WETLAND MITIGATION PLAN
NEW LIGHT CREEK SITE

R-2000

Wake County, North Carolina

State Project No. 8.0401712

Prepared for:

North Carolina Department of Transportation
Planning & Environmental Branch
Raleigh, North Carolina

Prepared by:

Rust Environment & Infrastructure
5510 Six Forks Road, Suite 200
Raleigh, North Carolina 27609

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EXECUTIVE SUMMARY

The North Carolina Department of Transportation (NCDOT) proposes to construct the Northern Wake Expressway (R-2000) on a new location from NC 55 west of Morrisville to US 64 east near Knightdale (Figure 1). Construction of this project will result in unavoidable impacts to wetlands which occur within the proposed corridor. About 4.8 ha (12 ac) of wetland impacts are associated with R-2000E.

The New Light Creek Site has been selected as a mitigation site for these wetland impacts. The property is located north of Mangum Dairy Road along New Light Creek near the Granville/Wake county line. The site is 8 ha (19.8) acres in size. The main feature of the site is 5.1 ha (12.3 ac) of pasture within the floodplain of New Light Creek. The pasture has been drained by a main ditch which runs parallel to the creek, and tile drains which feed into this ditch. At the north end of the pasture is a 1.2 acre wooded area and then another pasture that is much smaller (0.8 acres), but also within the floodplain of the creek. The remainder of the site is an upland hill side.

Prior to conversion of the land to pasture/cropland in the 1950's the site was reportedly very wet. Wetland mitigation will consist of restoring the site to pre-development conditions. Wetland hydrology will be restored to this field by removal of tile drains and filling of the main ditch. This should raise the groundwater table sufficiently during the early and late part of the growing season to create saturated soil conditions at or near the ground surface. The flat pasture area will be slightly resculpted to provide a varied microtopography of depressions, swales, and slightly higher areas. Drainage from two small intermittent streams will be routed onto the floodplain and into the depressions to help maintain wetland hydrology across the site. The depressions should retain water for variable duration following a storm, which will create temporary pools and habitat for amphibians. Once the site has been contoured, it will be planted with selected bottomland hardwood species. Riparian vegetation will also be established along the banks of New Light Creek. The restoration area is 4.96 ha (12.27 acres) in size.

The site offers a high likelihood of success because minimal site alteration will be needed to restore hydrology. In addition, the proposed restoration will be completed in two phases to maximize success. The major alterations will be performed during early fall when it is typically dry. This strategy will provide an opportunity to complete post-construction monitoring of the hydrology during the last part of the growing season and before planting is performed. In this way, the hydrology can be slightly "modified" during the winter months (Phase 2) through additional grading or surface water detention should that be necessary.

Restoration of this site will provide 12 Mitigation Credits to mitigate for R-2000E wetland impacts. In addition, restoration of wetlands along New Light Creek will provide water quality benefits to the Falls Lake Watershed (classified as Class WS-IV) and will help form an important riparian corridor for wildlife, in combination with Falls Lake Game Lands immediately downstream of the site.

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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

The North Carolina Department of Transportation (NCDOT) proposes to construct the Northern Wake Expressway (R-2000) on a new location from NC 55 west of Morrisville to US 64 east near Knightdale (Figure 1). Construction of this project will result in unavoidable impacts to wetlands which occur within the proposed corridor. About 4.8 ha (12 ac) of wetland impacts are associated with R-2000E.

To mitigate these impacts, it will be necessary to create or restore 4.8 ha (12 ac) of wetlands to meet the NC Division of Water Quality requirements. The US Army Corps of Engineers will also require additional wetland restoration, enhancement, or preservation, beyond the above 4.8 ha (12 ac) of restoration, to fully compensate for wetland impacts. The amount of mitigation will be dependant upon the type of mitigation.

The New Light Creek Site has been selected by the NCDOT for mitigation of wetland impacts that will occur due to the construction of R-2000E. The property consists of a portion of a farm along New Light Creek near the Wake/Granville county line in northern Wake County (Figure 1). The mitigation area consists of about 6 ha (15 ac) of pastureland within the floodplain of New Light Creek.

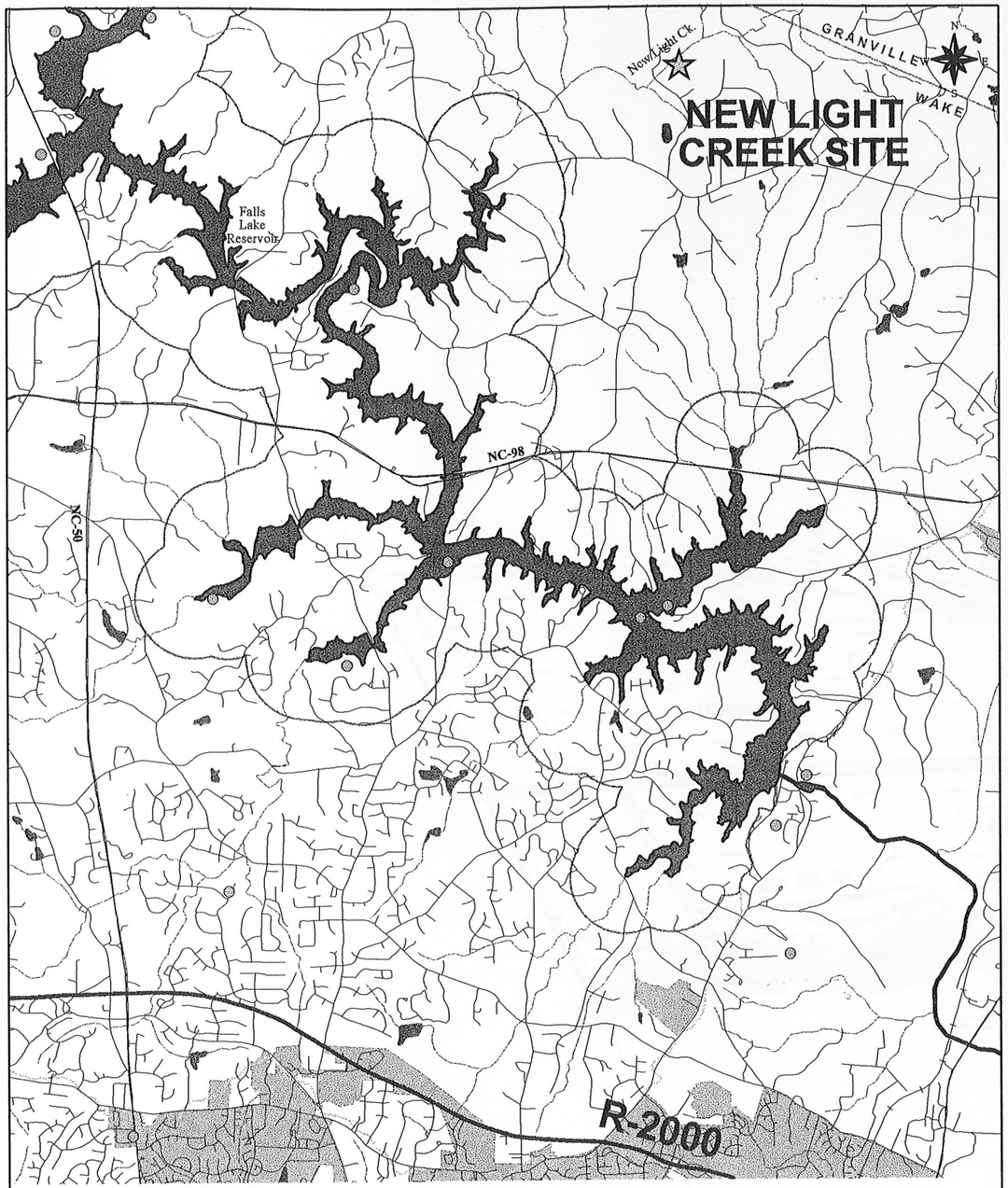
Rust Environment & Infrastructure (REI) conducted a feasibility study of the site. A site walk-over was conducted with the US Army Corps of Engineers, Division of Water Quality, and NC Wildlife Resources Commission on March 9, 1998. At that time the agency personnel verbally agreed that the site appeared to be suitable as a mitigation site. A conceptual wetland mitigation plan was then prepared and presented to agency personnel on April 16, 1998. Recommendations made in this report are based on the analysis of existing information and data collected during field investigations and may change as additional information is collected.

1.2 STUDY AREA

The New Light Creek Site lies within the Piedmont Physiographic Province. This area was formed on metamorphic rock (biotite, gneiss and schist) of the Raleigh Belt. Topography of the area is characterized as rolling to hilly and contains steep slopes adjacent to major drainageways.

Elevations within the mitigation area range from 81 to 83 m (267 to 273 ft) National Geodetic Vertical Datum (NGVD). The adjacent slopes are steep and rise to 122 m (400 ft) within 457 m (1500 ft) east of the floodplain.

The surrounding properties are characterized by agricultural, wooded, and residential areas. The Falls Lake Game Lands owned by the US Army Corps of Engineers are located south of SR 1911.



New Light Creek Site
Natural Heritage Elements
R2000
TIP
Primary Routes
Rivers
Streams
Critical Area - Water Supply
Protected - Water Supply
Municipal Boundaries
County Boundaries

0.5 0 0.5 Miles

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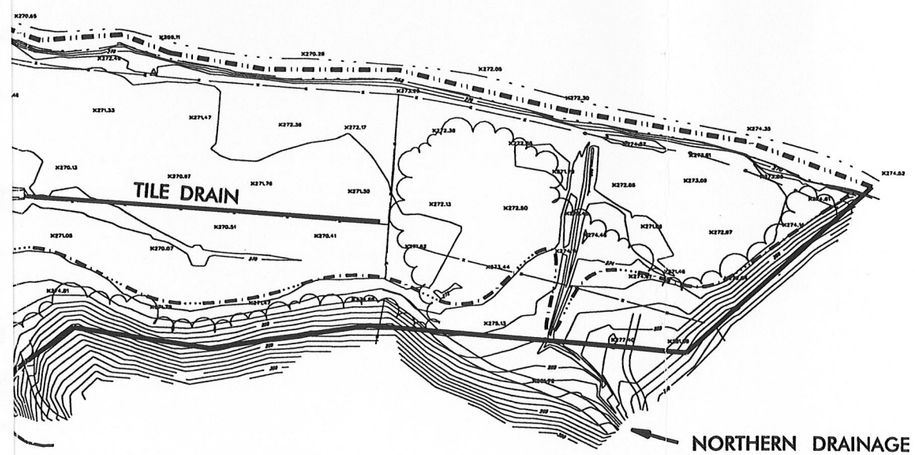
FIGURE 1
Location Map

New Light Creek
Wetland Mitigation Plan

Wake County, North Carolina

Cadastral and topographical data: NCDOT GIS, 1997. Projection: NAD83, m



100 0 200

SCALE 1" = 200'

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Figure 2
Existing Conditions

New Light Creek
Wetland Mitigation Plan

Wake County, North Carolina

2.0 EXISTING CONDITIONS

This section describes the current features of the mitigation site including existing topography, soils, plant communities, and drainage features. Figure 2 provides a site map showing many of these features.

2.1 GENERAL SITE DESCRIPTION AND HISTORY

The site is located east of SR 1191 (Mangum Dairy Road) adjacent to New Light Creek near the Wake/Granville county line. The site is located approximately 8 km (5 mi) northwest of Wake Forest, North Carolina in a rural area of Wake County.

The proposed mitigation site consists of a 8 ha (19.8 ac) tract which was once part of a larger dairy farm. The mitigation area is located in the floodplain and is bounded to the west by New Light Creek (Figure 2). Elevations of the mitigation area are nearly level ranging from 81 to 83 m (267 to 273 ft) National Geodetic Vertical Datum (NGVD). The adjacent slopes are steep and rise to 114 m (375 ft) within 366 m (1200 ft) east of the floodplain.

The site includes an approximately 5.0 ha (12.3 ac) pasture which is regularly grazed, and a smaller pasture [approximately 0.4 ha (0.9 ac)] in the northern portion of the site. These two areas are separated by a small wooded area which is approximately 0.5 ha (1.2 ac) in size. The main feature of the southern pasture is a ditch in the center of the pasture which drains to the south.

The site has been part of a dairy operation since the early 1950s. According to the landowner, prior to 1950 the site was wooded and so wet that only a few trees would grow. The two on-site tributaries drained into wet depressions within the floodplain, and there were no distinct stream channels leading into New Light Creek. In the late 1950s the site was timbered and the landowner dug the central ditch which is currently on the property. In the early 1960s, drain tiles were installed along the base of the slope to help drain several seepage areas. Drainage tiles were also installed at the head of the ditch to help drain the northern portion of the site. Once the site was drained, it was leveled by filling in the depressions. The site is currently used as pasture. It has also been used to grow corn.

The landowner has removed numerous fallen trees and debris from New Light Creek. He has straightened the section of the creek adjacent to his pasture by strategically placing downed trees in the meander bends.

2.2 NATURAL COMMUNITIES

Two communities are present on the site, pasture and upland forest. A third community, a floodplain forest is present immediately to the south of the site. A description of this community is provided as reference for conditions prior to conversion to farmland.

2.2.1 Pasture

The pasture consists of two fields separated by a small wooded area (described below). Vegetation in the pasture, which is regularly grazed by cattle, includes alfalfa (*Medicago sativa*), clover (*Trifolium spp.*) and orchard grass (*Dactylis glomerata*) which were planted by the owner. Other species observed in the field include henbit (*Lamium purpureum*), plantain (*Plantago virginica*), and dandelion (*Taraxacum officinale*).

The larger southern field consists of 5.0 ha (12.3 ac) in the southern portion of the property. This pasture has areas of hydric as well as nonhydric soils. Soils in the southern portion of the field consist of a grayish brown (10 YR 5/2) clay loam with oxidized rhizospheres. In the central and northern portions of the field, the soils are a brighter, nonhydric sandy loam. The smaller field, which is north of the small wooded area, is approximately 0.4 ha (0.9 ac) in size. The soils in this area consist of a gray (10YR 5/1) clay loam with oxidized rhizospheres.

The pastures are located along the floodplain of New Light Creek. According to the NRCS records, the potential for the presence of hydric soils in the pasture was noted, however, the presence of hydric soils has not been confirmed by the NRCS and this field was never classified as Prior Converted (PC) wetlands because a request for classification was never made by the landowner. The areas of the pastures adjacent to the toe of slope are characterized by small groundwater seepage areas which contained saturated soils.

2.2.2 Upland Forest

Approximately 180 m (590 ft) east of New Light Creek, the floodplain transitions to a steep slope. The species on this slope include white oak (*Quercus alba*), southern red oak (*Quercus falcata*), loblolly pine, eastern red cedar (*Juniperus virginiana*), umbrella magnolia (*Magnolia tripetala*), mockernut hickory (*Carya tomentosa*), American holly (*Ilex opaca*), and Christmas fern (*Polystichum acrostichoides*). This community, which occurs on the upland Appling soils, is similar to the Dry Oak-Hickory Forest as described in Schafale and Weakley (1993).

2.2.3 Floodplain Forest

This community, which occurs on the adjacent property to the south of the site, is dominated by sycamore (*Platanus occidentalis*) and river birch (*Betula nigra*), with American beech (*Fagus grandifolia*) along the levee. Moving upslope away from the creek, species are similar, but also include tulip poplar (*Liriodendron tulipifera*) and sweet gum (*Liquidambar styraciflua*). The shrub layer includes Chinese privet (*Ligustrum sinense*), blackberry (*Rubus sp.*), and the herbaceous layer includes poison ivy (*Toxicodendron radicans*), Japanese honeysuckle (*Lonicera japonica*), and aster (*Aster sp.*).

This floodplain forest may have included bottomland wetlands at one time, however, a ditch which runs parallel to New Light Creek from north to south approximately 76 m (250 ft) southeast of New Light Creek has reduced much of the hydrology in this area. The soils in some parts of this area are not hydric (10 YR 4/4) although they are mapped as hydric Wehadkee-Bibb soils (Section 2.4). It

is possible that this entire forested area was previously wetter; however, due to the drainage ditch which traverses it from the mitigation site (Section 2.3.3) the hydrology has been modified on the mitigation site.

There is an additional small floodplain forest area which separates the two pastures. This area is approximately 0.5 ha (1.2 ac) in size. Canopy species are similar to those above with the addition of some mature loblolly pine. There is no shrub layer and only some sparse ground cover at this time of year including wild onion (*Allium canadense*), and Japanese honeysuckle. The fauna in this habitat is likely limited due to its small size and fragmentation between the two pastures. Soils in this area are hydric (low chroma with mottles) but dry. There are some signs of overbank flooding from a stream which is channelized through this area. This unnamed tributary is described in Section 2.3.2.

According to NWI mapping, the New Light Creek floodplain is mapped as PFO1/4A (palustrine forested, needle-leaved evergreen and broad-leaved deciduous, temporarily flooded wetlands) indicating mixed loblolly pine and bottomland hardwood wetlands. A portion of the NWI map is provided as Figure 3.

2.3 CURRENT SITE HYDROLOGY

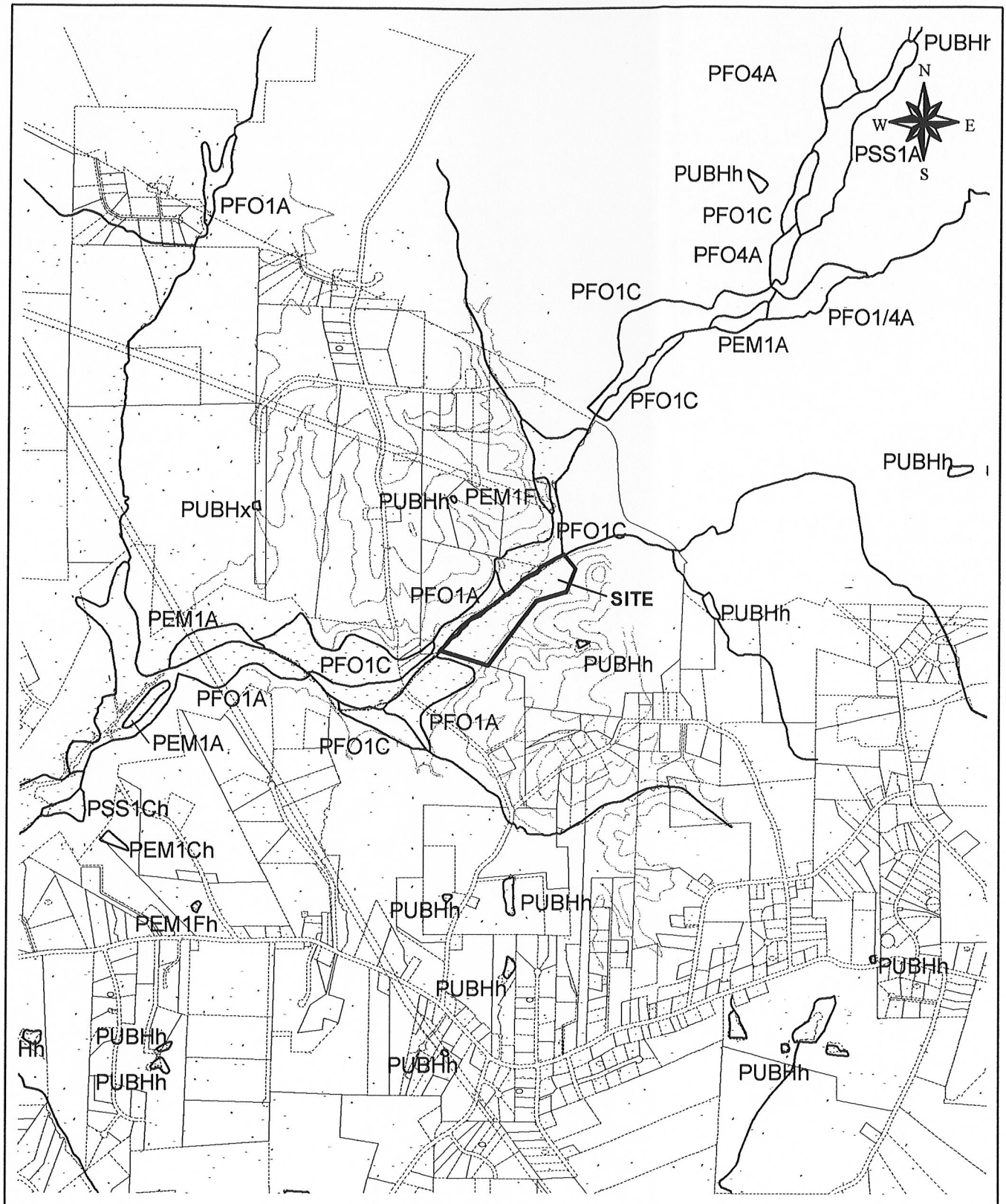
2.3.1 New Light Creek

New Light Creek originates about 6.4 km (4 mi) north of the project area and flows into Falls Lake, about 3.2 km (2 mi) to the southwest. The drainage basin above the site is about 29.5 sq k (11.4 sq mi). New Light Creek ranges from approximately 4.6 to 6.1 m (15 to 20 ft) wide within the project area, and has moderate streamflow. No stream flow data exists for New Light Creek, but anecdotal evidence indicates that it overtops its banks thereby flooding much of the pasture at least once a year.

This portion of New Light Creek [Index # 27-13-(0.1)] is classified as a Class WS-IV NSW waterbody. Water Supply IV (WS-IV) indicate waters protected as water supplies which are used as sources for drinking, culinary, or food processing purposes for those users where a WS-I, II or III classification is not feasible. WS-IV waters are generally in moderately to highly developed watersheds or Protected Areas.

The classification of New Light Creek changes to WS-IV NSW CA approximately 2.4 km (1.5 mi) downstream of the project area. The CA designation indicates a Critical Area which is the land adjacent to a water supply intake (Falls Lake) where risk associated with pollution is greater than from remaining portions of the watershed.

At the site, the banks of the creek are approximately 2 m (6.5 ft) high and are entrenched and eroding. In the project area, the creek has been straightened, however, there are signs of erosion and deposition as the creek is trying to form meanders within the channel. The creek has an open canopy with most of the riparian vegetation removed. Some scattered black willow (*Salix nigra*), sycamore, walnut (*Juglans nigra*), and river birch remain along the banks.


PUBHh
PFO4A
N
W
E
S
PSS1A
PUBHh
PFO1A
PFO1C
PFO4A
PFO1C
PFO1/4A
PEM1A
PFO1C
PUBHh
PUBHx
PUBHh
PEM1F
PFO1C
PFO1A
SITE
PUBHh
PEM1A
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PFO1C
PSS1Ch
PEM1Ch
PEM1Fh
PUBHh
PUBHh
PUBHh
PUBHh
Hh
PUBHh
PUBHh
PUBHh
PUBHh
Scale 1" = 2000'
1000 0 1000 2000 3000 Feet
New Light Creek Site Boundary
NWI Boundaries
Property Lines
Index Contour 25' Interval
RUST
Rust Environment & Infrastructure
Data Source: National Wetlands Inventory Map, Grissom, N.C. 1995.
FIGURE 3
NWI Map
New Light Creek
Wetland Mitigation Plan
Wake County, North Carolina

2.3.2 Unnamed Streams

An unnamed stream to New Light Creek crosses the northern third of the property through the small wooded area. This stream originates through the valley to the east of the site. It has been straightened through the floodplain and has a berm along its southern bank. This stream is 0.9 to 1.2 m (3 to 4 ft) wide, with grassy banks and a sandy bottom. The drainage area for this stream is about 4.4 ha (11 ac) (see Figure 2).

Another small stream or drainage enters the proposed mitigation area from the east near the middle of the site. According to the landowner, this stream originates at a farm pond on his property and has flow year-round. A small berm or dam has been constructed to keep this water off of the field. The water is ponded behind this small "dam". A grate covered pipe at the base of this ponded area conveys the flow under the pasture to the main ditch described below. The drainage area for this stream is about 13.3 ha (33 ac).

Both streams appear to be recharged by groundwater from the upland areas in their drainage basins and it is not known whether they are perennial or intermittent. Flow has been observed during each site visit even when no precipitation has occurred for several days. Base flow in the streams was measured on April 29, 1998. A light rain had fallen the day before (0.01 inches), but no significant measurable precipitation had occurred for about 5 days (0.10 inches on 4/22). Therefore it is likely that these streams were at base flow for this time of year. Using a Global Flow Probe, stream velocity was measured at three separate locations in each stream. Cross sectional area was measured and base flow rate (cubic feet per sec) calculated. Base flow was measured at 0.02 cubic ft per sec in the southern stream and 0.06 cubic ft per sec in the northern tributary.

2.3.3 Ditches/Tiles

The pasture along New Light Creek has been altered by ditches and drain tiles which were installed in the 1960s (Figure 2). According to the landowner, the majority of the field was wet before the ditches were constructed. These alterations have reduced the hydrology to allow for cattle grazing as well as crop production (corn) in the past.

One main ditch runs from the north and is parallel with New Light Creek. The ditch is approximately 1.5 m (5 ft) wide and 1.2 m (4 ft) deep. Typically, the water in the ditch is about 8 cm (3 in) deep and the flow is slow to moderate. During rain events there is increased flow in the ditch, primarily due to runoff from tributary 2. The vegetation in the field is maintained up to the edge of the ditch, however, the sides of the ditch are vegetated with grasses and other herbaceous vegetation including foxtail grass (*Alopecurus carolinianus*) and violets (*Viola sp.*). There is also pennywort (*Hydrocotyle sp.*) in the bottom of the ditch in some places. This ditch flows south through the adjacent property and drains into New Light Creek along SR 1191. On the adjacent property, the ditch is about 1 m (3.3 ft) wide and 1 m deep and appears to drain the forested area. A tile drain is located at the head of this main ditch and extends almost up to the small wooded area between the north and south pasture. Water has been observed draining from this tile drain into the central ditch during every site visit.

A second drainage ditch runs perpendicular to (and drains into) the main ditch. This ditch is about 0.8 m (2.5 ft) wide with 1 m (3.3 ft) grassy banks. There is a small seep at the base of the slope which drains directly to this ditch. A tile drain is located to the north of this ditch at the base of the slope which intercepts groundwater and surface water from the adjacent slope.

2.3.4 National Flood Insurance Program Mapping

The floodplain along New Light Creek is within Zone AE which indicates special flood hazard areas inundated by the 100-year flood where base flood elevations have been determined. The 100-year floodplain elevation is shown as 85 m (279 ft) on the northern end of the site and 82.9 m (272 ft) on the southern end. Almost the entire pasture and floodplain area is within the 100-year floodplain. The location of the 100-year flood elevation is shown on Figure 2.

Adjacent to Zone AE is a small transition area approximately 23 to 30 m (75-100 ft) wide mapped as Zone X which indicate areas of 500-year flood. The remainder is outside the 500-year floodplain.

2.4 SOILS

According to the NRCS mapping (Soil Survey of Wake County, 1970) the detailed map unit along the floodplain of New Light Creek consists of Wehadkee and Bibb soils (Wo) which are described as poorly drained soils on floodplains with 0 to 4% slopes (Figure 4). These soils are similar in use and management, therefore the Wake County Soil Survey maps them together as an undifferentiated unit. Some areas consist of Wehadkee and some of Bibb and others are a combination of both soil types. Both are listed as hydric soils by the NRCS. These soils are subject to frequent flooding for long periods. Surface runoff is slow to ponded and infiltration is fair. The presence of hydric soils in the floodplain was confirmed in the field through the evaluation of shallow hand-auger borings.

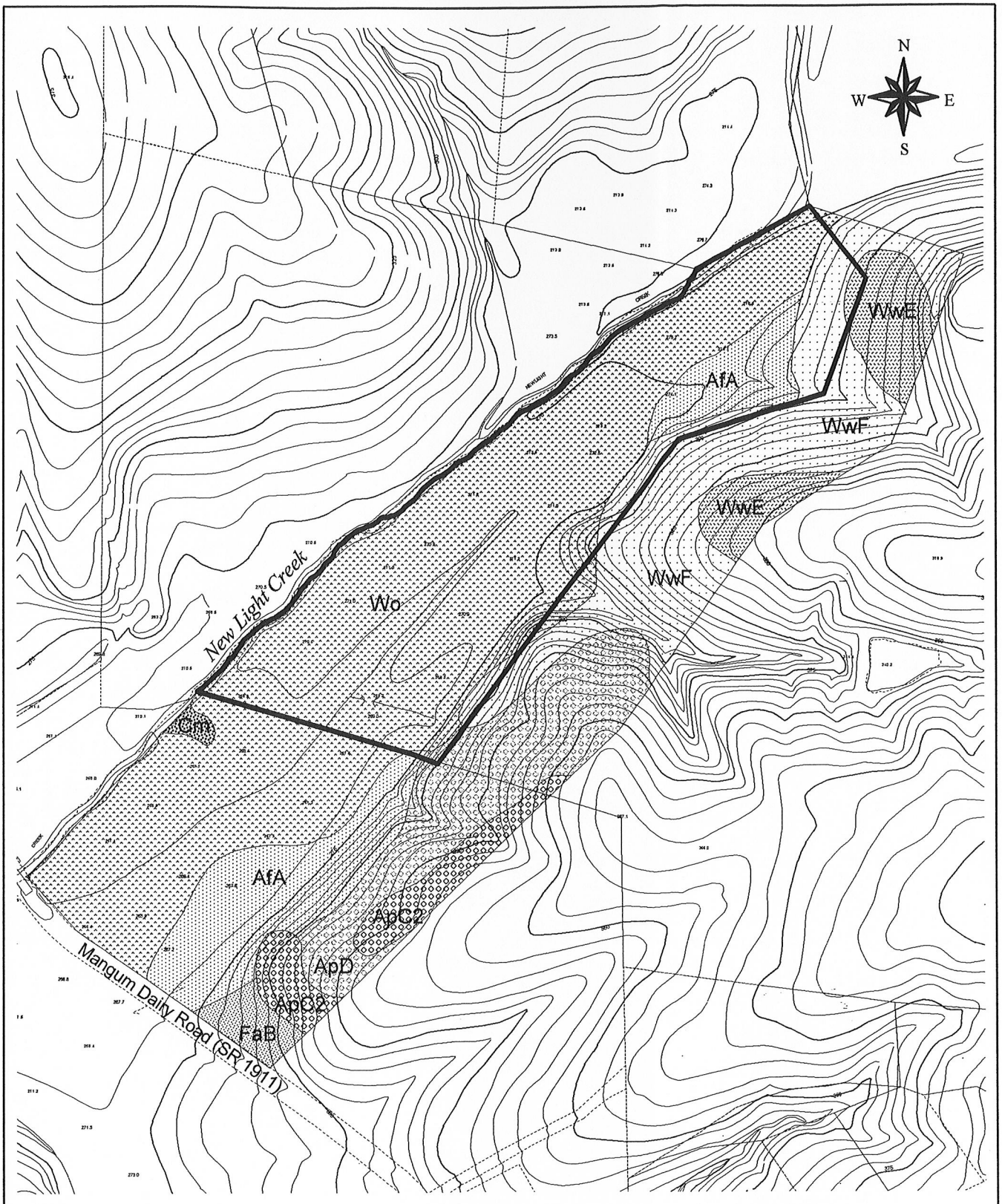
Smaller areas of Altavista fine sandy loam (AfA) are mapped along the adjacent upland areas. Altavista is described as nearly level and gently sloping, moderately well drained soils on low stream terraces. Infiltration is good and surface runoff is slow to medium.

The adjacent steep slope to the north and northeast of the pasture is mapped as Wilkes soils (WkE-20 to 45% slopes). Wilkes soils consist of steep well drained soils on side slopes bordering major drainageways.

2.5 REFERENCE WETLANDS

A "Reference Wetland" was identified to aid in the design of proposed mitigation site. This wetland area is located about 550 m (1,800 ft) west (and downstream) of the site on New Light Creek. The approximate location of this wetland area is shown on Figure 5. The wetlands here are in a similar landscape position as the mitigation site. The floodplain is similar in width, the soils are similar (Wo - Wehadkee and Bibb), and the site receives drainage from an upland area.

These wetlands are dominated by green ash (*Fraxinus pennsylvanica*) and sycamore, with some river birch. The shrub layer was relatively sparse containing primarily green ash saplings. The



New Light Creek Site Boundary

Index Contour 25' Interval
Intermediate Contour 5' Interval
Property Lines

Soils

- AfA - Altavista fine sandy loam
- ApC2 - Appling sandy loam
- ApD - Appling sandy loam
- FaB - Faceville sandy loam
- Wo - Wehadkee and Bibb Soils
- WwE - Wilkes soils
- WwF - Wilkes soils
- Cm - Chewacla soils

Scale 1" = 400'

200 0 200 400 600 Feet

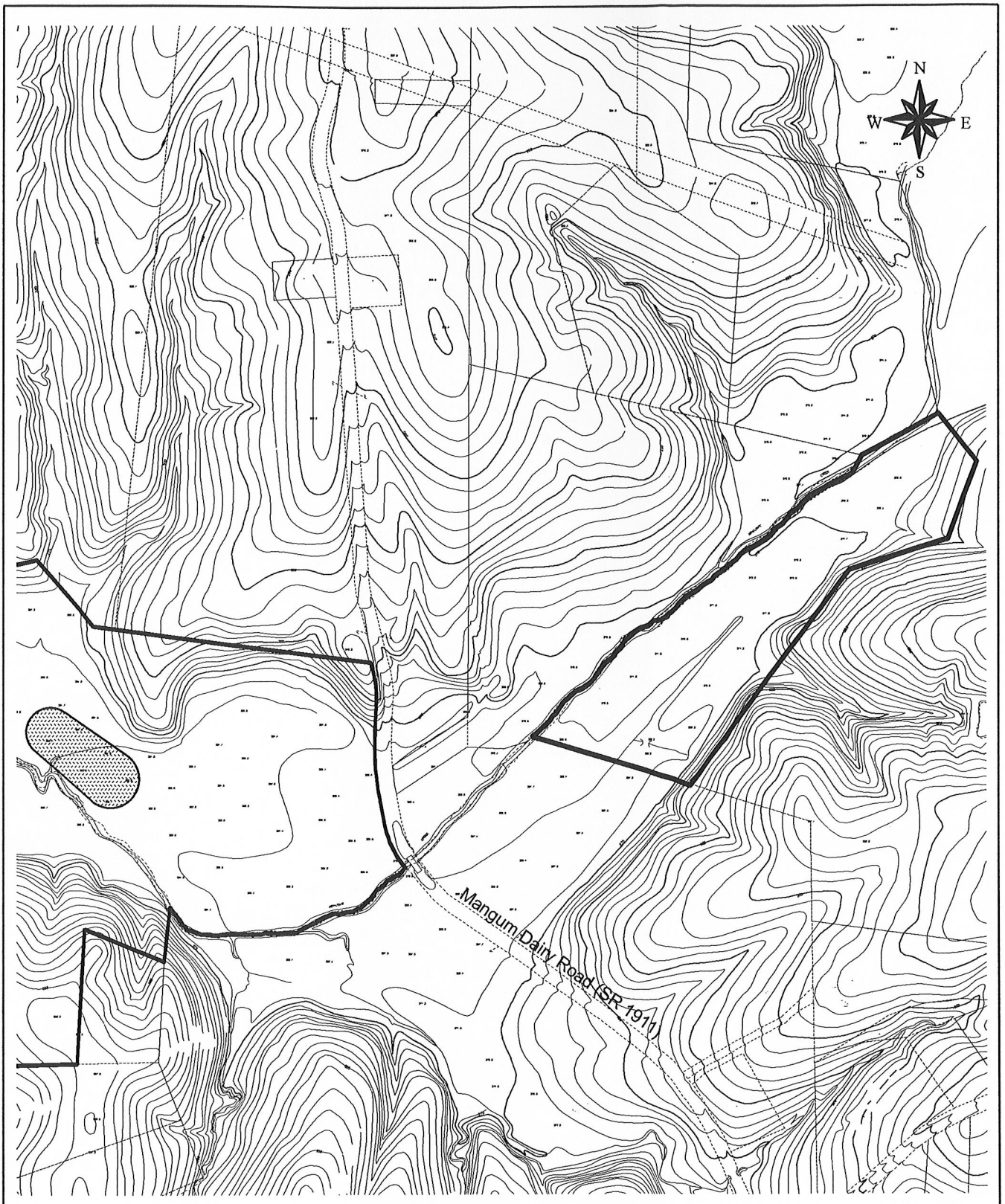
RUST
Rust Environment & Infrastructure

Soil Data: USDA Soil Survey, Wake County, NC, 1970;
Cadastral and topographic data: Wake County GIS, 1997; Projection: NAD83, m.

FIGURE 4
Soil Map

New Light Creek
Wetland Mitigation Plan

Wake County, North Carolina



Scale 1" = 600'

300 0 300 600 900 Feet

New Light Creek Site Boundary
COE Property Boundary

Index Contour 25' Interval
Intermediate Contour 5' Interval
Property Lines
Wetland Reference Area

RUST
Rust Environment & Infrastructure

FIGURE 5
Reference Wetland Location

New Light Creek
Wetland Mitigation Plan

Wake County, North Carolina

Data Source: National Wetlands Inventory Map, Grissom, N.C. 1995

herbaceous vegetation was lush containing lizards tail (*Saururus cernuus*), arrow-arum (*Peltandra virginica*), water plantain (*Alisima subcordatum*), and several different sedges (*Carex* spp.).

The ground surface of this wetland area consists of a series of swales and hummocks. The swales vary in width from 1.2 to 7.8 m (4 to 26 ft) and in length from 9 to 90 m (30 to 300 ft). In general the swales are parallel to New Light Creek. Elevations of the various points in the swales were measured with a transit and level. Typically the bottom of the swales are 15 to 20 cm (6 to 8 in) lower than the tops of the hummocks. At the time of the evaluation on April 29, 1998, 2.5 cm (1.0 in) to 15 cm (6 in) of water was present in the swales. At slightly higher elevations the soils were saturated to the surface.

This reference wetland area was identified to aid in the design of the mitigation site and will not be part of the success criteria. It is the intent to try to mimic the topographic variation found in the reference area on the proposed mitigation site. In addition, a groundwater monitor well will be installed in the reference wetland area. The purpose of this groundwater monitor well will be to help evaluate conditions on the mitigation site during the monitoring period. For example, if groundwater levels on the mitigation site are low, they will be compared to groundwater levels at the reference area. If levels in the reference area are low as well, then it is likely due to seasonal climatic conditions at that time.

3.0 WATER BUDGET

A monthly water budget was developed for the site to help evaluate whether sufficient water is available during the growing season to meet the requirements for wetland hydrology. The budget was based upon methodology developed by the US Army Corps of Engineers, Norfolk District (USCOE, 1994). A water budget for an average, wet, and dry year were developed. Methodology, data, and formulas used in calculating the water budgets are presented in Appendix A.

The purpose of the water budget is not to specifically model the hydrologic conditions at the site, but to confirm that sufficient water is available and persists for sufficient duration to restore wetland hydrological conditions.

3.1 INPUTS

There are three primary inputs of water onto the site, direct precipitation, surface water from the two drainage features that empty onto the site, and groundwater discharge from the upland area.

3.1.1 Precipitation

Precipitation data was obtained from the NC State Climate Office. Data include monthly precipitation averages for the years 1961 through 1995 and daily data for the years 1989, 1994, and 1997.

The Wake County area receives an average 41.4 inches of precipitation a year. In general, the precipitation is spread evenly throughout the year, with slightly more precipitation (4 in) in July and August, with the months of April, October, and November receiving less than 3 inches. For the purposes of the water budgets developed for the site, daily precipitation data for the years 1989 (wet-58.5 in) 1994 (average) and 1997 (dry-33.9 in) were used.

3.1.2 Surface Runoff

Surface runoff occurs onto the site from the upland area to the east of the site. This runoff is primarily channelized into two drainage features. The total watershed of the upland area is about 19 ha (48 ac). The watershed of the northern drainage feature is 4.4 ha (11 ac) and the southern drainage is 13 ha (33 ac). The remaining upland area discharges directly on the mitigation site via sheetflow. The watersheds are characterized by steep topography and are primarily wooded with some open pasture.

Because the soils in the upland watershed are relatively permeable and the slopes are well vegetated, little direct runoff is produced from precipitation. A minimum storm event of 2.2 cm (0.9 in) is required to produce runoff from the watershed.

The majority of the flow in these two streams is not surface runoff from storm events but is in the form of "base flow" as groundwater discharge. According to the landowner, flow occurs in these streams throughout most of the year. Flow measurements taken on April 29, 1998 indicate that at

this time of year base flow is approximately 0.0005 cu m (0.02 cu ft) per sec in the northern drainage and 0.0015 cu m (0.06 cu ft) per second in the southern drainage. This equates to about 4,354 cu m (155,520 cu ft) of water per month available for wetland mitigation over the entire area or 8.7 cm (3.5 in) per month per acre.

3.1.3 Groundwater Inflow

Due to landowner constraints, groundwater inflow onto the site was not directly measured and is therefore not considered in the water budget. However, it is likely that groundwater will be an important component of the water budget. Hand augered borings conducted on March 12, 1998 indicated that the groundwater table or soil saturation was within 0.3 to 0.6 m (1 to 2 ft) of the ground surface across the site. With the removal of the on-site ditches and tile drains, groundwater levels should be higher.

3.2 OUTPUTS

Water outputs from the site include evapotranspiration, infiltration into the soils, and surface water outflow. For the purposes of the water budget, Rust assumed that there would be no surface water outflow and that excess water will be retained on-site.

3.2.1 Evapotranspiration

Potential Evapotranspiration (PET) losses were calculated using the Thornwaite Method which is based on mean monthly air temperature. Evapotranspiration is the primary method of loss of water in the water budget. It is likely that PET losses are over estimated as the calculations assume an unlimited water supply. When water supply is limited, actual evapotranspiration losses are usually less.

3.2.2 Infiltration

Infiltration rates of the soils within the mitigation area were estimated based on available information from the NRCS. The NRCS has classified all soils into hydrologic soil groups to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. According to this NRCS classification system Wehadkee and Bibb soils are in the Group D soils. These soils have a high runoff rate and a low infiltration rate when thoroughly wetted. These soils have a water transmission rate of 0.0 to 0.125 cm/hr (0.0 to 0.05 in/hr).

For the purposes of the water budget a rate of 0.0125 cm/hr (0.005 in/hr) or 8 cm/month (3.6 in/month) was used.

3.2.3 Surface Runoff

For the purposes of this water budget surface run-off from the site was not considered. Surface runoff is basically excess water that is available as ponded water above the ground surface. Excess surface water will be stored in on-site depressions.

3.3 WATER BUDGET RESULTS

Water budgets were developed for dry, average, and wet conditions. The results of these budgets are presented in the graphs below and additional information can be found in Appendix A. The following is used to calculate the amount of water available to the site for maintaining hydrologic conditions.

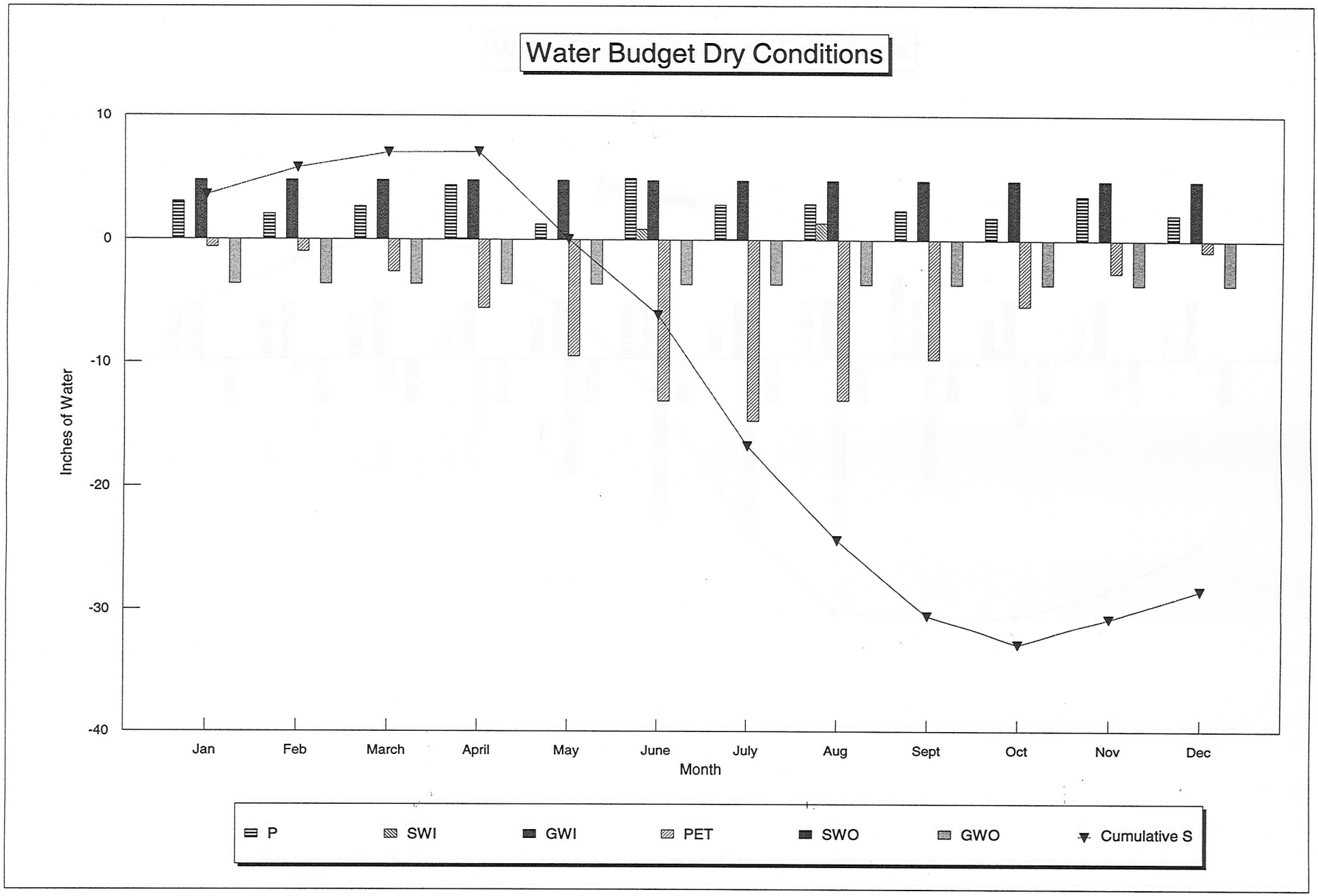
$$S = P + SWI + GWI - PET - SWO - GWO$$

where:
P = Precipitation
SWI = Surface Water Inflow
GWI = Groundwater Inflow (calculated as baseflow from the streams)
PET = Potential Evapotranspiration
SWO = Surface Water Outflow (Is 0 for these budgets)
GWO = Groundwater Outflow (Infiltration rates)
S = Change in Storage

A positive S indicates that "excess" water is present on the ground surface. This water is available for creating wetland hydrological conditions or storage. A negative S indicates that no "excess" surface water exists. A negative S does not imply that groundwater levels will drop, although this is a normal occurrence in the Piedmont area during the summer.

The water budgets indicate that under wet, dry, and average conditions excess water (soil saturation) persists from January through April/May and that the site will tend to "dry out" during the late spring and summer. According to this model, wetland hydrology will therefore be satisfied for at least 1 to 2 months during the growing season. The site then begins to be "recharged" in November and December. The primary influence in the water budget is calculated PET. Since PET is usually greater than actual evapotranspiration rates, this is a conservative water budget. It is likely that actual evapotranspiration is going to be less and the site will start "recharging" earlier and the "deficit" will not be as great.

This data supports what typically happens in typical Piedmont bottomland hardwood wetland systems, and bottomland wetland systems that are present along New Light Creek. The NWI mapping (Figure 3) indicates that PFO1A and PFO1C wetlands are present along New Light Creek. These are temporarily and seasonally flooded wetland systems.



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Filling of the central ditch and removal of the drain tiles will be performed in September and October while the site is relatively dry. Five groundwater monitor wells will be installed across the site to monitor site hydrology and assist with final design. Observed water elevations during November and December will be used to help evaluate whether the proper hydrology has been restored, prior to planting of the hardwood seedlings in January and February.

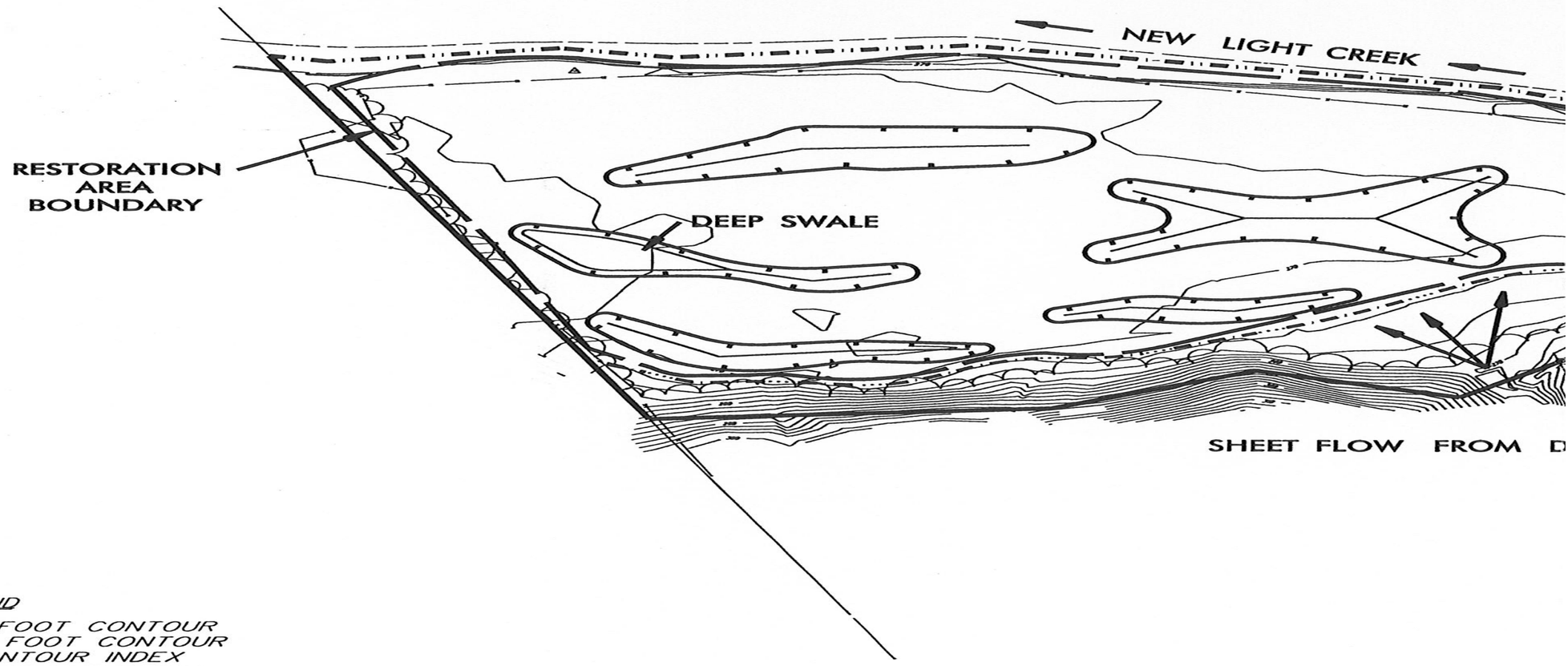
4.2 TOPOGRAPHIC MODIFICATION

Prior to conversion to pasture, a number of swales/depressions were present across the site. Minor grading is proposed to reestablish microtopographic relief across the site and establish several swales or depressions to help retain surface water on the site. The general configuration of these proposed swales are shown on Figure 6. The swales will be 6 to 18 m (20 to 50 ft) wide and 30 to 90 m (100 to 300 ft) long. The middle of the swale will be about 15 to 30 cm (0.5 to 1.0 ft) below the elevation of the swale edge. Small deeper 30 cm (1.0 ft) depressions will be constructed in the downstream end of several of the swales to provide an area that experiences temporary ponding and a diverse habitat.

The location, shape, and elevations of the swales was based on the depressions within a bottomland forest area located about one-half mile south of the mitigation site. This wetland area is located on similar soils and a similar landscaped position as the mitigation site. The location of this wetland is shown on Figure 6. The general shape and dimensions of these depressions were measured using a transit and level and 100-foot tape measure. In general the swales in this area were roughly parallel to the stream irregular in shape but tending towards long and narrow. Measurements in this reference area indicated that the maximum elevation differences between the tops of hummocks and the bottom of swales is 1 foot. The average difference in elevation was 0.47 feet. The swales varied in width from 4 feet to 26 feet, and in length from 30 feet to over 300 feet.

In addition, some soil and tree trunks have been placed along the tops of the banks of New Light Creek to help reduce overtopping of the banks. This material will be removed to allow natural over banking to occur.

It is anticipated that initial site grading and removal of all tile, ditches, and pipes will occur in September of 1998. During late fall/early winter, and prior to planting, elevations of the swales and other site features may be modified. Modification will be based upon observed conditions such as water levels in on-site monitor wells and observed surface water condition.



LEGEND

- 2 FOOT CONTOUR
- 10 FOOT CONTOUR
- 130 CONTOUR INDEX
- 135 SPOT ELEVATION
- DEPARTMENT OF TRANSPORTATION GPS STATION
- FENCE LINE
- CREEK OR DITCH LINE
- TREE LINE
- PROPERTY LINE
- 100 YR FLOOD
- SWALES (6"-10" DEEP)

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4.3 REFORESTATION

The target community for the site is a Piedmont bottomland hardwood forest. This community will include a levee along New Light Creek. Behind the levee, the topography will be varied across the site and will include swales or microtopographic depressions, and slightly higher areas.

Once the appropriate hydrologic conditions have been established, appropriate species will be planted based on their tolerance to flooding. The areas along the levee will be planted with species typically associated with this type of community. Proposed species to be planted within each area (dependent upon availability) include the following:

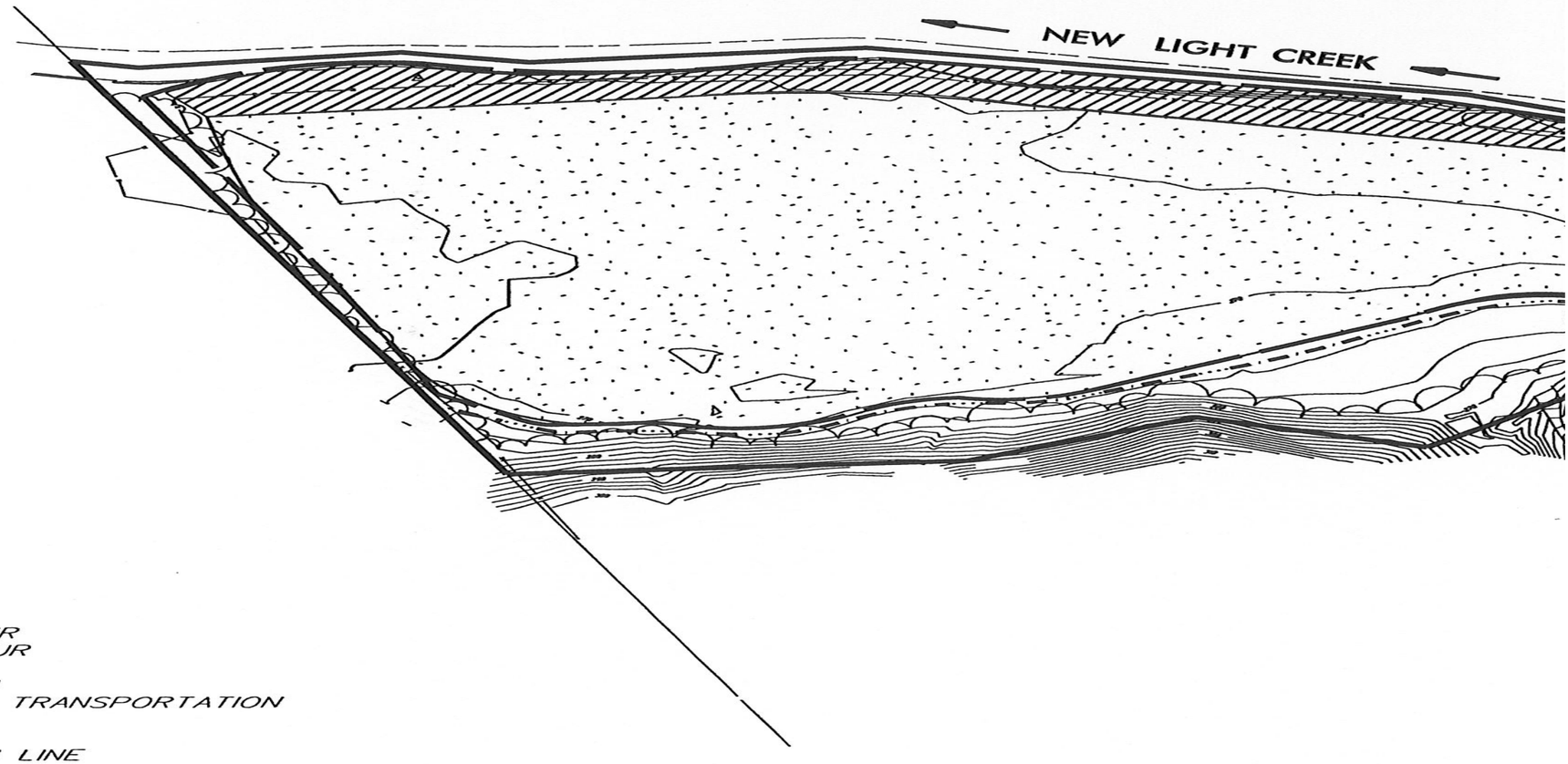
Bottomland Hardwoods (Zone A)	**Wetland Indicator Status**
Cherrybark oak (*Quercus pagoda*)	FAC+
Swamp chestnut oak (*Quercus michauxii*)	FACW-
Willow oak (*Quercus phellos*)	FACW-
Overcup oak (*Querucus lyatra*)	OBL
Green ash (*Fraxinus pennsylvaticum*)	FACW
Black gum (*Nyssa sylvatica*)	FAC

Levee Forest (Zone B)	
Black walnut (*Juglans nigra*)	FACU
Sycamore (*Platanus occidentalis*)	FACW-
River birch (*Betula nigra*)	FACW
Bitternut hickory (*Carya cordiformes*)	FAC
Willow oak (*Quercus phellos*)	FACW-
Overcup oak (*Querucus lyatra*)	OBL

Figure 7 provides the locations of each of these vegetative zones.

Prior to planting the soil will be tested and amended as necessary with lime to achieve a pH between 5.5 and 7. The site will be seeded with seed rye grain to help stabilize the soil after initial site alterations and prior to planting of tree seedlings. Bare root seedlings of tree species will be planted at a density of 680 stems per acre on approximately 8-foot centers. Seedlings will be at least one season old and 12 to 18 inches in height.

Planting will be performed between December and February to allow plants to stabilize during the dormant period and set root during the spring season.



LEGEND

- 2 FOOT CONTOUR
- 10 FOOT CONTOUR
- 430 CONTOUR INDEX
- 445 SPOT ELEVATION
- DEPARTMENT OF TRANSPORTATION GPS STATION
- FENCE LINE
- CREEK OR DITCH LINE
- TREE LINE
- PROPERTY LINE
- 100 YR FLOOD
- BOTTOMLAND HARDWOODS (ZONE A)
- LEVEE FOREST (ZONE B)

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4.4 MONITORING AND SUCCESS CRITERIA

Monitoring of the wetland mitigation site will be performed until success criteria are met. Monitoring is proposed of both vegetation and hydrology. The monitoring plan has been designed in accordance with the US Army Corps of Engineers Compensatory Hardwood Mitigation Guidelines (1993a).

4.4.1 Vegetation

Prior to planting, the site will be inspected and checked for proper elevation and suitability of soils. Availability of acceptable, good quality plant species will be determined. The site will be inspected at completion of planting to determine proper planting methods, including proper plant spacing, density, and species composition.

During the first year, vegetation will receive a cursory, visual examination to evaluate the degree of overtopping of the saplings by herbaceous plants. Quantitative sampling of the vegetation will be performed between August 1 and October 31 at the end of the first year and after each growing season until the vegetation criteria is met.

In preparation of the quantitative sampling, 0.05 acre vegetative plots will be established in the reforested area. Plots will be evenly distributed throughout the wetland mitigation site. Sample plot distribution will be correlated with the hydrological monitoring locations to help correlate data between vegetation and hydrology parameters. For each plot, species composition and density will be reported. Photo points will be taken within each zone. Monitoring will take place once each year for five years.

Success will be determined by survival of target species within the sample plots. A minimum of 240 trees/acre must survive for at least five years after initial planting. At least six different representative tree species should be present on the entire site. If the vegetative success criteria is not met, the cause of failure will be determined and appropriate corrective action will be taken.

4.4.2 Hydrology

Monitoring wells will be installed across the site to monitor site hydrology. Monitoring wells will be installed in accordance with USACE guidelines (USACE 1993b).

Hydrology will be considered successful if the soil is ponded, flooded, or saturated within 12 inches of the surface for at least 12.5% of the growing season. A groundwater monitor well will also be installed in the reference wetland for comparative purposes (not for success determination) to help evaluate the hydrology and natural hydrological variation within this nearby jurisdictional wetland area.

A stream gage (in New Light Creek) and a precipitation gage will be installed and maintained. Stream gage data will determine the frequency of overbank flooding events.

4.5 DISPENSATION OF THE PROPERTY

Land owned by the US Army Corps of Engineers is present along New Light Creek, immediately south of Mangum Dairy Road. This land is buffer part of a buffer area associated with Falls Lake. Discussions are currently underway between NCDOT and the COE to determine if the COE will accept ownership of the property. Until an acceptable agreement can be reached, ownership will remain with NCDOT. NCDOT will also remain responsible for meeting the success criteria established in the mitigation plan.

4.6 WETLAND MITIGATION CREDIT

This mitigation plan is proposed to fulfill compensatory mitigation requirements for wetland impacts associated with R-2000E. The 4.8 ha (12 ac) of wetland restoration will meet the 1:1 requirement for the DWQ and will be used to offset wetland impacts associated with R-2000E.

5.0 REFERENCES

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APPENDIX A

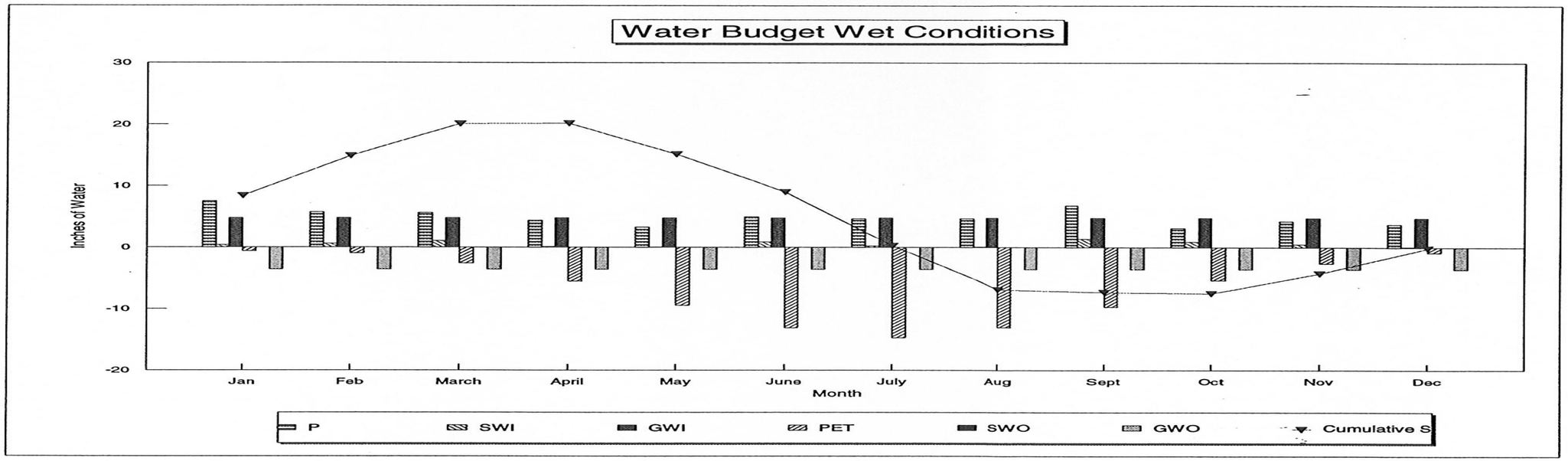
Water Budget

NEW LIGHT CREEK WETLAND MITIGATION SITE

P+SWI+GWI+ET+SWO+GWO=S

P=Precipitation
SWI=Surface Water Inflow
GWI=Groundwater Inflow
ET=Evapotranspiration (expressed as a negative number)
SWO=Surface Water Output (expressed as a negative number)
GWO=Groundwater Output (expressed as a negative number - this is the same as infiltration)
S=Change in Storage

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
P	7.49	5.71	5.61	4.36	3.26	4.96	4.63	4.66	6.80	3.10	4.22	3.75
SWI	0.36	0.58	1.04	0.08	0.01	0.85	0.21	0.04	1.35	0.90	0.48	0.08
GWI	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76
PET	-0.64	-0.97	-2.60	-5.54	-9.47	-13.09	-14.73	-13.04	-9.70	-5.37	-2.62	-0.87
SWO												
GWO	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60
S	8.37	6.49	5.21	0.06	-5.03	-6.12	-8.74	-7.17	-0.39	-0.20	3.24	4.11
Cumulative S	8.37	14.86	20.07	20.13	15.10	8.98	0.24	-6.93	-7.33	-7.53	-4.29	-0.18



Assumptions: Infiltration Rate of 0.005 inches per hour

Groundwater level in january starts at an elevation of 0 inches below ground surface

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24 Hour Preciptitation
Year 1996 - Wet

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
	0.24	1.28	0.02	0.17	0.51	0.96	0.04	0.6	0.52	0.04	0.01	1.19	
	0.08	1.25	0.5	0.01	0.52	1.95	1.31	0.04	0.22	0.06	0.74	0.02	
	0.85	0.06	0.32	0.84	0.01	0.6	0.01	0.01	1.62	0.07	0.04	0.72	
	0.04	0.03	0.03	0.01	0.02	0.02	0.13	0.03	1.51	1.99	0.02	0.39	
	0.84	0.03	0.46	0.24	0.22	0.29	0.48	1.06	1.77	0.02	1.67	0.15	
	1.51	0.01	1.08	0.72	1.01	0.61	0.57	0.46	0.04	0.08	0.01	0.01	
	0.01	0.08	0.86	0.44	0.31	0.12	0.65	0.29	0.08	0.14	0.19	0.06	
	0.81	0.01	0.28	0.04	0.54	0.19	0.06	0.34	0.01	0.51	0.61	0.21	
	0.04	0.83	2.06	0.66	0.02	0.21	1.16	0.01	0.01	0.19	0.23	0.17	
	1.13	1.55		1.2	0.1	0.01	0.04	0.01	1.02		0.31	0.27	
	0.07	0.09		0.03			0.18	1.05			0.39	0.37	
	1.72	0.48						0.76				0.08	
	0.15	0.01										0.11	
Monthly Total	7.49	5.71	5.61	4.36	3.26	4.96	4.63	4.66	6.8	3.1	4.22	3.75	58.55

Source: NC State Climate Office

Station: Raleigh-Durham WFSO Airport

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Surface Water Input

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
	0.000	0.030	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.018	
	0.000	0.025	0.000	0.000	0.000	0.199	0.035	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.073	0.213	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.142	0.000	0.113	0.000	
	0.073	0.000	0.007	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.239	0.000	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.000	
	0.011	0.082	0.000	0.019	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	
												0.000	
												0.000	
runoff per acre in inches	0.085	0.138	0.246	0.019	0.003	0.200	0.049	0.011	0.318	0.213	0.113	0.018	1.41
Runoff volume - acre inches	4.305	7.016	12.502	0.965	0.137	10.192	2.489	0.536	16.178	10.858	5.754	0.904	71.84
Inches on mitigation site	0.359	0.585	1.042	0.080	0.011	0.849	0.207	0.045	1.348	0.905	0.480	0.075	5.99

Q=(P-0.2S)(P-0.2S)/(P+0.8S)

Q=Runoff volume as inches of depth over the watershed
P=24 hour precipitation in inches
S=Retention S=(1000/CN)-10
CN=Curve Number from TR-55

Precipitation = 0.90
For CN below S= 4.49
CN used for calculation 69

Set J29 to amount of precip necessary to produce runoff (.2S)

Size of watershed in acres 50.9 acres
Size of mitigation site in acres 12 acres

Calculation of Potential Evapotranspiration using Thornwait Equation

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
Wind Speed	21.6	25	26	28	20	20	22	21	25	19	25	25	
Temperature F	38.5	41	49	58	66	73	77	76	70	59	50	41	
Temperature C	4	5	9	14	19	23	25	24	21	15	10	5	
Temperature C-from above	4	5	9	14	19	23	25	24	21	15	10	5	
Sat. Vapor Pressure													
Ave Relative Humidity													
Atmos Vapor Pressure													
Delta/Lamda													
Local Correction Factors	0.84	0.91	1	1.09	1.17	1.21	1.2	1.13	1.03	0.95	0.86	0.82	
EO													
Atmos Radiation													
% cloudiness													
% Sunshine	1	1	1	1	1	1	1	1	1	1	1	1	
Mean Solar Radiation													
Long Wave Radiation													
Net Radiation													
Equiv. Depth Evaporation													
													TOTAL
Monthly Heat Index - I	0.72	1.00	2.41	4.69	7.41	9.87	11.18	10.52	8.61	5.20	2.83	1.00	65.42
a	1.52												
PET inches/month	0.76	1.06	2.60	5.09	8.09	10.82	12.28	11.54	9.42	5.65	3.05	1.06	71.41
PET Corrected for Latitude	0.64	0.97	2.60	5.54	9.47	13.09	14.73	13.04	9.70	5.37	2.62	0.87	78.64

PET=1.6 [(10xT)/I]a

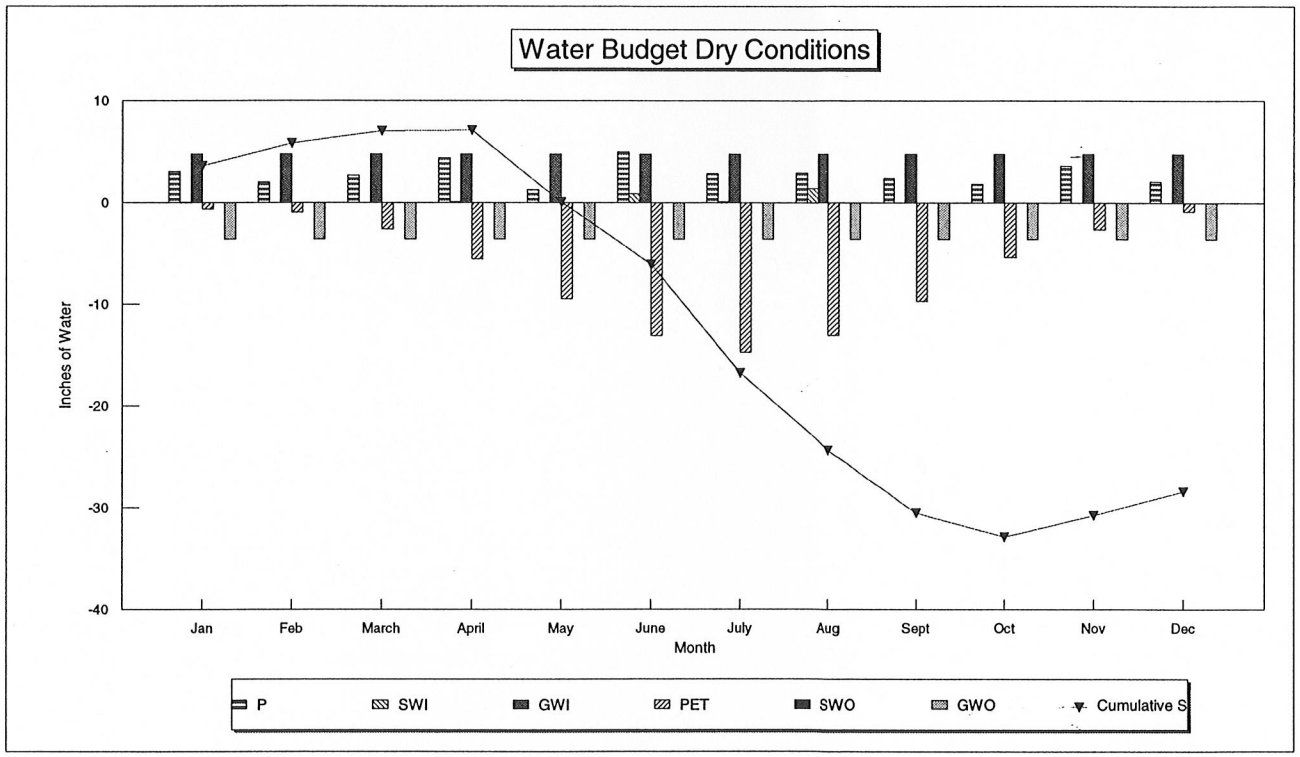
T=Mean Monthly Air Temperature (C)
I = monthly heat Index, assumed constant

NEW LIGHT CREEK WETLAND MITIGATION SITE

P+SWI+GWI+ET+SWO+GWO=S

P=Precipitation
SWI=Surface Water Inflow
GWI=Groundwater Inflow
ET=Evapotranspiration (expressed as a negative number)
SWO=Surface Water Output (expressed as a negative number)
GWO=Groundwater Output (expressed as a negative number - this is the same as infiltration)
S=Change in Storage

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
P	3.05	2.02	2.66	4.36	1.26	4.96	2.83	2.92	2.39	1.82	3.58	2.06
SWI	0.02	0.00	0.00	0.08	0.00	0.85	0.06	1.36	0.00	0.00	0.00	0.00
GWI	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76
PET	-0.64	-0.97	-2.60	-5.54	-9.47	-13.09	-14.73	-13.04	-9.70	-5.37	-2.62	-0.87
SWO												
GWO	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60
S	3.59	2.21	1.22	0.06	-7.05	-6.12	-10.68	-7.60	-6.15	-2.39	2.12	2.35
Cumulative S	3.59	5.80	7.03	7.08	0.04	-6.08	-16.76	-24.36	-30.51	-32.90	-30.78	-28.43



Assumptions: Infiltration Rate of 0.005 inches per hour

Groundwater level in january starts at an elevation of 0 inches below ground surface

24 Hour Preciptitation
Year 1997

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
	0.07	0.03	0.02	0.17	0.51	0.96	0.04	0.42	0.18	0.13	0.37	0.06	
	1.04	0.13	0.5	0.01	0.02	1.95	0.07	0.22	0.49	0.21	0.14	0.02	
	0.02	0.46	0.32	0.84	0.01	0.6	0.01	2.27	0.23	0.26	0.15	0.12	
	0.65	0.04	0.03	0.01	0.02	0.02	0.13	0.01	0.47	0.01	0.08	0.05	
	0.11	0.75	0.46	0.24	0.22	0.29	0.48		0.8	0.36	0.11	0.3	
	0.01	0.37	0.08	0.72	0.01	0.61	0.01		0.06	0.01	0.78	0.58	
	0.29	0.01	0.86	0.44	0.31	0.12	0.65		0.16	0.14	0.34	0.34	
	0.27	0.09	0.28	0.04	0.04	0.19	0.06			0.51	0.67	0.03	
	0.51	0.04	0.11	0.66	0.02	0.21	1.16			0.19	0.6	0.56	
	0.07	0.1		1.2	0.1	0.01	0.04				0.34		
	0.01			0.03			0.18						
Monthly Total	3.05	2.02	2.66	4.36	1.26	4.96	2.83	2.92	2.39	1.82	3.58	2.06	33.91

Source: NC State Climate Office

Station: Raleigh-Durham WFSO Airport

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Surface Water Input

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	
	0.004	0.000	0.000	0.000	0.000	0.199	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.321	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
runoff per acre in inches	0.004	0.000	0.000	0.019	0.000	0.200	0.014	0.321	0.000	0.000	0.000	0.000	0.56
Runoff volume - acre inches	0.220	0.000	0.000	0.965	0.000	10.192	0.732	16.326	0.000	0.000	0.000	0.000	28.43
Inches on mitigation site	0.018	0.000	0.000	0.080	0.000	0.849	0.061	1.360	0.000	0.000	0.000	0.000	2.37

Q=(P-0.2S)(P-0.2S)/(P+0.8S)

Q=Runoff volume as inches of depth over the watershed
P=24 hour precipitation in inches
S=Retention S=(1000/CN)-10
CN=Curve Number from TR-55

Precipitation =	0.90
For CN below S=	4.49
CN used for calculation	69

Set J29 to amount of precip necessary to produce runoff (.2S)

Size of watershed in acres	50.9 acres
Size of mitigation site in acres	12 acres

Groundwater Input — Groundwater discharge from 48 acre basin as surface water flow from streams

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Precipitation	3.05	2.02	2.66	4.36	1.26	4.96	2.83	2.92	2.39	1.82	3.58	2.06
Runoff	0.00	0.00	0.00	0.02	0.00	0.20	0.01	0.32	0.00	0.00	0.00	0.00
PET												
Infiltration	3.05	2.02	2.66	4.34	1.26	4.76	2.82	2.60	2.39	1.82	3.58	2.06
volume acre inches	155.03	102.82	135.39	220.96	64.13	242.27	143.32	132.30	121.65	92.64	182.22	104.85
Inches on mitigation site	12.92	8.57	11.28	18.41	5.34	20.19	11.94	11.03	10.14	7.72	15.19	8.74

Infiltration = Precip - Runoff- PET

Size of watershed in acres	50.9	acres
Size of mitigation site in acres	12	acres

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Measure volume acre/inches	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76

Flow rate	0.08	cu ft/sec	207360	cu ft/mo
	86400	sec/day		
	30	days/mo		
	43560	sq ft/acre	4.760331	ft/mo/acre

Calculation of Potential Evapotranspiration using Thornwait Equation

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
Wind Speed	21.6	25	26	28	20	20	22	21	25	19	25	25	
Temperature F	38.5	41	49	58	66	73	77	76	70	59	50	41	
Temperature C	4	5	9	14	19	23	25	24	21	15	10	5	
Temperature C-from above	4	5	9	14	19	23	25	24	21	15	10	5	
Sat. Vapor Pressure													
Ave Relative Humidity													
Atmos Vapor Pressure													
Delta/Lamda													
Local Correction Factors	0.84	0.91	1	1.09	1.17	1.21	1.2	1.13	1.03	0.95	0.86	0.82	
EO													
Atmos Radiation													
% cloudiness													
% Sunshine	1	1	1	1	1	1	1	1	1	1	1	1	
Mean Solar Radiation													
Long Wave Radiation													
Net Radiation													
Equiv. Depth Evaporation													
													TOTAL
Monthly Heat Index - I	0.72	1.00	2.41	4.69	7.41	9.87	11.18	10.52	8.61	5.20	2.83	1.00	65.42
a	1.52												
PET inches/month	0.76	1.06	2.60	5.09	8.09	10.82	12.28	11.54	9.42	5.65	3.05	1.06	71.41
PET Corrected for Latitude	0.64	0.97	2.60	5.54	9.47	13.09	14.73	13.04	9.70	5.37	2.62	0.87	78.64

PET=1.6 [(10xT)/I]a

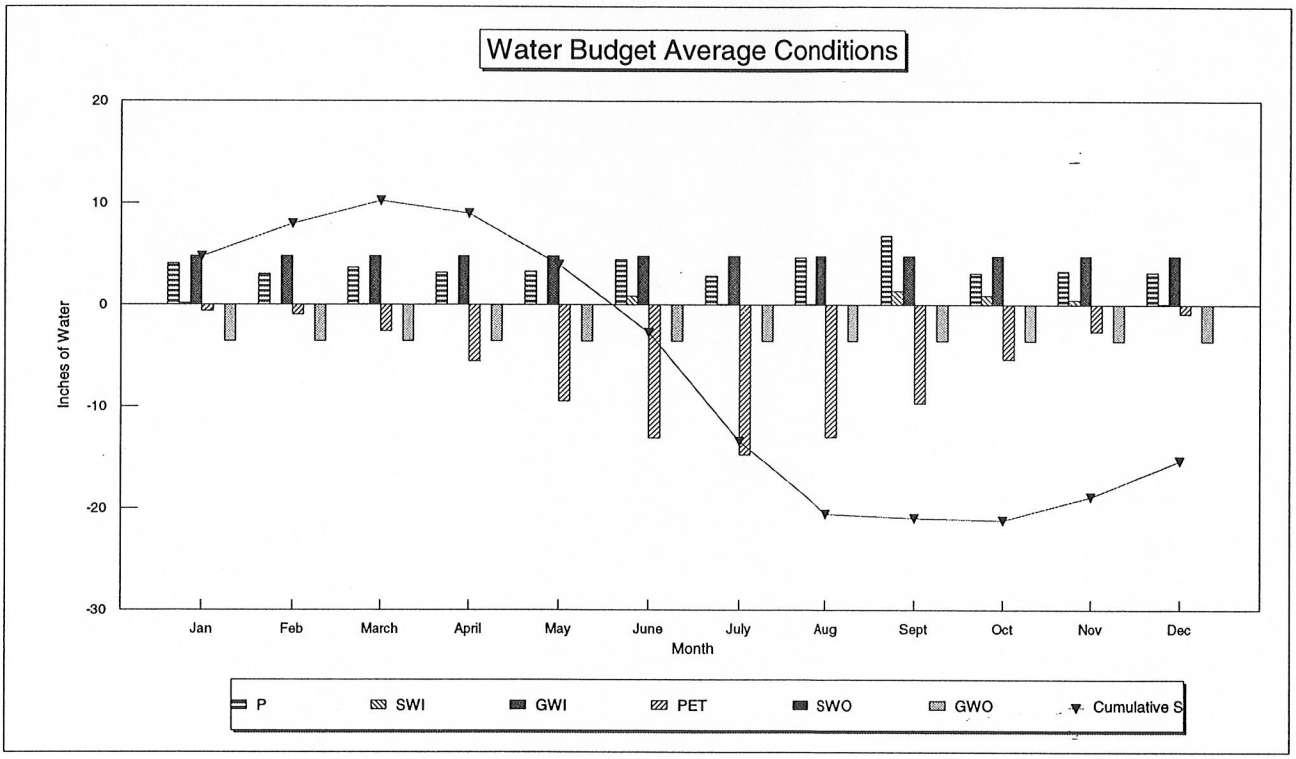
T=Mean Monthly Air Temperature (C)
I = monthly heat Index, assumed constant

NEW LIGHT CREEK WETLAND MITIGATION SITE

P+SWI+GWI+ET+SWO+GWO=S

P=Precipitation
SWI=Surface Water Inflow
GWI=Groundwater Inflow
ET=Evapotranspiration (expressed as a negative number)
SWO=Surface Water Output (expressed as a negative number)
GWO=Groundwater Output (expressed as a negative number - this is the same as infiltration)
S=Change in Storage

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
P	4.05	3.02	3.66	3.13	3.26	4.42	2.83	4.66	6.80	3.10	3.29	3.19
SWI	0.15	0.01	0.03	0.00	0.01	0.85	0.06	0.04	1.35	0.90	0.48	0.08
GWI	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76
PET	-0.64	-0.97	-2.60	-5.54	-9.47	-13.09	-14.73	-13.04	-9.70	-5.37	-2.62	-0.87
SWO												
GWO	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60
S	4.73	3.22	2.25	-1.25	-5.03	-6.66	-10.68	-7.17	-0.39	-0.20	2.31	3.55
Cumulative S	4.73	7.95	10.20	8.95	3.91	-2.74	-13.43	-20.60	-21.00	-21.20	-18.89	-15.34



Assumptions: Infiltration Rate of 0.005 inches per hour

Groundwater level in january starts at an elevation of 0 inches below ground surface

24 Hour Preciptitation
Average

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
	0.07	0.03	0.02	0.17	0.51	0.96	0.04	0.6	0.52	0.04	0.01	1.19	
	1.04	0.13	0.5	0.01	0.52	1.95	0.07	0.04	0.22	0.06	0.74	0.02	
	0.02	0.46	0.32	0.84	0.01	0.06	0.01	0.01	1.62	0.07	0.04	0.72	
	0.65	0.04	0.03	0.01	0.02	0.02	0.13	0.03	1.51	1.99	0.02	0.39	
	0.11	0.75	0.46	0.24	0.22	0.29	0.48	1.06	1.77	0.02	1.67	0.15	
	0.01	0.37	1.08	0.72	1.01	0.61	0.01	0.46	0.04	0.08	0.01	0.01	
	1.29	1.01	0.86	0.44	0.31	0.12	0.65	0.29	0.08	0.14	0.19	0.06	
	0.27	0.09	0.28	0.04	0.54	0.19	0.06	0.34	0.01	0.51	0.61	0.21	
	0.51	0.04	0.11	0.66	0.02	0.21	1.16	0.01	0.01	0.19		0.17	
	0.07	0.1			0.1	0.01	0.04	0.01	1.02			0.27	
	0.01						0.18	1.05					
								0.76					
Monthly Total	4.05	3.02	3.66	3.13	3.26	4.42	2.83	4.66	6.8	3.1	3.29	3.19	45.41

Source: NC State Climate Office

Station: Raleigh-Durham WFSO Airport

Surface Water Input

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.018	
	0.004	0.000	0.000	0.000	0.000	0.199	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.073	0.213	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.142	0.000	0.113	0.000	
	0.000	0.000	0.007	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.031	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	
												0.000	
												0.000	
runoff per acre in inches	0.036	0.003	0.007	0.000	0.003	0.200	0.014	0.011	0.318	0.213	0.113	0.018	0.94
Runoff volume - acre inches	1.817	0.137	0.359	0.000	0.137	10.192	0.732	0.536	16.178	10.858	5.754	0.904	47.60
Inches on mitigation site	0.151	0.011	0.030	0.000	0.011	0.849	0.061	0.045	1.348	0.905	0.480	0.075	3.97

Q=(P-0.2S)(P-0.2S)/(P+0.8S)

Q=Runoff volume as inches of depth over the watershed
P=24 hour precipitation in inches
S=Retention S=(1000/CN)-10
CN=Curve Number from TR-55

Precipitation = 0.90
For CN below S= 4.49
CN used for calculation 69

Set J29 to amount of precip necessary to produce runoff (.2S)

Size of watershed in acres 50.9 acres
Size of mitigation site in acres 12 acres

Groundwater Input — Groundwater discharge from 48 acre basin as surface water flow from streams

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Precipitation	4.05	3.02	3.66	3.13	3.26	4.42	2.83	4.66	6.8	3.1	3.29	3.19
Runoff	0.04	0.00	0.01	0.00	0.00	0.20	0.01	0.01	0.32	0.21	0.11	0.02
PET												
Infiltration	4.01	3.02	3.65	3.13	3.26	4.22	2.82	4.65	6.48	2.89	3.18	3.17
volume acre inches	204.33	153.58	185.94	159.32	165.80	214.79	143.32	236.66	329.94	146.93	161.71	161.47
Inches on mitigation site	17.03	12.80	15.49	13.28	13.82	17.90	11.94	19.72	27.50	12.24	13.48	13.46

Infiltration = Precip - Runoff- PET

Size of watershed in acres 50.9 acres
Size of mitigation site in acres 12 acres

Measure volume acre/inches	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76

Flow rate 0.08 cu ft/sec
86400 sec/day
30 days/mo
43560 sq ft/acre

207360 cu ft/mo

4.760331 ft/mo/acre

Calculation of Potential Evapotranspiration using Thornwait Equation

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
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Temperature F	38.5	41	49	58	66	73	77	76	70	59	50	41	
Temperature C	4	5	9	14	19	23	25	24	21	15	10	5	
Temperature C-from above	4	5	9	14	19	23	25	24	21	15	10	5	
Sat. Vapor Pressure													
Ave Relative Humidity													
Atmos Vapor Pressure													
Delta/Lamda													
Local Correction Factors	0.84	0.91	1	1.09	1.17	1.21	1.2	1.13	1.03	0.95	0.86	0.82	
EO													
Atmos Radiation													
% cloudiness													
% Sunshine	1	1	1	1	1	1	1	1	1	1	1	1	
Mean Solar Radiation													
Long Wave Radiation													
Net Radiation													
Equiv. Depth Evaporation													
													TOTAL
Monthly Heat Index - I	0.72	1.00	2.41	4.69	7.41	9.87	11.18	10.52	8.61	5.20	2.83	1.00	65.42
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PET Corrected for Latitude	0.64	0.97	2.60	5.54	9.47	13.09	14.73	13.04	9.70	5.37	2.62	0.87	78.64

PET=1.6 [(10xT)/I]a

T=Mean Monthly Air Temperature (C)
I = monthly heat Index, assumed constant

APPENDIX B

USACE Check List

COMPENSATORY MITIGATION PLANNING
CHECKLIST
9/19/94

ACTION ID: _____

SITE NAME: New Light Creek Wetland Mitigation Site

LOCATION/WATERBODY/COUNTY: Mangum Dairy Road (SR 1191) and New Light Creek, Wake County, North Carolina

USGS QUAD(S): Grissom, NC

SOIL SURVEY SHEET NOS.: 6

PREPARED BY: Ron Johnson DATE: 5/11/98

I. INTRODUCTION

A. Type of Mitigation (Circle / A separate checklist may be prepared if more than one type)

1. Restoration Creation Enhancement Preservation

a. In-kind Out-of-kind Both

b. On-site Off-site Both

2. Up-front Concurrent After-the-fact Bank

B. Wetland types and acreage Impacted / Attach or Describe:

4.8 ha (12 ac) bottomland forest

C. Wetland types and acreage Mitigated / Attach or Describe:

4.8 ha (12.3 ac) bottomland forest

D. Describe mitigation Ratios : _____

	YES	NO
E. Will any Endangered Species, Archeological Resources, or Haz/Tox sites be impacted by this effort?		X
F. Has a wetland determination been undertaken and verified?		X

II. TARGET GOALS AND FUNCTIONS

	YES	NO
A. Are there stated GOALS?	X	

Describe: Restore Bottomland hardwood forest vegetation and hydrology to site

B. Describe Success Criteria: Vegetation - 320 stems/acre surviving for 5 years, at least 6 species no species >20% total. Hydrology-saturated soils within 12" for 12.5% of growing season

Are they:	YES	NO
1. Specific	X	
2. Measurable	X	
3. Attainable	X	

	YES	NO
C. Target FUNCTIONS chosen and indicated?		X

Describe:

	YES	NO
D. Was a Reference Ecosystem (RE) report prepared? (Attach)		X

1. Describe comparison between the RE and the Mitigation Plan:

III. STRUCTURAL COMPONENT

A. VEGETATION:

		YES	NO
1.	Are plantings listed to species?	X	
2.	Are "local" (200 Miles North/South) propagules to be planted and verified by nursery certificate?	X	
3.	Have diversity and densities of species within the RE been considered in the plan?	NA	
4.	Has consideration been given to planting the interface between the mitigation site and upland habitats with suitable transition zone species?	X	

5. Describe Quality Control during planting: _____

B. SOILS:

		YES	NO
1.	Have the soils been mapped?	X	
2.	Soils Series/Phases Primarily Wehadkee		
3.	Fertility Sampling undertaken in RE? (Attach Report)		X
4.	Fertility Sampling undertaken on mitigation site? (Attach Report)		X

	YES	NO
5. Are fertility results within the standards for the proposed plantings?	____	____

Describe Results / Amendments Required: Fertility sampling to be conducted prior to planting

	YES	NO
6. Are the soil types appropriate for the target wetland?	X	____

Describe: Soils are a drained hydric soil

7. If PC Farmland, has site been evaluated for:	YES	NO
a. Plow pans	X	____
b. Field crowns	____	X
c. Herbicide carry-over	____	X
d. Drainage system	X	____

Describe: ____

C. HYDROLOGY:

	YES	NO
1. Were the principles of HGM or other classification system considered?	____	X

Describe: ____

2. Describe the primary hydrologic input(s): _____

Groundwater and surface water from two drainage features

	YES	NO
3. Was a Hydrology Model/Water Budget developed?	X	
a. Were low, average, and high precipitation/water table/ flood conditions considered?	X	

Describe the water budget: _____

See report

4. Will the hydrologic regime predicted by the Water Budget be appropriate for the target wetland? X

Describe: Site will likely dry out during the summer which is typical of Piedmont bottomland hardwood systems

Site will have excess water in winter and spring.

5. Have Monitoring Wells/tide/ flood gauges been installed? X

Describe: Wells will be installed following topographic modifications

---

NOTES: _____

IV. MONITORING

A. Name and number of person responsible for the success of this project: NCDOT ( )

	YES	NO
B. Is there a Monitoring Plan?	X	

Describe: Vegetative monitoring of 5 50'X50' plots Hydrological monitoring with monitoring wells.

	YES	NO
C. As Built Report provided?		
D. Procedure to account for beneficial natural regeneration?		

Describe:

V. CONSIDERATION OF CAUSES OF FAILURE

A. How does project rate regarding the following:

1. Elevation:

	YES	NO	N/A
a. Have biological Benchmarks been established?		X	
b. Is there a grading plan?	X		
c. Is grading plan specific?	X		
d. Is discing proposed after grading and/or prior to planting?	X		

2. Describe provisions for Drainage: _____

3. Describe Erosion Control Measures: _____

To be developed by NCDOT

4. Describe management of Human Impacts: _____

5. Describe management of Herbivory/Noxious Plants:

B. Are there Contingency Plans built into the proposal to address these factors? YES _____ NO _____

Describe when and how will these contingencies be implemented: _____

NOTES: _____

VI. SITE MANAGEMENT

A. Describe Final Disposition of the property

Potential to NC Wildlife Resources Commission

B. Who will manage the site after the mitigation effort is deemed a success? ( )

YES NO

C. Will wetland functions be impacted by current or future land use patterns? ____ ____

Describe: Unknown

D. Will this site have the opportunity to function as planned? X ____

Describe:

E. Describe how this project rates ecologically:

HIGHLIGHT AND ADDRESS ALL PROBLEMS AND/OR INADEQUACIES WITH THE MITIGATION PLAN/SITE AS INDICATED BY THIS CHECKLIST.
