**Roseland Lake Nutrients Modeling QAPP**
**Quality Assurance Project Plan**
**EPA Tracking # RFA 17056**

**Eastern Connecticut Conservation District**
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## 1.0 Title and Approval Sheet

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**1.1 Title Page**

# ROSELAND LAKE, WOODSTOCK, CT

# NUTRIENT SOURCE STUDY
**13-01e(i)**

# Quality Assurance Project Plan

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## Lake Nutrient Loads Modeling

**US EPA RFA #17056**

**Eastern Connecticut Conservation District**

**Approved 4/20/17**

This document outlines the protocols for utilizing water quality data and mathematical models to estimate the nutrient load sources impacting water quality in Roseland Lake, Woodstock, CT.

This project is funded in part by an US EPA Clean Water Act § 319 NPS grant through the CT DEEP. Project support also provided by the Town of Putnam, CT and The Last Green Valley, Inc.

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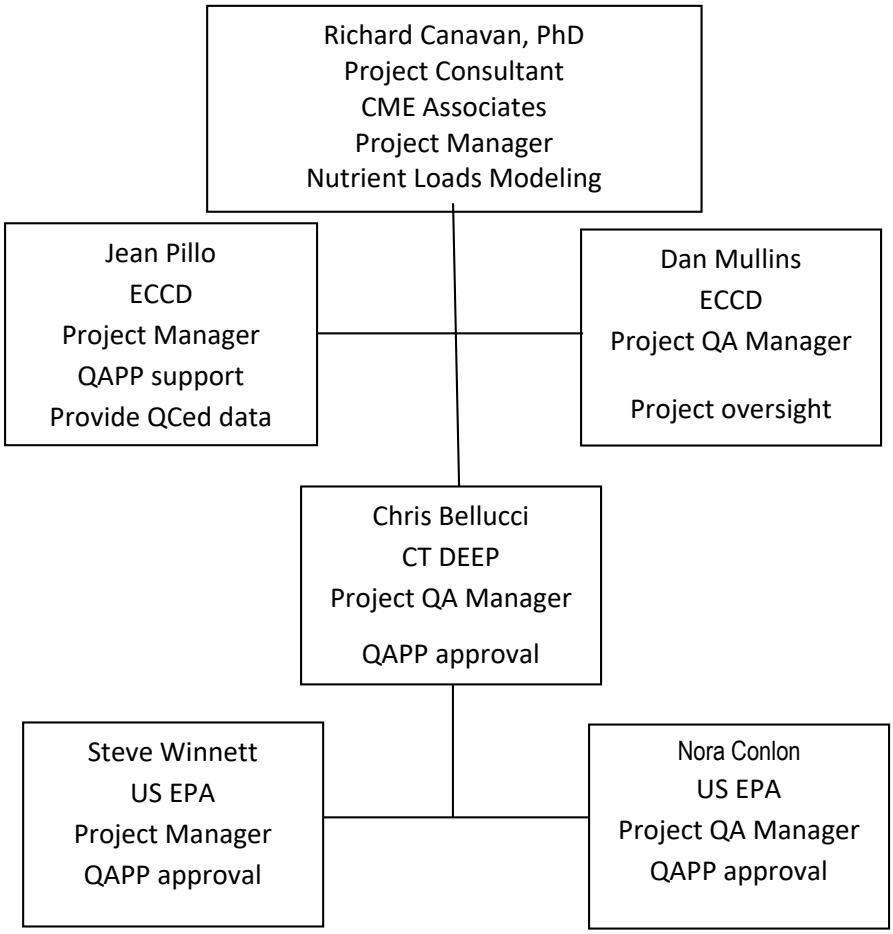
## 1.3 Distribution List

The following agencies, organizations and individuals will receive a copy of the approved QAPP. A complete copy of the approved Quality Assurance Project Plan will be kept on file by the project QA Manager at the Eastern Connecticut Conservation District, and will be available upon request.

- Eastern Connecticut Conservation District: Dan Mullins, Jean Pillo
- Connecticut Department of Energy and Environmental Protection (CT DEEP): Chris Bellucci, Eric Thomas
- US Environmental Protection Agency (EPA): Steve Winnett, Nora Conlon
- CME Associates (CME): Wayne Bugden, Richard Canavan (former CME employee and now contract employee for this project)
- Town of Putnam: Jerry Beausoleil

## 1.4 Project/Task Organization



## 1.5 Problem Identification/Background

### 1.5.1 Problem Definition

Roseland Lake, located in the Little River watershed in Woodstock, CT, has been listed as impaired for recreation in the CT DEEP Water Quality Assessment Report, most recently in 2014. The functional definition of recreation is swimming, water skiing, surfing or other full body contact activities (primary contact), as well as boating, canoeing, kayaking, fishing, aesthetic appreciation or other activities that do not require full body contact (secondary contact). The impairment category for Roseland Lake is Nutrient/Eutrophication and Biological Indicators.

### 1.5.2 Background Information

Roseland Lake is in the Little River watershed, and is approximately two miles upstream of a drinking water supply surface intake serving approximately 4000+ people in the neighboring town of Putnam. The lake was last evaluated for sediment and nutrient contributions from the watershed in 1991 based on data collected from 1981 – 83. During that period, it was estimated that an average of 427 tons of sediment was being deposited into Roseland Lake annually by Muddy Brook, the main tributary to the lake. Nitrogen and phosphorus loading from the watershed were reported to support eutrophic conditions in the lake.

A review of existing water quality data from Roseland Lake suggests that the water quality in Roseland Lake has declined from mesotrophic conditions in the late 1930s to eutrophic/highly eutrophic conditions in more recent decades. Based on a predictive model completed by CT DEP in 1978, Roseland Lake would be expected to be eutrophic[1]. This was a based on an analysis of the size of the watershed draining into the lake compared to the size of the lake.

The potential for the lake to support toxic cyanobacteria (blue green algae) blooms is a big concern in terms of managing Roseland Lake upstream of a public drinking water supply intake. Although public bathing beaches are prohibited in the lake per Public Health Code Section 19-13-B32, the lake is used for recreation by recreational boaters and fishermen. There has been a significant increase in people in kayaks on the lake in the past decade.

In freshwater ecosystems, phosphorus is typically the limiting nutrient for promoting algal and plant growth. The main sources of phosphorus in surface waters include erosion, fertilizer, animal waste (including waterfowl), wastewater discharges and failing septic systems. High levels of nutrients in the lake surface water will support algae blooms in warm weather months. Once the algae die, their remains settle to the bottom of the lake and the phosphorus will bind with naturally occurring iron compounds in the lake sediments. Over time, the accumulation of this "legacy" phosphorus in the lake bottom sediment can become significant.

In shallow thermally stratified lakes, phosphorus normally bonded with metals in the sediments can be released back into the water if the bottom layer (hypolimnion) lacks dissolved oxygen. This phosphorus may be available to support algae growth at the surface (epilimnion). Many species of cyanobacteria (blue green algae) have gas vesicles allowing them to control their buoyancy in the water column and, therefore,

[1] Connecticut. Department of Environmental Protection. The Causes of Algae Growth in Roseland Lake, Woodstock, CT. Hartford, CT: 1978. Print.

may be able to utilize these lake bottom phosphorus sources to support their growth if there is a weak thermocline in the lake[2] .

The Putnam Water and Sewer Department has been managing Roseland Lake for excess algal growth by treatment with copper sulfate since approximately 1980. Its staff have been using a subjective method to decide when to apply the algaecide. Copper sulfate is applied one to several times during the summer months. Improper application of copper sulfate can be both damaging to the aquatic habitat and can actually exacerbate the problem they are trying to treat. Roseland Lake is observed to experience numerous algae blooms during the warm weather season, including blue green algae (cyanobacteria) blooms.[3] Identification of the types and concentration of algae in Roseland Lake is important to protect recreational boaters and fishermen from coming in contact with potentially toxic harmful algae blooms and is important data for developing appropriate treatment methods for control of algae blooms. Beginning in 2015, two studies were in progress to identify and enumerate phytoplankton populations in Roseland Lake.

### 1.5.3 State decisions to be made, actions to be taken, or outcomes expected from the information obtained from modeling activities.

The outcomes of the Roseland Lake and watershed nutrient contributions modeling project will be used to guide future in-lake management and lake watershed management decisions. The model will estimate the percent of the nutrient load contribution from the watershed sources versus in-lake bottom sediment sources. The data will also identify sub-watersheds that may be contributing a larger amount of nutrient and sediment loading to the lake and remedial activities can be prioritized by sub-watershed basin.

### 1.5.4 Identify the regulatory information, applicable criteria, action limits, etc. that the model outcomes will reference.

There are no current regulatory limits for nutrients or total suspended solids in surface water in Connecticut.

The Connecticut Department of Energy and Environmental Protection is responsible for determining water quality standards for the State of Connecticut. The Connecticut Water Quality Standards and Classifications were last updated in October 2013. Within this document are parameters and defining ranges for the trophic states of lakes in Connecticut. The trophic state of a lake is determined by both water column data and the percentage of the surface area covered by aquatic plants large enough to be seen without magnification (macrophytes). Macrophyte distribution and abundance data shall be reviewed in conjunction with the water column data to determine the trophic states of lakes and ponds.

- If macrophyte growth is very extensive (75 - 100% of water body area) and dense, the trophic state of a lake or pond shall be considered "highly eutrophic" regardless of the water column data.
- If macrophyte growth is extensive (30 - 75% of water body area) and dense, the trophic state shall be considered "mesotrophic" when the water column indication is oligotrophic, and the trophic

[2] Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring and management
Edited by Ingrid Chorus and Jamie Bartram
© 1999 WHO
ISBN 0-419-23930-8 Chapter 2 CYANOBACTERIA IN THE ENVIRONMENT by Luuc R. Mur, Olav M. Skulberg and Hans Utkilen http://www.who.int/water_sanitation_health/resourcesquality/toxcyanchap2.pdf

[3] Connecticut. Department of Environmental Protection. The Causes of Algae Growth in Roseland Lake, Woodstock, CT. Hartford, CT: 1978. Print.

state shall be considered "eutrophic" when the water column indication is mesotrophic or eutrophic.

| Parameters and Defining Ranges for Trophic State of Lakes in Connecticut | | |
|---|---|---|
| Trophic State Based on Water Column Data | Parameters | Defining Range |
| Oligotrophic | Total Phosphorus | 0-10 ug/l spring and summer |
| | Total Nitrogen | 0-200 ug/l spring and summer |
| | Chlorophyll-a | 0-2 ug/l mid-summer |
| | Secchi Disk Transparency | 6 + meters mid-summer |
| Mesotrophic | Total Phosphorus | 10-30 ug/l spring and summer |
| | Total Nitrogen | 200-600 ug/l spring and summer |
| | Chlorophyll-a | 2-15 ug/l mid-summer |
| | Secchi Disk Transparency | 2-6 meters mid-summer |
| Eutrophic | Total Phosphorus | 30-50 ug/l spring and summer |
| | Total Nitrogen | 600-1000 ug/l spring and summer |
| | Chlorophyll-a | 15-30- ug/l mid-summer |
| | Secchi Disk Transparency | 1-2 meters mid-summer |
| Highly Eutrophic | Total Phosphorus | 50 + ug/l spring and summer |
| | Total Nitrogen | 1000 + ug/l spring and summer |
| | Chlorophyll-a | 30 + ug/L mid-summer |
| | Secchi Disk Transparency | 0-1 meters mid-summer |

Table 1.5.4.1 Parameters and Defining Ranges for Trophic States of Lakes in Connecticut

## 1.5.5 Identify assumptions for the modeling process.

The mass balance approach will use collected information about flows and nutrient concentrations to calculate loads over the period of this study.

Flow, Q (volume/time) X Concentration (mass/volume) = load (mass/time)

Based on the available water quality sampling information and stream flow information, subwatershed loads will be calculated. This will be calculated for Muddy Brook, Mill Brook and the Little River. A load factor for watershed area will be calculated for the streams where direct mass balance can be calculated. For watershed areas which are not included in the direct mass balance calculations inputs will be estimated based on:

- The field measured load factors in adjacent subwatersheds
- Land cover in the additional areas

The output load = nutrient load at Little River

If Input to Roseland Lake > than output load, then Roseland Lake is a nutrient sink.

If Input load to Roseland Lake < than output load, then Roseland Lake is a nutrient source.

We would expect this to shift from sink to source once internal loading kicks in.

This process will assume that the conditions in the water samples collected and analyzed are representative for longer time periods. However, during the study period, rainfall totals were below average and nearby streams monitored by USGS in late summer/early fall were measured to have below normal to much below normal flows. The region was reported to be experiencing a moderate hydraulic drought[4] for part of the study period. Actual rainfall data was collected daily at the nearby West Thompson Lake weather station and this data will be compared to flow data as a reference to actual field conditions.

Nutrient cycling within the lake and contributions from the watershed will be simplified with regards to pathways where groundwater interactions are not considered beyond stream base flow measurements, and atmospheric deposition is also not considered separately from transport in stream flow. Nutrient loading to the lake will be modeled to include:

- Calculated loads from monitored tributaries
- Estimated loads from watershed area not captured in monitored tributaries
- Internal loading estimates based on in-lake nutrient monitoring results from water and sediment.

The use of other literature models such as watershed land-use nutrient export estimation includes both the assumptions included with the development of those models and additional errors that may arise from the current available land-use data and its application to older regression equations. Land-use-based spreadsheet models that may be used include the Simple Method (Schueler, 1987) and the Watershed Treatment Model (Center for Watershed Protection, 2013). The Simple Method estimates stormwater runoff pollutant loads as a product of annual runoff volume and pollutant concentrations:

$$L = 0.226 * R * C * A$$

where: L = annual load (lbs)
R = annual runoff (inches)
C = pollutant concentration (mg/l)
A = area (acres)
0.226 = unit conversion factor

The Watershed Treatment Model (WTM) is based on the Simple Method, but allows the user to input existing management practices to modify base source loads predicted by the Simple Method. It also allows the user to predict loads based on future management practices and future development in the watershed.

Assumptions associated with the use of these models include generalized pollutant load concentrations for each land use type based on national averages as identified in multiple sources including the National Stormwater Quality Database (Maestre & Pitt, 2005), the National Urban Runoff Program (EPA, 1993) and the University of New Hampshire Stormwater Center. Pollutant concentrations for runoff from agricultural

[4] USGS WaterWatch https://waterwatch.usgs.gov/index.php?id=ww_drought

land use, including pasture, hay land, tilled and untilled cropland, are derived from a literature review (Table x). No net gain of wetlands is assumed, and an impervious cover of 1% is used to represent ledge and naturally barren land. Land cover and land uses are based on the 2010 CLEAR land cover dataset and the Multi-Resolution Land Characteristics Consortium (MRLC) 2006 National Land Cover Dataset (NLCD).

**Table 1.5.5.1 Summary of sources of agricultural runoff concentration data.**

| **Mean Runoff Concentrations from Agricultural Land (mg/l)** | | | | | |
|---|---|---|---|---|---|
| **Crop Type** | **Location** | **TN** | **TP** | **TSS** | **Source** |
| unspecified agriculture | VT | 1.01 | 0.2 | | Gustafson and Wang, 2002 |
| tilled cropland | NE | 2.44 | 0.46 | | Elrashidi et al, 2014 |
| multiple agricultural uses | OK | 8.89 | 2.17 | | Smith et al, 1988 |
| dairy pasture, improved hay land and tilled cropland | NY | | 1.97 | 205 | Hively et al, 2005 |
| manured hayfield | CT | 6.03 | 0.80 | | Clausen et al, 2008 |
| row and forage crops | WI | 14.98 | 3.51 | 859.17 | Stuntebeck et al, 2011 |
| multiple agricultural uses | NE and Mid-Atlantic US | 9.5 | 10.5 | | Moore et al, 2011 |

The following table presents a summary of what data will be used in project calculations and the source of the data. Although data from earlier studies may be used for discussion the model calculations of loads will not use concentrations of phosphorus or nitrogen from other sources. The use of existing watershed land use models will be conducted using literature values and existing land use data. Internal loading calculations will include information from lake water column oxygen profiles to estimate duration and volumes of anoxic water in the hypolimnion of Roseland Lake.

**Table 1.5.5.1 Summary of input data for models**

| Input data | Additional input | Calculation method | Result |
|---|---|---|---|
| TP and TN obtained under QAPP for this project | field measured stream flow by sub-watershed | Load (mass/time)= concentration (mass/vol)*flow (vol/time) | project calculated sub-watershed load |
| TP and TN obtained under QAPP for this project | estimated sub-watershed flows | Load (mass/time)= concentration (mass/vol)*flow (vol/time) | project estimated watershed load |
| hypolimnetic TP and sediment TP obtained by this project | duration of hypolimnetic anoxia, lake bathymetry (volumes) | using methods of Nurnberg (1984) | estimation of internal load of Phosphorus |
| subwatershed landuse cover from UConn CLEAR | watershed based loading estimations | Norvell et al (1979), DEP (2009) | landuse estimated watershed load |

## 1.5.6 Provide for notification when new models will be created that will justify the inability to use existing models in certain situations.

No new models are proposed to be created for this project. Simple mass balance calculations will be conducted and compared with other literature models.

## 1.5.7 Provide for notification of modifications to model code.

No code is modified for this process. The modeling is simple algebra with limited parameterization or computational processes. The use of other watershed land-use regression modeling (e.g. Simple Method or WTM) is used without modification of the relationships developed in those studies.

## 1.5.8 Describe how the suitability of models to resolve the application niche will be evaluated

The main focus of this exercise is to determine the relative amount of nutrient enrichment arriving into Roseland Lake from external sources compared to internal loading from legacy deposits in the lake sediments. The calculated loads from field data will be compared with watershed loading from models such as Simple and land-use based regression models (e.g. Norvell et al 1979). Results of in-lake nutrient sampling and bottom sediment analysis will be used for estimating in-lake contributions of total phosphorus.

A secondary project goal is to examine whether improved watershed practices have significantly reduced nutrient loading relative to the earlier more intensive USGS[5] study. Where practical, current external nutrient loading to Roseland Lake will be compared to a previous study reported on by USGS in 1991.

[5] Kulp, Kenneth, Suspended-Sediment Characteristics of Muddy Brook at Woodstock, CT. Prepared by the USGS for CT DEP, 1991.

## 1.6 Project/Task Description

The Eastern Connecticut Conservation District (ECCD), with assistance and support from The Last Green Valley Volunteer Water Quality Monitoring Program, collected water quality data from Roseland Lake and its tributaries from spring 2015 – fall 2016 during the ice free months. This water quality data was collected and analyzed in accordance with the Roseland Lake Nutrients Quality Assurance Project Plan for Collecting Lake, Stream and Storm Water Samples for Analysis Using a Qualified Laboratory (EPA RFA# 15060). All data has been reviewed by the ECCD staff for adherence to the quality control objectives outlined in the QAPP prior to being presented to CME Associates for use in the nutrient modeling analysis.

In addition to lake and tributary water quality data, the legacy phosphorus concentration in the bottom sediments of Roseland Lake was determined by sediment sampling and analysis in accordance with the Roseland Lake Nutrients Quality Assurance Project Plan Collection and Analysis of Lake Bottom Sediments for Phosphorus Concentration (EPA RFA# 17003). The lake sediment sampling and analysis was completed in October 2016.

Dr. Richard Canavan, formerly employed by and now under contract with CME Associates, will utilize the water quality and sediment nutrient data to conduct calculations of nutrient loading from the watershed to Roseland. This data was collected subject to an approved Quality Assurance Project Plan and met the QA requirements of those plans. This will include:

- Review all data within three months of it being provided by ECCD,
- Develop watershed loading estimates based on land-use,
- Calculate watershed export loads based on direct measurements completed by ECCD,
- Estimate spring phosphorus loading from the upper watershed to Roseland Lake,
- Estimate in-lake internal loading based on water quality and nutrient data and sediments sample analysis results,
- Develop nutrient mass balance for Roseland Lake which may be useful by lake managers and DEEP for preliminary Total Maximum Daily Load development. Data necessary to support the development of a nutrient mass balance will include a combined approach to develop a range of loading estimates. These estimates may be derived from:
    - local watershed,
    - land-use based on regression equations, direct watershed export measurements,
    - direct lake measurements to determine the extent of internal loading.

Dr. Canavan will present the draft results to ECCD, DEEP and local stakeholders by May 2017.

The modeling work will use the data collected both in Roseland Lake and in tributaries which were monitored. The project sampling plan and reference watershed map are attached for reference. (Attachment 1)

## 1.7 Data Quality Objectives for Measurement Data

Data from this project was evaluated for the modeling portion of the project based on the monitoring and laboratory analysis QAPP prepared for this project. Based on the available numbers of samples

and duration of the study we seek qualitative results which do not require the incorporation of additional data. The review of other data sources (Putnam Water Treatment Plant raw water data for example) may be useful for further study but the data quality review of additional data is beyond the scope of this study. The eventual goal of the study is to make qualitative comparisons of the loading estimated in previous studies compared to this study and to estimate the relative importance of internal loading. Both watershed nutrient loads and internal sediment loading are dynamic based on flows and seasonality, the mass balance calculations (modeling) will be 'steady-state' looking at a fixed time interval and not allow for dynamic loading through time. Because of this simple approach the acceptance criteria is also simplified to results accepted by the project's sampling and chemical QAPP.

### 1.7.1 Objectives and Project Decisions

The general goals of examining watershed nutrient loads to Roseland Lake and nutrient cycling in the lake, (watershed loads and internal loading) will include estimates of nutrient inputs based on the measured flows and concentrations from the watershed. The model analysis will attempt to use the collected field data as much as possible to estimate field measured loading rates. If some portions of the watershed could not be characterized because of issues such as:

- Field environmental conditions (e.g. no flow)
- Sample analytical problems,

additional estimates may be required for the loading calculations. Reporting narrative with the results will identify where missing or unavailable field data required additional estimation. It is understood that the loading analysis will occur with the available data and estimations where required. Additional data collection will not be feasible.

### 1.7.2 New Data Measurement Performance Criteria/Existing Data Acceptance Criteria

The project will seek to utilize the results from field analysis for this project to the maximum extent practicable. That data was collected in compliance with the Standard Operating Procedures and Quality Assurance (QA) provisions outlined in an EPA approved QAPP and the QA criteria in the QAPP were used for a determination of what results are acceptable. Incorporation of additional results will include an analysis of whether other QC measures were in place during collection and analysis. For example, downstream water department samples may be considered because those samples are collected under QA requirements of the Connecticut Department of Public Health. Additional review of methodologies would be required to compare nutrient analysis methods used and additional data procured to ensure they met the same criteria of the field data collected specifically for this study.

The model work proposed in this project does not require extensive calibration and will not allow for predictive modification of parameters. The validation method proposed is to use estimation techniques which do not require field analysis to compare relative to the calculated loads from

site-specific measurements. Given the uncertainty of both methods, the goal of the validation will not be to fully match the results but simply to confirm that the calculations based on the recent field study are consistent with watershed land-use model estimates.

## 1.8 Special training Requirements and Certifications

No special training is required for the mass-balance calculations that will be conducted for this project.

## 1.9 Documents and Records

Project reporting will include excel spreadsheets with data files. This project does not propose the creation of code or software. The model analysis will be single calculations which do not require multiple runs or testing. Files will be transferred electronically between ECCD and Rick Canavan to ensure that a backup of data files and calculations files are available.

### 1.9.1 QA Project Plan Distribution

This QAPP will be distributed by email to the project team listed in Section 1.4 for review, revision, approval and possible future revision. Any changes will be distributed to the entire team.

# 2.0 Data Generation and Acquisition

## 2.1 Data Acquisition Requirements (non-direct measurements)

The primary data source for this project will be the associated field sampling project. This modeling effort is made as a part of that study to calculate nutrient loads to and within Roseland Lake. That is the shared goal of both the field data collection and the model analysis of that data. The Roseland Lake Monitoring Plan Map is located in Attachment 1.

For all field collected samples, standard quality control requirements, including field and lab duplicates and field and lab blanks and data transcription SOPs were completed in compliance with the requirements of the Roseland Lake Monitoring Plan and QAPP.

The effort to make additional estimates of nutrient loading based on watershed land use require estimation of watershed size, land use and the use of previously established linear regression models of watershed loading. This process will include citations for sources of land-use data and regression models, which provide additional information about the methods used in those studies. That effort will be made to provide a reference to the field-calculated results (validation). The use of land use regression models will have limitations based on the age of available land use cover data, the methods used to create the land use data and the fact that land use regression models themselves may have biases based on the time period they were developed and if they incorporate internal loading or point sources into the watershed loading estimation.

## 2.2 Data management

ECCD staff, with assistance of The Last Green Valley Water Quality Monitoring Program volunteers, were directly involved with the collection of field data utilized in this project. ECCD staff directly supervised all data acquisition and adherence to all Quality Control procedures outlined in the Quality Assurance Project Plan.

In-situ Troll 9500 data for temperature, dissolved oxygen, pH, conductivity, turbidity and depth, plus secchi disk data derived from direct field measurements were uploaded into an excel spreadsheet stored on a laptop computer operated by Jean Pillo, ECCD's watershed conservation project manager. After transcription of the data into the excel database, the hard copies of the field sheets will be stored for five years at the Windham County Agricultural Center located at 139 Wolf Den Road, Brooklyn, CT 06234. All equipment calibration records will be scanned into electronic format. Backup copies of the electronic data will be stored on an external hard drive that will be kept in a secure location at 218 Day Road, Pomfret Center, CT, 06259.

Laboratory results from the UCONN Center for Environmental Science and Engineering Lab, Horsebarn Hill Road, Storrs, CT, the Connecticut Department of Public Health laboratory, Rocky Hill, CT and the New England Laboratories, Berlin, CT were scanned and stored electronically on an external hard drive that will be kept in a secure location at 218 Day Road, Pomfret Center, CT. Data were/will be transcribed by the respective labs into an electronic database template provided by DEEP. All data will be stored on an external hard drive that will be kept in a secure location at 218 Day Road, Pomfret Center, CT, 06259. All hard copies of data sheets will be stored for 5 years in the ECCD storage space located at 139 Wolf Den Road, Brooklyn, CT 06234.

As part of the water quality monitoring project, staff gage rulers were installed and flow curves were generated at several key sampling locations in the watershed. Water levels were recorded when samples were collected. Pressure loggers were installed at four locations and data was downloaded by staff at CME Associates in Woodstock, CT. To estimate the stream flow during their deployment, pressure logger results will be compared to the field staff gage readings and the flow curves for those locations.

Bottom sediment sampling and analysis was completed by Solitude Lake Management staff utilizing methods outlined in an approved quality assurance project plan (Collection and Analysis of Lake Bottom Sediments for Phosphorus Concentration EPA RFA# 17003). The samples were analyzed independently for loosely sorbed Phosphorus and Iron-bound phosphorus at a certified lab qualified to conduct the analysis (Northeast Laboratory, Berlin, CT). At one random sampling location, duplicate samples were prepared from one grab sample for quality control purposes. A composite sample containing equal volumes of sediment samples from the four sampling locations was dosed with aluminum to determine the treatment requirements to immobilize the existing phosphorus in the sediment. The data from this analysis met the quality control objectives of the bottom sediment sampling QAPP. Solitude Lake Management prepared a report on this analysis which was submitted to DEEP for approval.

Before being transferred to CME Associates for use in the Roseland Lake Nutrient Loads Modeling project, all data was reviewed for consistency with quality assurance standards as established in the Quality Assurance Project Plan for data collection.

Jean Pillo, Eastern Connecticut Conservation District Water Conservation Project Manager, is responsible for data management.

Field data sheets were completed on the date of data collection and signed by the personnel involved with data collection. After verifying that the data sheet was complete, the data sheet was signed by the Quality Assurance manager.

For each water sample transported to a laboratory for analysis, a Chain of Custody sheet was prepared. The Chain of Custody sheet doubled as the test parameter order for each sample site. The Chain of Custody form was presented to the laboratory with the samples, signed, and copied.

At the end of the sampling day, all data sheets were scanned into an electronic format, saved onto a computer and backed up onto an external hard drive stored in a secure location. Hard copies of the data sheets were assembled by collection date, stapled together and stored in a secure location at an offsite facility. The data sheets will be stored for a minimum of five years.

The master data spreadsheet includes the units of measure in the heading of each data column and the significant figures for each parameter will be set for each parameter according to the limits of the testing methodology for that parameter.

Once the data quality assurance procedures are completed, the data will be transposed onto a master spreadsheet. Each data entry is verified to assure that no transcription errors have taken place.

No model-specific modification or manipulation of the data will be required.

Data modeling and analysis will be performed by Rick Canavan, hired consultant for CME Associates.

# 3.0 Assessment and Oversight

## 3.1 Assessment/Oversight and Response Actions

During field monitoring, ECCD staff assured that the data readings met data quality objectives of the monitoring QAPP. ECCD staff reviewed the field data sheet at the end of each monitoring event and signed it after determining it was complete.

As part of the quality assurance plan outlined in the QAPP, any data that fell outside a reasonable expected range required verification by the laboratory for accuracy. Samples that failed to meet QC standards were qualified. Several samples analyzed at the CT DPH lab exceeded the specified hold times prior to analysis. All these samples were qualified as a result and additional samples were collected to assure an appropriate sample size for making any statistical analysis. The qualified data will be scrutinized for relevance prior to use or the decision not to use it.

Review of model results prepared by Rick Canavan for ECCD will include written and verbal review by ECCD. Because the modeling process does not include significant parameterization or runs of a model with varied parameters, no formal model log is proposed. A report will be produced as listed in Section 5.0. A separate modeling process report will not be produced. Spreadsheet models themselves will be provided but the reporting will be on the results and not model methods and no specific format of model output review are developed.

# 4.0 Model Application

## 4.1 Model Parameterization (Calibration)

The mass balance model process will minimize parameterization. The mass balance model will seek to develop loading amounts by combining the concentrations (weight/volume) and flows (volume/time) to calculated loads (weight/time). Additional application of models from the literature, such as the watershed land use loading estimates, will rely solely on parameters from those studies.

## 4.2 Model Corroboration (Validation and Simulation)

The project will calculate nutrient loads based on field measured concentration and flows. This will be a calculation rather than a simulation. The project will seek to validate or corroborate the results of the calculations on the 2015/16 field results with a number of additional calculations. Calculated loads will be compared with lake volume and concentrations to compare inputs to the current concentrations, although an exact correspondence is not anticipated. Additional comparisons will be made with other estimation methods of watershed loading with the goal of both validating the field results with a result that is within the estimated variance of the loading model and allow for an examination of how site-specific conditions or data quality may account for observed differences.

The limited degree of parameterization and simulation will limit the need for detailed validation or model review.

## 4.3 Reconciliation with User Requirements

The final modeling report will discuss the limitations of the analysis of monitoring results. This discussion will begin with a description of the implementation of the field monitoring relative to the project plan. Additionally, the discussion will explain why elements of the field data were not incorporated, if they cannot be. Departures from the planned model phase outlined in this QAPP will be reported by the manager of the modeling phase, Rick Canavan, to the overall project manager, Jean Pillo, as they are being considered. Additional discussion will include the rest of the project team if it is determined to be necessary.

## 4.4 Reports to Management

Reporting is anticipated to occur by email and phone during the work on the project. Based on the limited time available reporting will not be formalized by frequency or format.

A draft report will be prepared and presented to ECCD by early May. A presentation on the draft project outcomes will be presented to ECCD and CT DEEP staff and other project stakeholders for peer review. Commentary from that review will be incorporated into the final project report.

# 5.0 Reports

The contents of the report from the template list are provided below:

- Introduction and Background – this will place the model analysis in the context of the project objectives and goals and introduce the model analysis;
- Physical Setting;

- Data used in the analysis, including any older data usage and data exclusion and discussion of the data quality objectives of any data additions;
- References to models and discussion of calculations;
- Model validation discussion using site data calculation and other modeling;
- Deviations from the QAPP Including a List of Non-Applicable Reporting Elements with Explanations;
- Conclusions, Recommendations, References and Appendices.

## 6.0 References and Glossary

Preliminary references

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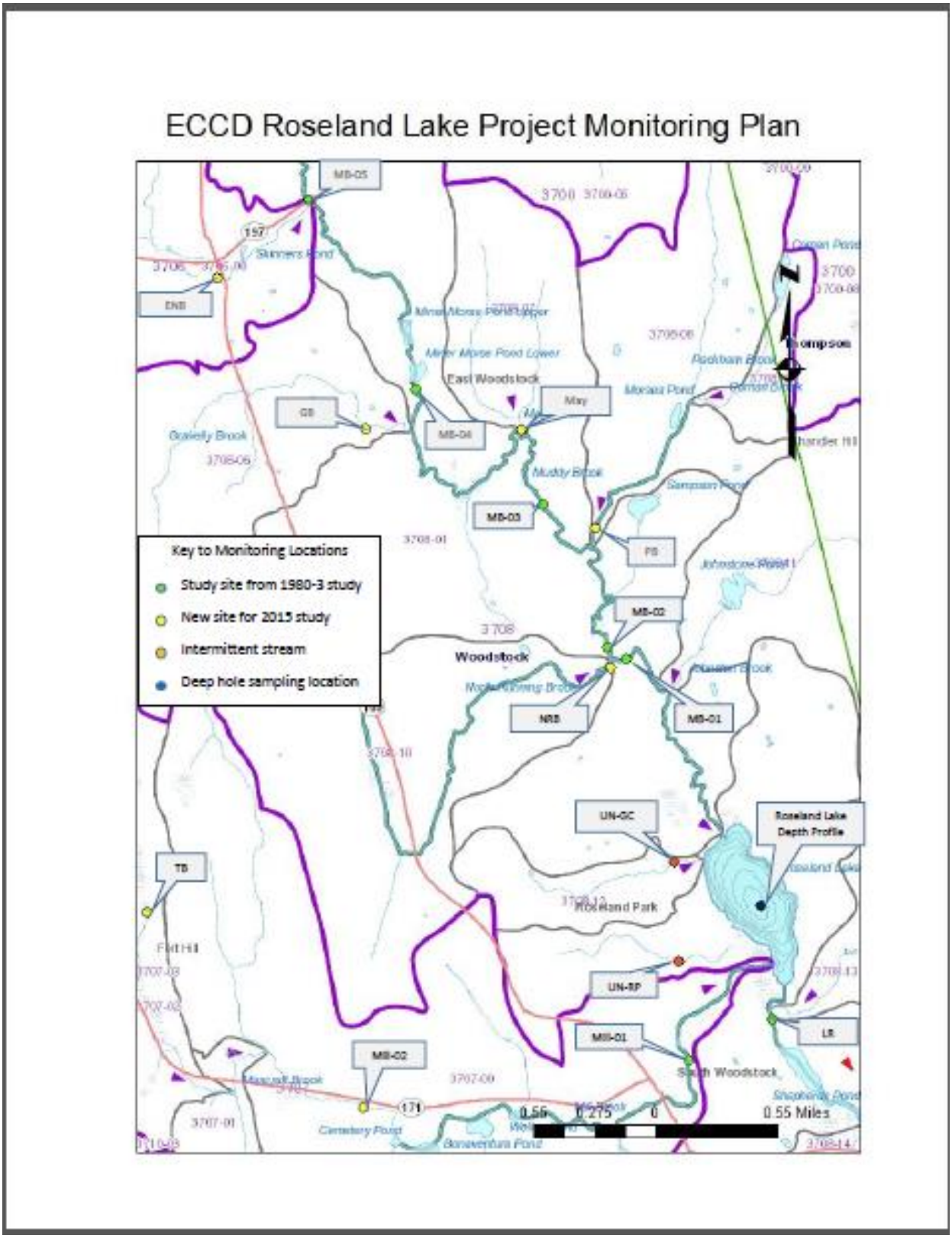
Attachment 1 Roseland Lake Monitoring Plan Map