and malfunctions. To be effective, inspections and maintenance shall be performed on a regular basis and include such routine procedures as training of staff, periodic inspections, grass cutting and fertilizing, soil aeration, silt and debris removal and disposal, upkeep of moving parts, storm drain vacuuming, control of mosquitoes and other insects, pond maintenance, and review of maintenance and inspection work to identify where the maintenance program could be more effective.

B. Repair procedures are required to correct a problem or malfunction at a stormwater management facility and to restore the facility’s intended operation and safe condition. Based upon the severity of the problem, repairs shall be performed on an as-needed or emergency basis and include such procedures as structural repairs, mosquito control, removal of debris, sediment and trash which threaten discharge capacity, erosion repair, snow and ice removal, fence repair, and restoration of vegetation.

ARTICLE V

EFFECTIVE DATE OF ORDINANCE

10/18/01
This ordinance shall take effect 30 days after its adoption.
TREE PROTECTION ORDINANCE
TREE PROTECTION AND REMOVAL MODEL ORDINANCE

1. PURPOSE

(Insert municipal name) having found that indiscriminate, uncontrolled and excessive destruction, removal and clear cutting of trees upon lots and tracts of land results in increased drainage control costs, increased soil erosion and sedimentation, decreased fertility of the soil, degradation of water resources, decreased groundwater recharge, increased buildup of atmospheric carbon and increased dust and decreased property values, all of which negatively affect the character of (insert municipal name).

(Insert municipal name) realizing that the removal of trees adversely affects the health, safety and general welfare of our residents, desires to regulate and control indiscriminate and excessive cutting of trees by preserving the maximum possible number of trees in the course of development of a site, ensuring that the health of trees preserved on a site is maintained throughout the development process, protecting larger, older specimens of trees and encouraging innovative design and grading to promote the preservation of existing trees.

It is recognized that there is a strong relationship between the integrity of (insert municipal name) and the region's water resources, the development on steep slopes, tree removal, soil disturbance, stormwater management and the general use of land resources. Therefore, the appropriate management of these resources is an important health, safety and general welfare concern.

2. APPLICABILITY

With the exception of the exemptions set forth in Section 5 of this ordinance, no tree shall be cut or otherwise removed from any lands in (insert municipal name) without a tree removal permit. All applications to the Planning Board or Zoning Board of Adjustment for approval of a major subdivision, minor subdivision or site plan requiring tree removal shall include an application for a tree removal permit. Any residential, commercial, business or industrial lot owner wishing to remove trees upon said lot must comply with the Section 8 of this ordinance. The application shall be submitted to (insert appropriate municipal office) for review and approval. No tree that was planted or preserved as part of any landscape plan or in accordance with any street tree requirements approved in conjunction with a subdivision or site plan shall be removed, except for such trees directed to be removed pursuant to Section 5, subsection F, G, H & I.

3. DEFINITIONS

(Municipalities should include the following definitions in their adopted ordinance unless the definition is already provided for in the adopted zoning ordinance)

Board - the municipal agency, either Planning Board or Zoning Board of Adjustment, to which the application for tree removal permit is submitted.

Caliper - Standard measure of tree size for trees to be newly planted. The measurement is taken 6 inches above the ground for trees 4 inches in diameter or less and 12 inches above the ground for
trees over 4 inches in diameter.

**Clear Cutting** - the removal of all standing trees on a lot or a portion of a lot.

**Diameter at Breast Height** - diameter of a tree measured four and one-half (4 1/2) feet (forestry method) above the ground level on the downhill side for existing trees. Diameter at Breast Height may appear as the abbreviation "DBH" (Diameter Breast Height).

**Drip Line** - a limiting line established by a series of perpendicular drop points marking the maximum radius of the crown of an existing tree, but not less than six (6) feet from the trunk, whichever is greater; and within which no construction or disturbance shall occur.

**Replacement Tree** - a nursery-grown certified tree, properly balled, marked with a durable label indicating genus, species and variety, and satisfying the standards established for nursery stock and installation thereof, set forth by the American Association of Nurseryman.

**Selective Cutting** - the removal of larger trees on an individual basis while leaving trees of lesser size.

**Silviculture** - the management of any wooded tract of land to insure its continued survival and welfare, whether for commercial or noncommercial purposes, pursuant to a plan approved by the New Jersey Bureau of Forestry.

**Thinning** - the removal of undesirable, competitive, diseased or damaged trees so as to cultivate and improve the development of remaining trees on the lot.

**Tree** - any self supporting woody plant which reaches a typical mature height of twelve (12) feet or more at maturity and has a typical DBH of four (4) inches or greater.

**Tree Canopy** - the top layer or crown of mature trees.

**Wooded Acres Permitted for Development** - means the wooded lands within a lot or tract which are not specifically excluded from development by any federal, state, county or municipal law or ordinance, deed restriction or covenant running with the lands. For purposes of this Ordinance, those lands specifically eliminated from consideration as wooded acres permitted for development include, but are not limited to, wetlands as defined by N.J.S.A. 13:9B-1 et seq.

4. **TREE CUTTING OR REMOVAL RESTRICTED**

With the exception of the exemptions set forth in Section 5, no person shall cut or remove, or cause to be cut or removed, any existing tree with a diameter at breast height (DBH) of six (6) inches or greater upon any lands within (insert municipal name) unless the cutting or removal can be accomplished in accordance with the provisions of this ordinance.

5. **EXEMPTIONS**

The following shall be exempt from this ordinance:
6. TREE REMOVAL REQUIREMENTS FOR MAJOR AND MINOR SUBDIVISIONS AND SITE PLANS

Each application to the Planning Board or Zoning Board of Adjustment (insert appropriate municipal office) for approval of a major or minor subdivision or a site plan that requires the removal of trees shall include an application for a tree removal permit. The application and development proposal shall conform to the following provisions:

A. Application Form - The application form may be obtained from the (insert appropriate municipal officer) and shall include the following information:

1. Name and address (street, lot and block) of the owner of the premises and status of legal entity (individual, partnership, corporation of this or any other state, etc.);

2. Description of the premises where removal is to take place, including lot and block numbers, street address as assigned;

3. A list of all trees to be removed with a DBH equal to or greater than six (6) inches identified by size and species, including total number of each species to be removed;
4. Purpose for tree removal (new construction, street or roadway, driveway, utility easement, recreation areas, parking lot, etc);

5. Proof that there are no delinquent property taxes or assessments due on the property for which the application is submitted; and

6. Such other information as may be deemed necessary in order to effectively process and decide such application.

B. Landscape Plan - The following information shall be provided on a landscape plan prepared by a Registered Landscape Architect or Registered Professional Engineer and submitted with the application for tree removal. The landscape plan must be submitted prior to tree removal permit approval.

1. Base information
   a. Location of existing tree canopy within the property boundaries.
   b. Location of individual trees with a DBH equal to or greater than six (6) inches identified by size and species within the area of development/limit of disturbance.
   c. Location of individual trees with a DBH equal to or greater than six (6) inches identified by size and species beyond the area of development/limit of disturbance.
   d. Location of individual existing trees and their drip lines noted for preservation within the area of development/limit of disturbance identified by size and species. Where clusters of trees exist on the site or are contiguous with adjacent sites, fragmentation of the cluster shall be avoided where possible.
   e. Location of all required replacement trees.
   f. Clear labeling of the area(s) intended for tree/vegetation removal.
   g. Tree protection material details and limit of disturbance line.
   h. Location of existing and proposed buildings/structures.
   i. All bodies of water and wetlands, including water retention and detention areas.
   j. Location of all existing driveways and parking areas.

2. Design Requirements
   a. Only those trees necessary to permit the construction of buildings, structures, streets, driveways, infrastructure and other authorized improvements shall be removed. Existing vegetation shall be preserved to the greatest extent feasible.
   b. No more than sixty (60) percent of the existing tree canopy within the property boundaries shall be removed. The location of the remaining forty (40) percent of the tree canopy to be preserved shall be noted on the landscape plan. Steep slope limits of disturbance shall supersede this section when appropriate.
c. No more than ten (10) percent of existing trees with a DBH equal to or greater than ten (10) inches within the area of development/limit of disturbance shall be removed unless the applicant shall replant trees removed in accordance with Section 7.

d. Input from a designated subcommittee of the Board and/or the Shade Tree Committee (Insert Planning Commission if other committees do not exist) shall be requested for recommended areas of tree preservation.

e. Landscape standards may be waived by the Board when trees and/or shrub masses are preserved and/or relocated on-site that duplicate or essentially duplicate the landscape requirements contained in this section.

f. The appropriate reviewing authority shall have the option of requiring a conservation easement to protect any or all trees or tree canopy areas to remain on site.

C. Site protection

1. Tree protection measures and the limit of disturbance line shown on the landscape plan shall be provided in the field with snow fencing or other durable material and verified by the (insert appropriate municipal officer) or other designated official prior to soil disturbance.

2. Protective barriers shall not be supported by the plants they are protecting, but shall be self-supporting. Barriers shall be a minimum of four (4) feet high and shall last until construction is complete.

3. Chain link fence may be required for tree protection if warranted by site conditions and relative rarity of the plant.

4. Snow fencing used for tree protection shall be firmly secured along the drip line, but shall be no less than six (6) feet from the trunk.

5. The grade of the land located within the drip line shall not be raised or lowered more than six (6) inches unless compensated by welling or retaining wall methods; and in no event shall welling or retaining wall methods be less than six (6) feet from the trunk of a tree.

6. No soil stockpiling, storage of building materials, construction equipment or vehicles shall be permitted within the drip line or within six (6) feet of any remaining trees, whichever is greater.

7. Any clearing within the drip line, or within six (6) feet of the trunk of a remaining tree, whichever is greater, shall be done by hand-operated equipment.

8. Where a tree that has been noted for preservation is severely damaged and unable to survive, tree replacement shall occur as provided in Section 7.

7. TREE REPLACEMENT AND REFORESTATION

A. The replacement of trees shall occur as prescribed in the following table.
### Tree Replacement Schedule

<table>
<thead>
<tr>
<th>Caliper of Existing Tree Removed</th>
<th>Number of Replacement Trees (3&quot; caliper)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 6 inches</td>
<td>1</td>
</tr>
<tr>
<td>Between 6 &amp; 12 inches</td>
<td>3</td>
</tr>
<tr>
<td>Between 12 &amp; 18 inches</td>
<td>4</td>
</tr>
<tr>
<td>Between 18 &amp; 24 inches</td>
<td>5</td>
</tr>
<tr>
<td>Between 24 &amp; 30 inches</td>
<td>7</td>
</tr>
<tr>
<td>Between 30 &amp; 36 inches</td>
<td>10</td>
</tr>
<tr>
<td>36 inches or greater</td>
<td>The equivalent of 3&quot; caliper trees or greater needed to equal the DBH of the removed tree</td>
</tr>
</tbody>
</table>

1. Replacement tree(s) shall be of nursery grade quality, balled and burlapped and located on site. Where replacement trees are required but not suitable for the particular site prescribed due to the size of the site, (insert municipal name) shall deposit the trees into a community tree bank. Trees deposited into the community tree bank shall be utilized for planting on public lands (Policy Decision).

2. The type of replacement tree(s) shall be the same as the species removed from the site or other as approved by the (governing body).

3. The planting of all replacement trees shall be done by or supervised by a person with horticultural training in tree care and planting methods.

4. Newly planted replacement trees shall be monitored for a period of one year to ensure the health of the trees. If the replacement trees die within the one year period, the developer/applicant shall replace the dead tree.

8. **TREE REMOVAL AND PROTECTION ON RESIDENTIAL, COMMERCIAL, INDUSTRIAL AND BUSINESS ZONED LOTS (EXCLUDING MAJOR AND MINOR SUBDIVISIONS AND SITE PLANS)**

A. **Applicability** - On any residential lot that is less than two times the required lot size with a tree removal rate of five (5) or more trees with a ten (10) inch DBH or greater in a two (2) year period; or, any residential lot that is twice the required lot size or greater with a tree removal rate of more than six (6) trees with a ten (10) inch DBH or greater in a two (2) year period shall submit an application for a tree removal permit to the (appropriate municipal officer). The application and development proposal shall conform to the provisions contained herein.

2. The provisions of this section shall also apply to all commercial, industrial and business zoned lots.

C. **Application Form** - The application form shall be available from the (appropriate municipal officer).
and shall include the following information:

1. Name and address (street and lot and block) of the owner of the premises and status of legal entity (individual, partnership, corporation of this or any other state, etc.);

2. Description of the premises where removal is to take place, including lot and block numbers, and street address as assigned;

3. A list of all trees to be removed with a DBH equal to or greater than ten (10) inches identified by size and species, including total number of each species to be removed.

4. Purpose for tree removal (construction, building addition, street or roadway, driveway, utility easement, recreation area, patio, parking lot, etc.);

5. Such other information as may be deemed necessary in order to effectively process and decide such application.

D. Sketch Data

1. Base information
   a. A sketch shall be provided showing the location of the tree(s) to be removed with a DBH of ten (10) inches or greater.

2. Design requirement
   a. Trees to be removed shall be those trees necessary to permit the construction of buildings or building additions, structures, driveways, septic fields, decks and lawn areas. The trees removed shall not constitute more than one half acre or shall be no more than 50 percent of the lot size, whichever is less. Existing vegetation shall be preserved to the greatest extent feasible.

E. Site Protection

1. Site protection measures shall be provided in accordance with Section 6C.

F. Tree Removal Criteria - In addition to the design requirements stated above, the (insert appropriate municipal officer) may grant a tree removal permit based upon one or more of the following circumstances:

1. Where the location of an existing tree provides no other alternative but to place a structure outside the permitted building setbacks.

2. Where the location of an existing tree negatively impacts on an existing septic field.

3. Where no other alternative exists for the placement of a building, building addition, structure, septic field, driveway, deck, patio or lawn area for the recreational use by the inhabitants of the building or dwelling, or any other authorized improvements, but in the vicinity of an existing
4. Where the location or growth of a tree inhibits the enjoyment of any outdoor pool, patio or deck.
5. Where the location, angle or growth of an existing tree makes it a hazard to structures or human life.

**Review by Planning Board** - If, in the opinion of the (insert appropriate municipal officer), the request for tree removal does not satisfy the above criteria, then the application may be forwarded to the Planning Board for action.

**Tree replacement**

1. Tree replacement shall be accordance with the provisions in Section 7 of this ordinance.

**REVIEW STANDARDS**

In accordance with the design requirements provided in this ordinance, unless otherwise indicated herein, a tree removal permit may only be granted for the following reasons and under the following terms and conditions:

**A.** Where the area proposed for tree removal is to be occupied by: a building or other structure; a street or roadway; a driveway; a parking area; a patio; a swimming pool; a recreation area; a power, drainage, sewerage or any other utility line, easement, or right-of-way, or where the area of tree removal is 20 feet or less from either side of or around the perimeter of any of the foregoing, whichever is applicable.

In areas proposed for tree removal which are not to be occupied by any of the uses or facilities set forth in part A of this Section:

1. That the continued presence of such tree or trees is likely to cause danger to persons or property upon the property for which removal is sought, or upon adjoining or nearby property.

2. That the area where such tree or trees are located has a cut, depression or fill of land, or the topography of the land is of such a character as to be injurious or dangerous to such tree or trees, or to tree or trees located nearby.

3. That the removal of trees is for the purpose of conducting forestry activities, which activities include, but are not limited to, the harvesting of trees in accordance with a forest management plan and the thinning out of a heavily wooded area, with some trees to be removed, and other trees to remain.

Upon an express finding by the appropriate decisional authority that the proposed tree removal will not result in or cause, increase or aggravate any or all of the following conditions: impaired growth or development of remaining trees or shrubs on the property of the applicant or upon adjacent property, soil erosion, sedimentation and dust, drainage or sewerage problems, dangerous or hazardous conditions, and depression in the land value of the subject property and properties in the neighboring area.

The appropriate decisional authority shall have the power to affix reasonable conditions to the granting
of the permit for the removal of trees.

10. PROTECTION OF TREES

Whenever an application for tree removal is granted under the terms and conditions of this ordinance, the following protective measures shall be observed:

A. No material or temporary soil deposits shall be placed within the drip line of any existing tree to be preserved.

B. Except while engaged in tree removal, no equipment shall be operated within six feet of any tree protected by this ordinance nor shall such equipment be operated at any time in such a manner as to break, tear, bruise, decorticate or otherwise injure any living or dormant tree. Except while engaged in tree removal, all requirements of Section 6 shall be observed.

11. PERMIT APPROVAL

A. Time limits for approval

1. Where the permit application is submitted as a part of an application for major subdivision, minor subdivision or site plan approval, the time for approval shall be governed by the timing requirements applicable to major subdivision, minor subdivision or site plans.

2. Where the application is made in connection with a residential, commercial, business or industrial lot that is not part of a major or minor subdivision or site plan, the (insert appropriate municipal officer or body) shall act on the application within thirty (30) days of its receipt or within such additional time as is consented to by the applicant. Failure to act within thirty (30) days, or any extension thereof, shall be deemed to be an approval of the application and thereafter, a tree removal permit shall be issued.

3. Approval by default with regard to major subdivision, minor subdivision and site plan applications, shall not be deemed to be a waiver of a tree removal permit.

12. DURATION OF PERMITS

Permits granted for the removal of trees under the terms and conditions of this ordinance shall run with the land and shall remain in force and effect for the following periods of time, and not thereafter. Once the permit has expired, a new application must be submitted for review and a new permit issued.

A. If granted for a lot or parcel of land for which no building permit is required - one year from the date of issuance.

B. If granted for a lot or parcel of land for which a building permit is required, but for which no site plan approval is required by the Planning Board, until expiration of the building permit granted with such tree removal permit.

C. If granted for a lot or parcel of land for which site plan approval from the Planning Board/Zoning Board is required as a condition precedent to obtaining a building permit - until expiration of the site plan...
approval, or expiration of the building permit issued after such site plan approval.

If granted for a lot or parcel of land for which minor subdivision is sought - one year from the date of granting such minor subdivision.

If granted for a lot or parcel or land for which preliminary approval of a major subdivision is sought - until expiration of such approval.

**INSPECTION**

1. Prior to taking final action upon any application for tree removal, an inspection of the site shall be made by the (insert appropriate municipal officer, board or committee), in those cases where final determination is to be made by that body as to the granting or denial of an application.

2. Prior to any tree removal, all trees must be marked and areas to be cleared identified for inspection by a municipal representative.

3. The (insert appropriate title) shall periodically inspect the site throughout the duration of construction in order to ensure compliance with this ordinance. Such inspection shall be made of the site referred to in the application, and of contiguous and adjoining lands, as well as of lands in the vicinity of the application, for the purpose of determining drainage conditions and physical conditions existing thereon.

**NOTICE OF COMMENCEMENT OF TREE REMOVAL**

A. The holder of a tree removal permit shall notify the (insert appropriate municipal officer) in writing at least four (4) business days in advance of when the tree removal activity will commence.

B. The notice shall also include information as to the manner of disposal of the removed trees.

In the case of the removal of dead or diseased trees, the dead or diseased trees shall not be turned into mulch and applied to the site, but shall be disposed of in a manner so as not to disease other trees on site.

**FEES**

1. A review fee of ___ dollars shall accompany the application for tree removal.

**PENALTIES**

When regulated trees are removed without a tree removal permit, the affected areas shall be replanted to the satisfaction of the appropriate municipal authority.
EROSION CONTROL ORDINANCE
SOIL EROSION & SEDIMENT CONTROL
MODEL ORDINANCE

1. STATUTORY AUTHORIZATION

This ordinance is adopted pursuant to the provisions of the Soil Erosion and Sediment Control Act, Chapter 251 of the New Jersey Public Laws of 1975, N.J.S. 4:24-39 and following.

2. TITLE

This ordinance shall be known and may be cited as the Soil Erosion and Sediment Control Ordinance of (insert municipal name).

3. PURPOSE

To promote the public health, safety, convenience, general welfare and water quality of (insert municipal name) through the protection of environmental resources by preventing floods and controlling soil erosion, sedimentation and related environmental damage resulting from, but not necessarily limited to, the disturbance of land or earth by construction activities such as those for housing, commercial, utility, highway, public works and other similar developments, as well as from the modification of stream channels and drainageways and the creation of recreational facilities.

The specific purposes of this ordinance are to require adequate provisions for:

1. Protecting land from soil erosion.
2. Protecting the water quality and biodiversity of streams and waterbodies by preventing sedimentation.
3. Preventing danger to life and property from flooding resulting from excessive runoff and sedimentation of waterways and drainage facilities.
4. Detaining surface waters, including both temporary and permanent measures.
5. Preserving the recreational use of water bodies for swimming and fishing.
6. Reducing public expenditures for repair and maintenance of public facilities resulting from flooding, soil erosion and sedimentation.
7. Conserving the taxable value of property by preserving the environmental character of the municipality.
8. Ensuring that adequate inspection and enforcement procedures are followed.

4. APPLICABILITY

This ordinance shall be applicable to any major subdivision or site plan application as defined in the Municipal Land Use Law, or any project as defined in this ordinance. The provisions in this ordinance shall also be applicable to the new construction of single and multi-family dwelling units, as well as all building additions.

5. DEFINITIONS

(Municipalities should include the following definitions in their adopted ordinance unless the definition is already provided for in the adopted zoning ordinance)

Applicant - a person requesting the issuance of a land disturbance permit

Application - a submission meeting the requirements of a complete application, as hereinafter defined

Approved Plan - a plan, as hereinafter defined, which has been reviewed and approved by the proper municipal authority

Certification - a written and signed statement by the municipal engineer that specific construction and/or land treatment measures required by a Plan, as hereinafter defined, have been performed in accordance with all of the terms and conditions therefore and in accordance with State standards, as hereinafter defined, and the provisions of this ordinance

Clearing - any activity which removes all of the vegetative ground cover

Complete Application - the submission to the municipality of the following:

a. an application form completed and executed by the applicant
b. a Plan, as hereinafter defined
c. all required accompanying documents
d. the appropriate review, escrow and inspection fees

Conditional use - a land use permitted under the Zoning Ordinance of (insert municipal name), but only upon the issuance of an authorization therefore by the municipal Planning Board or Zoning Board of Adjustment

Construction permit - a permit issued for a building or structure in accordance with the State Uniform Construction Code Act and Regulations promulgated thereunder

Critical area - an area which has a high potential for erosion, sedimentation or related
environmental damage, or an area which has experienced such damage.

**Cut** - a portion of land surface or area from which earth has been removed or will be removed by excavation; the depth below original ground surface to excavated surface.

**Detention pond or basin** - a pond, basin or other structure or measure that provides for temporary storage of storm water and which includes a spillway or other facility to release the water at a controlled rate of flow.

**Diversion** - a channel with or without a supporting ridge on the lower side constructed across or at the bottom of a slope.

**Embankment** - a man-made deposit of soil, rock or other materials.

**Erosion** - the detachment, wearing away or movement of soil or rock fragments by the action of water, wind, ice or gravity.

**Excavation** - any act by which soil or rock is cut into, dug, quarried, uncovered, removed, displaced or relocated and shall include the conditions resulting therefrom.

**Existing grade** - the vertical location of the existing ground surface prior to excavation, cutting or filling.

**Farm conservation plan** - a plan developed in accordance with the ____ County Soil Conservation District which provides for use of land, within its capabilities and treatment, within practical limits, according to chosen use to prevent further deterioration of soil and water resources.

**Fill** - a man-made deposit of soil, rock or other materials.

**Finished grade** - the final grade or elevation of the ground surface conforming to a proposed design.

**Floodplain** - the land bordering or adjacent to a river, stream, brook, lake, pond, swamp or other waterway which is subject to flooding as evidenced by a. observed or recorded flood events; b. alluvial soil as shown on soil maps; or c. as determined by other soil or hydraulic studies.

**Government agency** - any department, commission, independent agency or instrumentality of the United States or of the State of New Jersey, and any County or other governmental unit.

**Grading** - any stripping, cutting, filling or stockpiling, or any combination thereof, this term including the land in its cut or filled condition.

**Land** - any ground, soil or earth including marshes, swamps, drainage ways and areas not
permanently covered by water

**Land disturbance** - any activity involving the clearing, cutting, excavation, grading, filling, storing, transporting of land or any other activity which causes land to be exposed to the danger of erosion

**Land disturbance permit** - a permit issued pursuant to the provisions of this ordinance authorizing land disturbance subject to the terms and conditions of the permit

_____ County Soil Conservation District - a governmental subdivision of this State, which encompasses (insert municipal name), organized in accordance with the provisions of N.J.S. 4:24-1 and following

**Mulching** - the application of plant or other suitable materials on the soil surface to conserve moisture, hold soil in place and aid in establishing plant cover

**Multi-family dwelling unit** - any building containing two or more dwelling units per building and being designed for occupancy of families living independently of one another

**Natural ground surface** - the existing surface of land prior to any land disturbance

**Natural drainage** - channels formed in the existing surface topography of the earth prior to changes made by unnatural causes

**Permit** - see land disturbance permit

**Person** - any individual, firm, partnership, corporation or other legal entity, public or private, including a government agency

**Plan** - see Soil Erosion, Sediment Control and Flood Prevention Plan

**Planned development** - any planned development that may be permitted under the provisions of the Zoning Ordinance of (insert municipality name)

**Professional engineer** - an engineer duly registered or licensed by the State of New Jersey to practice in the field of civil engineering

**Project** - any activity, undertaking, construction or work of any nature which involves land disturbance. The term includes but is not limited to the improvement or development of land pursuant to any conditional use, construction permit, planned development, site plan, subdivision or zoning variance

**Retention pond or basin** - a facility designed to retain stormwater runoff on a development site
Sediment - soil material, both mineral and organic, that is in suspension, is being transported or has been moved from its site of origin by erosion

Sediment basin - a pond, basin or other structure or measure that provides for the detention of water and the deposit of sediment

Single-family dwelling unit - a detached building designed and occupied by a single family

Site - a lot, tract or parcel of land or a combination of contiguous lots, tracts or parcels of land

Site plan - a plan for the development of one (1) or more lots required to be reviewed and approved in accordance with the provisions of the Site Plan Review and Approval ordinance of the municipality

Slope - the degree of deviation of a surface from the horizontal usually expressed in percent or degree

Soil - all unconsolidated mineral and organic material of whatever origin which overlies bedrock and which can be readily excavated

Soil Erosion, Sediment Control and Flood Prevention Plan - a plan (referred to in this ordinance by the term "Plan") which indicates construction and/or land treatment measures, including a schedule of the timing for their performance, to effectively prevent floods and minimize soil erosion and sedimentation. Every Plan shall meet or exceed State standards as hereinafter defined

Soils engineer - a professional engineer who is qualified by education, training and experience to practice applied soil mechanics and foundation engineering

Standards - State standards

State standards - standards for soil erosion and sediment control in New Jersey as promulgated by the State Soil Conservation Committee

Stripping - any activity which removes or significantly disturbs vegetated or otherwise stabilized soil surface, including clearing and grubbing operations

Subdivision - the division of a lot, tract or parcel of land into two (2) or more lots, tracts or parcels in accordance with provisions of the Subdivision Ordinance of (insert municipal name)

Temporary protection - stabilization of erosion or sediment-producing areas of land

Vegetative protection - stabilization of erosive or sediment-producing areas of land by covering the soil with one (1) or more of the following: permanent seeding or permanent plantings
producing long-term vegetative cover; short-term seeding or short-term plantings producing temporary vegetative cover; and sodding, producing areas covered with a turf or perennial sod-forming grass.

**Watercourse** - a natural or artificial river, stream, brook, ditch, channel, conduit, gully, drain, culvert, ravine, wash or other waterway in which water flows in a definite direction or course, either continuously or intermittently, within a definite channel, and including any area adjacent thereto subject to inundation by reason of overflow of flood water.

**Zoning variance** - any land use which may be permitted as a departure from the provisions of the Zoning Ordinance of (insert municipal name).

For the purposes of this ordinance the word "shall" indicates a mandatory requirement, and the word "may" indicates a permissive action.

6. **LAND DISTURBANCE PERMIT REQUIRED**

No person within (insert municipal name) shall undertake or commence any project, as defined in this ordinance, except a project which is exempt under the provisions herein without first having obtained a land disturbance permit.

7. **ACTIVITIES EXEMPT FROM PERMIT REQUIREMENTS**

The following projects are exempt from the provisions of this ordinance:

A. Land disturbance in accordance with a farm conservation plan.

B. The planting and harvesting of crops, plants, flowers or shrubs in fields or areas devoted to such use prior to the adoption of this ordinance.

C. Road and road shoulder maintenance work performed by the (insert municipal name) Department of Public Works.

D. Projects exempt from the requirements of State law.

E. Land disturbance of an area less than one thousand (1,000) square feet.

8. **APPLICATIONS FOR LAND DISTURBANCE PERMITS**

A. **Jurisdiction Over Applications**
All other applications for land disturbance permits shall be reviewed and acted upon by the municipal engineer.

B. Application Forms

An applicant shall obtain application forms from the municipality. The form shall require at a minimum, the name of the applicant, the site location by street address and block and lot number, the proposed use of the site, any related applications for land use development approval and sufficient information for calculation of the filing fee required by (insert municipal name). The form shall also provide adequate space for approval or disapproval as well as the insertion for special provisions of terms and conditions of approval and the amount of any performance guarantee required.

C. Plan to Accompany Application - Every application for a land disturbance permit shall be accompanied by a Plan meeting the requirements set forth in this Section.

1. The Plan

   1. The Plan shall comprise a map and written report (together with whatever other instruments, writings, drawings, plans or specifications are necessary or appropriate as required by the governing body under the circumstances) which fully and adequately describe both temporary and permanent measures to be employed to control, minimize and protect against soil erosion, sedimentation and flooding from a proposed land disturbance, taking into account the particular nature and characteristics of the land, the surrounding area, the watercourses, the land disturbance and the development involved.

   2. The Plan shall cover all stages and aspects of the proposed land disturbance and planned development from grading, stripping, excavation and other site preparation through and including both finished grade and the installation of permanent improvements. It shall accordingly include a timing schedule or schedules indicating both:

      1. The anticipated starting and completion dates of each step in the land disturbance and development sequence and the time of exposure of each land area prior to the completion of effective erosion and sediment control measures,

      2. The sequence of installation of planned erosion and sediment control measures as related to the disturbance and development sequence referred to in paragraph 1. above, including anticipated starting and completion dates of such installations. The Plan shall
include a soil map prepared by the Soil Conservation Service upon which the proposed development shall be superimposed. The soil boundaries shall also be shown on the Plan.

2. General Conditions

1. It shall be the responsibility of the applicant to design the project so as to maintain as nearly as possible in its present state and condition any stream, watercourse, swale, floodplain, wetland, swamp, pond or lake.

2. The maintenance or repair of any of the above or of drainage facilities damaged or otherwise adversely affected by reason of the applicant's project shall be the responsibility of the applicant. Such maintenance or repair work shall be promptly performed.

3. It shall be the responsibility of the applicant to promptly remove sediment from any stream or watercourse, pond, lake, or drainage facility resulting from the applicant's project.

4. No person shall block, impede the flow of, alter or construct any structure or deposit any material or commit any act which will affect normal or flood flow in any stream or watercourse without having obtained a land disturbance permit and, where required, prior approval from the County Soil Conservation District.

5. An objective of the Plan shall be to retain sediment to the maximum extent feasible.

3. Soil Erosion and Sediment Control Measures - Soil erosion and sediment control measures shall as a minimum utilize and meet standards for soil erosion and sediment control in New Jersey as promulgated by the State Soil Conservation Committee. In addition, to the extent applicable in particular situations, the following measures or considerations shall be incorporated in the Plan:

1. The smallest practicable area of land shall be disturbed at any one time during development and the duration of such disturbance shall be kept to a practical minimum.

2. Whenever feasible, natural vegetation and the natural ground surface shall be retained and protected. The top layer of soil for a depth of 12 inches of any disturbed areas shall be set aside for retention on the premises and shall be re-spread over the premises when the rest of the soil has been removed.

3. Temporary vegetative protection, plant cover or mulching, or a combination
thereof, shall be used to protect erosion areas during development.

4. Diversions and outlets, both temporary and permanent, shall be constructed or installed to accommodate the runoff caused by the changed soil and surface conditions during and after development.

5. Disturbed soil shall be stabilized as quickly as practicable.

6. Until the disturbed area is stabilized, sediment in the runoff water shall be trapped and removed by the use of debris basins, sediments basins, desilting basins, silt traps or other acceptable methods.

7. Adequate provisions shall be made to minimize surface water from damaging slopes and embankments. Diversions may be utilized for this purpose.

8. Fill shall be placed and stabilized so as to minimize erosion and shall not encroach on watercourses closer than one hundred (100) feet unless specifically approved.

9. During grading operations, approved methods for dust control shall be exercised.

10. During grading, excavation and other construction activities, slopes and embankments shall be stabilized by mulching with straw sprayed with an asphalt mixture, or jute matting staked in position, or a seeding of annual rye grass, or a combination of the foregoing, or other acceptable method.

11. Permanent (final) vegetative protection, plant cover, lawn or ground cover, and mechanical erosion control devices and measures shall be installed or constructed and completed as soon as practicable.

12. Permanent improvements, such as pavement, catch basins, curbs and the like, shall be installed or constructed and completed as soon as practicable.

4. Qualifications of Preparer of Plan - The Plan shall be prepared by a licensed professional engineer and shall be signed and sealed by the person who prepared it.

5. Fees to Accompany Application

1. Review Fee to Accompany Application - Every applicant for a land disturbance permit shall pay a review fee to the municipality at the time of filing the application. The review fee shall be based upon a fee schedule as adopted and
updated annually by the governing body. However, if the application is made in connection with an application for the development of land pursuant to the Land Development Ordinance of (insert municipal name), then no separate application fee shall be required for the land disturbance permit as the application will be processed as a part of the application for the development of land and will be subject to the technical review fees provided by Section ____ (insert appropriate section or chapter of Subdivision land development ordinance if it exists) of the Land Development Ordinance of (insert municipality name).

2. Escrow Fee to Accompany Application - An escrow fee shall accompany every application for a land disturbance permit at the time of filing an application to (insert municipal name). The appropriate escrow fee shall be based upon a fee as adopted and updated annually by the governing body. No building permit will be issued unless the appropriate escrow fee has been submitted to the municipality. The escrow fee will be used to pay for inspections by the municipality or its engineer. If additional inspections are required, the escrow account shall be increased to cover the cost of additional inspections. However, if the application is made in connection with an application for the development of land pursuant to the Land Development Ordinance of (insert municipal name), then no separate escrow fee shall be required for the site as the application will be processed as a part of the application for the development of land and will be subject to the technical review fees provided by Section ____ (insert appropriate section or chapter of Subdivision land development ordinance if it exists) of the Land Development Ordinance of (insert municipality name).

3. In the event that the land disturbance permit was not issued in connection with the approval of an application for the development of land pursuant to the Land Use Ordinance, then there shall be no inspection fee for the initial inspection of work performed pursuant to the permit. If more than one (1) inspection of a property is required to be made by the municipal engineer by reason of a failure to comply with the terms and conditions of the permit, then the owner of the property shall pay to (insert municipal name) an inspection fee for each additional inspection. The fee shall be in accordance with the fee schedule of inspection fees established and from time to time amended by the governing body. All fees for any additional inspections shall be paid to the municipality prior to the issuance of a certification of completion of work in accordance with this ordinance.

4. No plans submitted to (insert municipal name) shall be approved unless all appropriate application and escrow fees have been paid by the applicant.

6. Application Procedure - A complete application for a land disturbance permit shall be filed with the municipality.
The applicant shall file ___ (insert appropriate #) copies of the application form accompanied by ___ (insert appropriate #) copies of the Plan and any other required documents.

9. ACTION ON APPLICATIONS

1. Review of Applications

   1. Applications for land disturbance permits within the jurisdiction of the Planning Board shall be reviewed by the Planning Board and the municipal engineer. The municipal engineer shall furnish comments on the application to the Planning Board within ___ (insert appropriate number) days after the submission of the application unless the Planning Board advises the municipal engineer of a longer period of time for his review. The Planning Board may refer an application to the ______ County Soil Conservation District, the municipal Environmental Commission or any other qualified governmental agency or agencies or consultants for review and comments within a period of time indicated by the Planning Board.

   2. Applications within the jurisdiction of the municipal engineer shall be reviewed by the municipal engineer. An application may be referred by the municipal engineer to the ______ County Soil Conservation District or any other qualified governmental agency or agencies or consultants for review and comments within a period of time indicated by the municipal engineer.

   3. The purpose of every review shall be to determine whether or not the application, Plan and any other accompanying documents meet the standards for soil erosion and sediment control in New Jersey as promulgated by the State Soil Conservation Committee and any other standards established by this ordinance.

2. Approval of Applications

   1. An application within the jurisdiction of the Planning Board shall be approved by the Planning Board if upon review the Board determines that the application meets the standards referred to in this ordinance. An application within the jurisdiction of the municipal engineer shall be approved by the municipal engineer if upon review it is determined that the application meets such standards.

   2. In the event that an application does not meet the standards referred to in this ordinance, the Planning Board or the municipal engineer, as the case may be, may approve the application subject to the imposition of terms and conditions which will provide for compliance with such standards. Any such terms and conditions shall be endorsed upon or attached to the application before approval is granted.

   3. Other special terms and conditions may be imposed upon an application by the
approving authority in order to assure proper implementation of the Plan in accordance with the intent and purposes of this ordinance and may include fixing the time schedule for exposure of land areas and for the construction and installation of improvements or the taking of other measures to prevent soil erosion sedimentation and flooding and may require that such work be completed prior to any site development work.

4. All terms and conditions imposed by the Planning Board or municipal engineer, as the case may be, shall become a part of the approved Plan for all purposes of the provisions of this ordinance.

5. As to every application which is approved, the approving authority shall endorse thereon the amount of the performance guarantee required pursuant to the provisions of this ordinance.

6. If an application is disapproved, the reason for disapproval shall be endorsed upon or attached to the application.

7. As soon as any application has been reviewed and acted upon, ___(insert appropriate number) copies of the application with endorsements or attachments shall be forwarded to the municipality. The municipality shall promptly notify the applicant in writing of the action taken by the Planning Board or municipal engineer, as the case may be, indicating whether the application was approved as submitted, approved subject to attached conditions, or denied for reasons stated. In cases of approval, the municipality shall also notify the applicant of the amount of the performance guarantee required to be furnished to the municipality.

8. The municipality shall also notify the municipal Environmental Commission of action taken by the Planning Board on applications within its jurisdiction. (Delete sentence if no environmental commission exists, or add other appropriate municipal body)

C. **Time Limitations**

1. The municipal Planning Board or municipal engineer, as the case may be, shall approve or disapprove the application for a land disturbance permit within a period of thirty (30) days after the submission of a complete application to the municipality, unless by mutual agreement in writing between the applicant and the reviewing authority the period of thirty (30) days is extended for an additional period of thirty (30) days.

2. Failure to approve or disapprove a complete application within such period or such extension thereof shall constitute approval of the application, and the applicant shall be entitled to the issuance of a land disturbance permit by the municipality as
though the application had been approved pursuant to the provisions of this ordinance in the form in which the application was submitted.

3. For purposes of this subsection, a major revision by the applicant of the Plan accompanying the application shall constitute a new submission of an application by the applicant.

4. The provisions of this subsection shall not relieve an applicant of the obligation to furnish a performance guarantee as required by this ordinance nor shall the provisions of this subsection relieve an applicant of any other obligation imposed by this ordinance upon a person to whom a land disturbance permit is issued.

4. Notification of ______ County Soil Conservation District

1. Immediately following action by the municipal Planning Board or municipal engineer, as the case may be, whether such action constitutes approval or disapproval, the municipality shall forward one (1) of the [insert appropriate numbers] complete applications received from the Planning Board or municipal engineer to the ______ County Soil Conservation District, together with such other information as the District may require.

2. In the event that an applicant obtains approval by inaction under the provisions of this ordinance, the municipality shall obtain from the Planning Board or municipal engineer, as the case may be, two (2) complete applications, and the municipality shall forward one (1) complete application to the ______ County Soil Conservation District, together with a statement of approval by inaction and such other information as the District may require.

10. ISSUANCE OF PERMITS

A. Requirement for Performance Guarantee

1. Following approval of an application for a land disturbance permit and prior to the issuance of the permit, the applicant shall furnish the municipality with a performance guarantee in an amount specified by the municipal Planning Board or municipal engineer on the approved application or as fixed by the municipal engineer in the event of approval by inaction.

2. A performance guarantee shall not be required to exceed one hundred twenty (120%) percent of the total cost of the improvements and measures called for by the approved Plan, as the total cost thereof shall be estimated by the municipal engineer.

3. The performance guarantee shall set forth the date or dates on or before which the improvements are to be constructed or installed or on or before which specified
measures are to be taken.

4. The performance guarantee shall provide that if the municipality shall obtain injunctive relief against the person to whom the land disturbance permit issued funds necessary to effect compliance with such relief shall be immediately available to the municipality.

5. The performance guarantee shall also assure the payment of all inspection fees for the project as required by this ordinance.

6. The performance guarantee may be in the form of a surety bond issued by a surety company authorized to do business in New Jersey, or the applicant may elect to deposit funds with the municipality by certified check, such funds to be held in a separate interest bearing account pursuant to a cash deposit agreement between the municipality and the applicant. All performance guarantees shall be subject to approval by municipal attorney as to form, sufficiency and execution. Performance guarantees shall be released.

2. Issuance of Permit

Upon receipt of an approved application, or upon approval by reason of inaction, the receipt of a performance guarantee meeting the requirements of this ordinance, the municipality shall issue a land disturbance permit to the applicant. The municipality shall attach to the permit a copy of the complete application as approved, including the Plan and all accompanying documents.

11. PERFORMANCE OF WORK

A. General

A person to whom a land disturbance permit has been issued shall be responsible for the performance of all work in strict conformity with the approved Plan and all terms and conditions thereof, including the time schedule for exposure of land areas and for the construction and installation of improvements or the taking of other measures to prevent soil erosion, sedimentation and flooding.

2. Inspections by the Municipal Engineer

1. The municipal engineer shall inspect every project for which a land disturbance permit has been issued. The municipal engineer shall be responsible for enforcing compliance with the permit and the provisions and requirements of this ordinance.

2. To assist in making inspections, a copy of the land disturbance permit to which is attached a complete copy of the application with the accompanying Plan and other documents as well as any terms and conditions imposed by the approving authority shall be kept at the site at all times during construction.
3. Generally, inspections shall be conducted at the following times:
   1. Prior to any construction or measures, in order to check details of location and field conditions.
   2. Intermittently during construction and vegetative protection measures.
   3. After completion of all construction and establishment of vegetation.
   4. At other times as may be necessary because of unsatisfactory conditions.

4. The municipal engineer shall bring to the attention of the person to whom a land disturbance permit has been issued, or to his agent in charge of work at the site, any deviations from the approved Plan and any other violations of this ordinance in order that such deviations and violations may be immediately corrected.

3. Stop Work Orders

When circumstances warrant such action, the municipal engineer may issue a stop work order to a person to whom a land disturbance permit has been issued or to his agent in charge of work at the site. Thereupon, until all deviations from the approved Plan and any other violations of this ordinance have been corrected, no work shall be carried on at the site except such work as is necessary to effect such correction. If such deviations and violations are not promptly corrected, the municipal engineer shall bring the matter to the attention of the municipal administrator for appropriate action by the municipality.

4. Minor Modifications

When deemed necessary or appropriate by reason of conditions arising in the field during the course of the performance of work, the municipal engineer may order or approve amendments, changes or modifications of a minor nature in an approved plan.

5. Approval of Completion

1. When the municipal engineer finds that all construction or installation work and all measures required under an approved Plan have been fully performed in accordance with all the terms and conditions thereof, the municipal engineer shall approve the completed soil erosion and sedimentation control measures.

2. No Certificate of Occupancy shall be issued for any building or structure which is part of a project for which a land disturbance permit has been issued until the aforementioned approval has been received by the municipality.
12. MAINTENANCE OBLIGATION AND MAINTENANCE GUARANTEE

A. Maintenance Obligation

The person to whom a land disturbance permit has been issued and the subsequent owners of the property subject of the permit shall be responsible for and shall maintain all construction and installation work and measures performed pursuant to the permit in good order for a period of two (2) years following the issuance of the certification by the municipal engineer.

B. Maintenance Guarantee

1. Following the issuance of the certification, the person to whom the land disturbance permit was issued, or if such person is no longer the owner of the land comprising the project then the current owner or owners, shall furnish the municipality with a maintenance guarantee in an amount of fifteen (15 %) (insert appropriate percent) percent of the total cost of the improvements and measures called for by the approved Plan, as the total cost thereof shall be estimated upon completion by the municipal engineer.

2. The maintenance guarantee shall meet the other requirements established by this ordinance for performance guarantees, and it shall guarantee the payment of inspection fees during the maintenance period. The maintenance guarantee shall be released by the municipality name at the end of the two (2) year period provided that the maintenance obligation set forth in this ordinance has been fulfilled.

3. Release of Performance Guarantee

Upon the acceptance of a maintenance guarantee in accordance with the provisions of this section, (insert municipal name) shall release the performance guarantee furnished in accordance with the provisions of this ordinance.

13. APPEALS

Any person who claims to be aggrieved by any decision or action of the Planning Board or municipal engineer in the administration of the provisions of this ordinance may appeal to the governing body. The procedure followed with respect to such appeal shall be as set forth in Section 8 of the Municipal Land Use Law, N.J.S. 40:55D-17.

14. PENALTIES AND INJUNCTIVE RELIEF

1. If any person violates any of the provisions of this ordinance, any of the standards for soil erosion and sediment control in New Jersey as promulgated by the State Soil Conservation Committee, or any standard established by this ordinance, or if
2. Any person who violates any of the provisions of this ordinance, any of the standards for soil and sediment control in New Jersey as promulgated by the State Soil Conservation Committee, or any standard established by this ordinance, and any person who fails to comply with the provisions of an approved Plan, or any terms or conditions imposed by the municipal authority approving such Plan shall be liable to a penalty of not less than (insert dollar amount) dollars nor more than (insert dollar amount) dollars to be collected in a summary proceeding pursuant to the Penalty Enforcement Law (N.J.S. 2A:58-1 and following). The Superior Court, County Court, County District Court and Municipal Court shall have jurisdiction to enforce the Penalty Enforcement Law. If the violation is of a continuing nature, each day during which it continues shall constitute an additional separate and distinct offense.