Appendix

Final Report

Appendix A
Quality Assurance Project Plan (QAPP)

Furnace & Oldham Ponds Watershed Restoration Project

Section 604b Project # 2009-07/ARRA 604

Prepared by
Comprehensive Environmental Inc. for
Town of Pembroke, MA

Prepared for
Massachusetts Department of Environmental Protection

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

Department of Environmental Protection
Kenneth L. Kimmel, Commissioner

Bureau of Resource Protection
Ann Lowery, Acting Assistant Commissioner

Division of Municipal Services
Steven J McCurdy, Director

June 2011

General Quality Assurance Project Plan Adoption Form For

Pembroke Ponds Quality Assurance Project Plan

By

Pembroke Watershed Association

May 5, 2010

2010 through 2012
Revision No: 4
RFA # 10085

1. Signature Page

We, the undersigned, have read and understand the requirements outlined in the General QAPP for Massachusetts Volunteer Coastal Monitoring, and establish that this project meets the overall intent and requirements set forth in the General QAPP.

Project Manager: Frederick H Baker Jr. ________ Date

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Program Monitoring Coordinator: Charles E Banks 5/16/10 Date

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Program Quality Assurance Officer: Howard League 5/16/10 Date

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MassDEP QA Officer R. C. 5-25-10 Date

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Appendix A PWA Water Quality Team
Appendix B Training Process and Documentation
Appendix C Water Sample Collection Data Sheet, Sample Bottle Label, Analytical Balance Chain of Custody Form, Analytical Balance Certificate of Analysis, Qualification / Requalification Sampling Competency, QC Checklist, Calibration Log
Appendix D Water Quality Testing and Qualification Procedure Manual
Appendix E Analytical Balance State Certification, Mass DEP Certified Parameter List
Appendix F Calibration/Maintenance SOPs for YSI-85 and YSI EcoSense pH100
Appendix G QAPP Amendment 1 for Furnace & Oldham Pond Watershed Restoration Plan

3. Distribution List

Project Manager:	Frederick Baker Jr.
MA DEP Project Officer	Gary Gonyea, MA DEP
MA DEP Quality Assurance Officer	Richard Chase, MA DEP
US EPA Project Officer	Mary Jo Feuerbach, US EPA Region 1
US EPA Quality Assurance Officer	John Smaldone, US EPA Region 1
Program Monitoring Coordinator:	Charles Banks
Program Quality Assurance Officer:	Howard League
Modeling QA/QC Officer	Nick Cristofori, Comprehensive Environmental Inc.
Project Field Coordinator:	Patricia McCabe
Modeling Coordinator:	Dave Nyman, Comprehensive Environmental Inc.
Project Lab Coordinator:	Robert Bentley, Analytical Balance Labs
Pembroke Watershed Association: www.pembrokeponds.org	Raymond Holman, President Frederick Baker Jr. Vice-President Elizabeth York Executive Secretary William C McCabe, Treasurer Mark Ames, Director Arthur Boyle, Director Patricia McCabe, Director Dottie MacInnes, Director
Town of Pembroke	Edward Thorne, Town Manager
Department of Public Works	Eugene B. Fulmine, Director
Recreation Commission	Gregory Hanley, Chairman
Herring Brook Commission	Mark DiGiovanni, Chairman
Conservation Commission	Robert Clarke, Conservation Agent
Board of Health	Fred Leary, Health Agent

4. Project Organization and Responsibilities

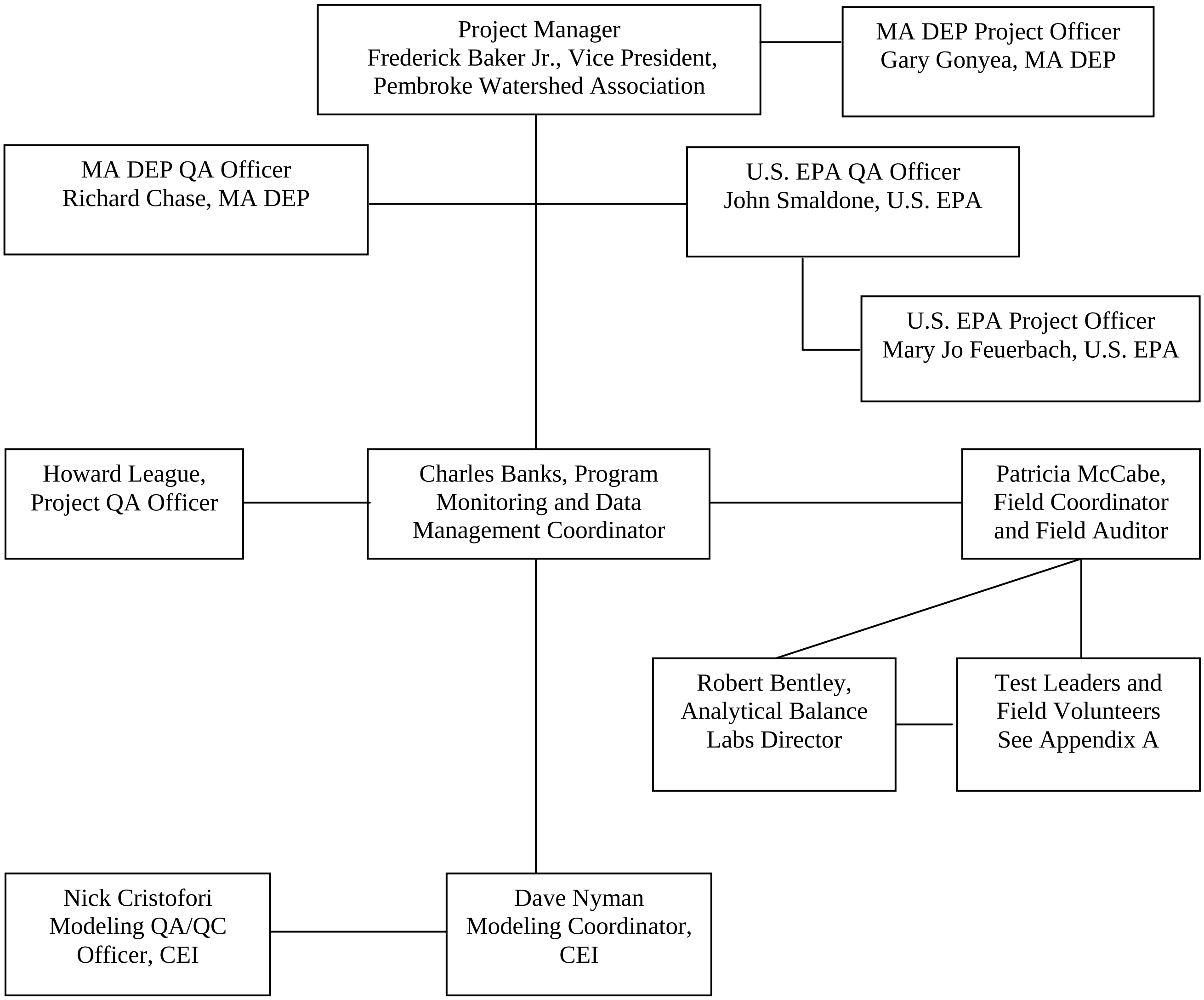
Table 4.1. Project Organization and Responsibilities

Name(s)	Project Title	Description of Responsibilities
Frederick Baker Jr.	Project Manager	Directs all project activities for the responsible agency, oversees development &submission of QAPP; assists with writing the QAPP
Gary Gonyea	MassDEP Project Officer	Responsible for overall MA DEP project grant management including technical and administrative supervision and final task review and approval.
Richard Chase	MassDEP QA Officer	Reviews *General QAPP Adoption Form*, reads QA reports, confers with program QA officer on quality control issues that arise during the course of a monitoring program.
Mary Jo Feuerbach	US EPA Project Officer	Responsible for overall EPA grant management.
John Smaldone	US EPA Quality Assurance Officer	Responsible for review and comment on the Quality Assurance Project Plan (QAPP). All modifications to the approved QAPP will be documented and submitted to Mr. Smaldone for approval, including but not limited to changes in sample design, sample collection, and data assessment and reporting.
Charles Banks	Program Monitoring and Data Management Coordinator	Oversees volunteer training & all elements of field monitoring & assesses field performance; compiles field and analytical data into comprehensive format, graphs and/or maps to correspond with format compatible with the state; Develops reports including annual report; Assists with writing the QAPP

Name(s)	Project Title	Description of Responsibilities
Howard League	QA Officer	Assists with writing the QAPP & oversees QA procedures as outlined in the QAPP to ensure all elements are followed and evaluates data against data quality objectives
Nick Cristofori	Modeling QA/QC Officer	Assists with writing the QAPP and oversees modeling QA procedures. Works with the Modeling Coordinator to ensure all project elements follow the procedures outlined in the QAPP.
Patricia McCabe	Field Coordinator and Field Auditor	Responsible for training and supervising volunteers. Ensures field forms are properly filled out and water samples and forms are transported to analytical lab as needed. In collaboration with project QA Officer, performs QC check Audit to make sure procedures are followed, maintains QC Logs.
Dave Nyman	Modeling Coordinator	Oversees modeling efforts for the project including calculations, land use analysis, hydrologic modeling, runoff calculations, and determination of phosphorus loads to the lakes.
Analytical Balance Corp. Labs	Robert E Bentley, Laboratory Director	Directs and conducts analysis of water samples for Total Phosphorous, Nitrate Nitrogen other parameters identified in Section 6
See Volunteers list: PWA Water Quality Team. Appendix A	Volunteers	Sample, perform field sampling, assist in data entry.
PWA Test Leader	Test Leader	Reports to the Field Coordinator. Oversees actual tests on a particular pond. Verifies that all required procedures are followed and that paperwork is complete. Delivers all paperwork to the Field Coordinator for review. Test leaders for a particular pond test are designated, there are no official test leaders.

Table 4.2. Organizational Chart:

Lines between boxes indicate who communicates directly with whom



5. Problem Definition/Background

The Pembroke Watershed Association - www.pembrokeponds.org
The Pembroke Watershed Association (PWA) was created on September 25, 2004 with the following mission statement:

> ***To educate the public and restore and protect the Ponds of Pembroke for clean and safe recreational, social and civic activities and to preserve these unique resources for future generations.***

The Pembroke Watershed Association implemented numerous programs for fundraising (fishing derby, family fun day, raffles, cook-outs), community education and involvement (workshops, lectures, public meetings, pamphlet distribution, pond cleanups, and school presentations) and maintains a visible presence in the community through newspapers, website, and local cable programming. They have partnered with the NSRWA to support education and low impact/green solutions to growth and water management and have joined the Watershed Action Alliance on the south shore to share best practices and continue to utilize experts in the area of water quality and water management.

The PWA has developed an aggressive program of water quality monitoring for the five ponds in our study group. Our initial water quality plan was based on input from other watersheds, COLAP and Rivernet seminars, previous diagnostic surveys mentioned, and information from the Massachusetts Waterwatch website. We selected sites based on previous studies and potential for valuable information regarding non-point source pollution as well as identified sites of pollution, such as bog return effluent or storm drains. We established a contract with Analytical Balance Laboratories in Middleboro, MA to conduct chemical analysis and garnered financial support from the town of Pembroke for chemical monitoring of the ponds. We developed field testing forms, a training manual, created or obtained testing equipment (oxygen meters from NSRWA, created a testing stick and Secchi discs). We also purchased a Hach Quanta meter to allow us to obtain turbidity and DO readings immediately, but found the equipment difficult to maintain, calibrate, and it needed repair multiple times; hence, we retired the meter. In July 2007 we were granted the use of YSI Model 85 meters and Checkmite pH meters which have been successfully integrated into our testing protocols. In 2009 we were granted use of YSI EcoSense pH100 meters to replace the Checkmite meters. We have maintained strict annual training and remediation standards to ensure that our water quality testing processes are accurate and reliable.

Initially we obtained grab samples, Secchi disc readings, and recorded DO readings in shallow water, often 2-3 feet in depth, with one deep hole sample area in each pond. We found our data to be inconsistent and Secchi disc readings were only accurate in deeper areas. The team of volunteer testers, the field monitoring coordinator, and the program monitoring coordinator reviewed the field monitoring sheets and the testing procedures with each testing session, and over time made decisions to improve the quality of the testing. The field monitoring sheets have been revised multiple times, and now include specific directions for completion. We have moved the sampling sites to deeper water and set a standard depth for all samples to be taken, and have found the data collection to be more consistent over the expanse of the pond. We have reduced the number of testing sites given the consistency of the data, and we have now included field blanks and blind samples as part of the routine testing process on each pond. Our water quality testing procedure manual has been revised multiple times to reflect the continuous quality improvement processes and lessons learned along the way.

This program has provided a valuable data base for future comparisons and evaluation and has provided the backbone for the volunteer training and water quality analysis SOP's. It is available on our web site www.pembrokeponds.org

The Value of Pembroke's Ponds

The Ponds of Pembroke are a natural resource (drinking water, irrigation for cranberry bogs and homes) as well as a water recharge system for the town wells. Furnace pond is a Class A. Public water supply source for Brockton Water Works. The ponds provide and support aquatic and wildlife habitats. Oldham and Furnace ponds provide herring spawning grounds. The ponds provide aesthetic beauty and natural resources that are unique to Pembroke. They provide a recreational resource for the town, including town beaches and fishing access and are a source of additional tax revenue from waterfront properties. The ponds within the town are a valuable part of either the South Coastal Watershed or Taunton Watershed and contribute to the Mass Bay estuary.

Description of Pembroke's Ponds Project

Oldham Pond, Furnace Pond, Little Sandy Bottom Pond and Hobomock Pond are bodies of water located within the town of Pembroke, Massachusetts and are part of the South Coastal Watershed. In addition, Stetson Pond, also located within the boundaries of Pembroke, Massachusetts is part of the Taunton River Watershed. These five ponds comprise the focus of our study. A description of each pond in our study is as follows:

Name	**WBID#**	**Size (acres)**	**Category** (2008)	**Reasons for study or impairment**
Furnace Pond	MA94043	103	5	Impaired due to organic enrichment / Low DO
Little Sandy Bottom Pond	MA904085	56	2	Not Impaired, monitoring to maintain status
Oldham Pond	MA94114	232	4c	Impairment from exotic species
Hobomock Pond	MA94177	13	2	Not Impaired, monitoring to maintain status
Stetson Pond	MA62182	88	5	Impaired due to Nutrients, organic enrichment / low DO and exotic species

Information from- the South Shore Watersheds Water Quality Assessment Report – 2001. Massachusetts Executive Office of Energy and Environmental Affairs, Department of Environmental Protection (with updates as needed).

The categories are those identified in the Massachusetts Integrated List (2008). Category 5 are "Waters requiring a TMDL"; Category 4c are waters where "Impairment not caused by a pollutant"; Category 2 is no impairment, NR indicates Not Reported. Two of these ponds, Oldham Pond and Furnace Pond have significant water quality problems with Oldham Pond listed as Category 4c for exotic species on the Massachusetts 303(d) list of impaired waters and Furnace Pond listed as Category 5 for organic enrichment and low dissolved oxygen. Oldham Pond is approximately 220-acres in size, approximately twelve feet deep, and directly feeds Furnace Pond. Furnace Pond is approximately 96-acres in size and approximately eight feet deep. Historic water quality data for both ponds indicates significantly high total phosphorus levels and turbidity likely lending to the excessive nuisance aquatic weeds and algal blooms. Located in a relatively developed watershed, the shoreline of these ponds is dotted with full-time residences and several commercial businesses.

Previous Studies

Previous studies include a Diagnostic Feasibility Study completed in 1993 for both Furnace and Oldham Ponds (Baystate Environmental Consultants, Inc., 1993). This study was completed under MGL Chapter 628, the Massachusetts Clean Lake Program that existed at that time. Extensive water quality data in this survey indicates that Oldham and Furnace have high levels of nutrient enrichment and invasive aquatic vegetation. Both ponds were also found to have stormwater impacts, although at the time the study's recommendations said little about how to specifically deal with stormwater contamination. The study did recommend leaching catch basins for the Furnace Pond drainage area. A subsequent study of Oldham Pond was completed under the Department of Environmental Management's (DEM now DCR) Lakes Program in the year 2000 (Comprehensive Environmental, Inc., 2000) while Furnace was completed under the same program in 2001 (Comprehensive Environmental, Inc., 2001). These studies included additional sampling data and updated recommendations based on the advancement of stormwater technologies at the time.

As a result of these studies, beginning in 2001, the Town received and successfully completed several MassDEP/EPA s.319 Nonpoint Source Pollution grant projects. Projects concentrated on the lower reaches of the watershed by retrofitting 27 catch basins with leaching basins and using a vacuum street sweeper adjacent to the ponds. More recently, the Town worked with the North and South Rivers Water Association (NSRWA), the Pembroke Watershed Association (PWA) and CEI to engineer and construct several Low Impact Development (LID) retrofit projects at the Oldham Pond boat ramp and Town Hall. Since 2006, the PWA has collected significant water quality data from both ponds and in 2008 began data collection under an approved Quality Assurance Project Plan.

As the studies approach the 10 year mark, the Town and the PWA would like to prepare an update that will evaluate watershed improvements completed to date, allow for the incorporation of more recent development and water quality testing and provide more specific BMP recommendations with quantifiable results to help guide future restoration efforts. Stakeholders include the Town of Pembroke, watershed residents, citizens utilizing the public beach for recreational purposes and swimming lessons and the dedicated members of the PWA. Additionally, Furnace Pond (fed by Oldham Pond) is a back-up drinking water supply for the City of Brockton. Stakeholders aim to gain over the next 10-years improved water quality to Oldham and Furnace Pond, specifically reduced phosphorus and sediment inputs therefore reducing algal blooms and nuisance aquatic weeds and decreasing fish kill events currently resulting from low DO.

The PWA received approval for a 604b assessment grant to further assess non-point source pollution in Oldham and Furnace in conjunction with Comprehensive Environmental Inc. The primary purpose of the project is to develop a long-term watershed restoration plan for both Oldham and Furnace Pond by utilizing a quantitative approach. This approach will prioritize future watershed protection activities to obtain the most cost effective pollutant removal, while estimating the anticipated improvements. The study will focus on where the pollutants, in this case phosphorus, are coming from and how much of it needs to be removed under existing and buildout conditions to reduce in-lake phosphorous levels to meet recreational goals. Ultimately, the Town of Pembroke can use the plan to implement the most cost-effective BMPs to meet water quality goals and to obtain future funds under the s319 grant program for implementation.

Monitoring and Data Use Objectives
This project will provide information related to the following issues:

- ✓ Water Quality Monitoring
- ✓ Data Assessment and recommendations for Best Management Practices (BMP)
- ✓ As explained in the GENERAL QAPP, the monitoring objectives of this project include:
- ✓ Provide quality-controlled data that support the assessment and restoration of the watershed and critical habitats through the implementation of Commonwealth programs such as:
  - ✓ DEP's 305(b) water body health assessments and TMDL development for impaired waters
  - ✓ EOEEA's watershed action plans for the Taunton and South Coastal Watersheds
  - ✓ National Estuary Programs' Comprehensive Management Plans
  - ✓ Leverage the Commonwealth's funds to increase the collection of quality data
  - ✓ Water body/watershed health assessment
  - ✓ Impact assessment
  - ✓ Public education and outreach

Table 5.1. Data users and intended uses

User	Intended Uses
Pembroke Municipal Boards	To guide local control & restoration strategies & secure money to implement projects. Prioritize management efforts as they relate to non-point source pollution storm water management plan
Pond Residents	To help understand the impact of actions within the watershed. Understand aquatic vegetation & restoration efforts.
MA Department of Environmental Protection	To provide information in future assessment & in developing total maximum daily load strategies.
Project Partners: Recreation Committee Herring Brook Commission Conservation Commission	To support grant applications for sedimentation projects & other non-point source pollution grants

6. Project /Task Description

Project Description
The Pembroke Watershed Association will organize and train volunteers to conduct water quality monitoring in the five (5) designated ponds within the town of Pembroke in the South Coastal and Taunton River watersheds. The monitoring will take place at the specific sites listed below for each pond. Site selection was established with reference to those sites chosen in the 1993 diagnostic and feasibility study performed by Bay State Environmental Consultants Inc. and in-house analysis by the Pembroke Watershed Association to identify addition sites for assessment. Water quality monitoring teams test:

1. pH
2. Water Temperature
3. Dissolved Oxygen
4. Conductivity
5. Salinity
6. Water clarity (Secchi disk)

The grab sample is sent to Analytical Balance to test for:

1. Turbidity
2. Total Phosphorous
3. Alkalinity
4. Chloride
5. Nitrogen Series is tested once per year per pond
    a. Nitrite
    b. Nitrate
    c. Ammonium Nitrate
    d. TK Nitrogen
    e. Total Nitrogen is calculated by the lab

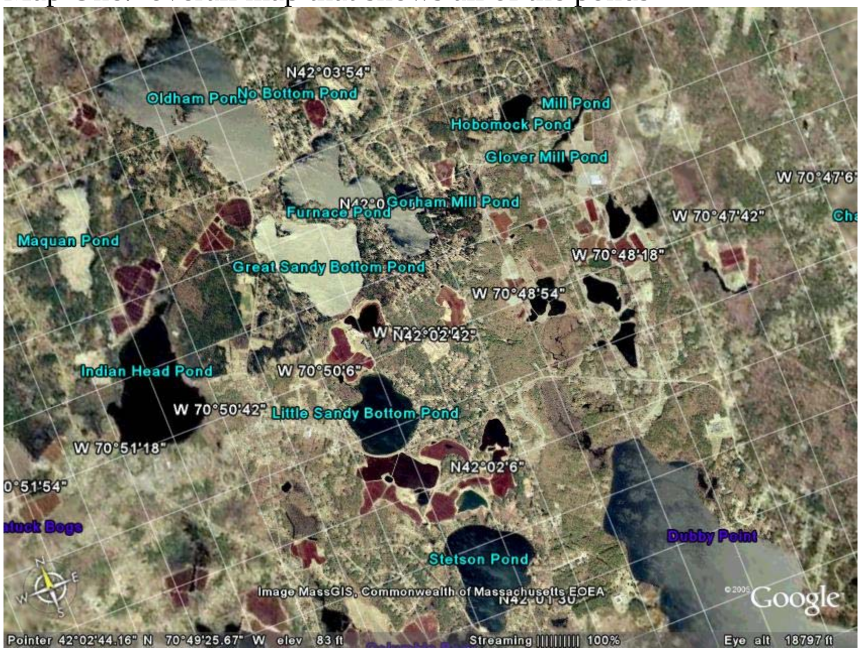
Monitoring will be conducted June through September on a monthly basis for Oldham and Furnace ponds, bi-monthly for Stetson pond and annually for Little Sandy Bottom pond as per the schedule submitted by the Program Monitoring Coordinator. At present, testing on Hobomock pond has been suspended due to the discovery of Hydrilla and will not be resumed until authorized by the appropriate state agency. A specified number of sample sites have been designated for each pond.

Currently, all grab samples are taken at a depth of 48 inches. The YSI /pH instrument measurements are conducted at a depth of 48 inches and 84 inches to obtain a profile of the pond and determine if the pond stratifies. Sampling in Oldham and Furnace Ponds will involve collecting temperature and dissolved oxygen data at two-foot intervals at each deep hole location. If stratification is found to occur in each of these two ponds, two phosphorus samples will be collected, one from the epilimnion layer (surface) and one from the hypolimnion layer (bottom). All test parameters listed above are evaluated and compared to state standards and when applicable US EPA nutrient criteria. The information collected will be used as base line data against which to assess future changes.

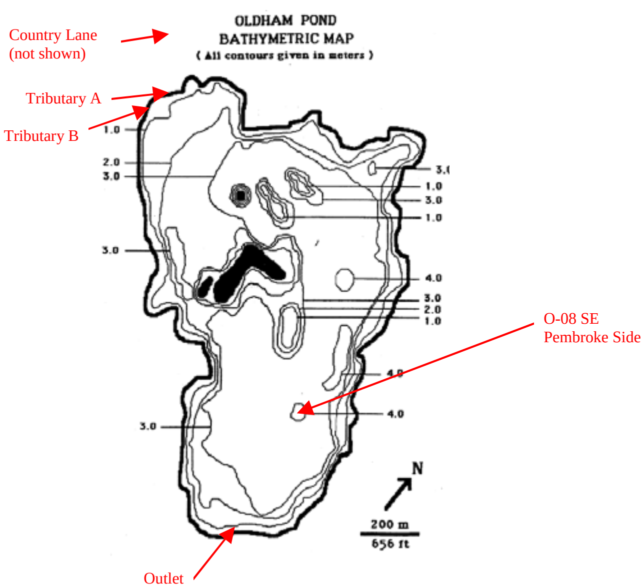
Pembroke Watershed Association: Water based testing

Using Google Earth view of our ponds we have included our testing sites, marked in yellow, on each of the ponds. Site identification includes our identifier and the 1988 survey identifier for the same site. We utilized GPS coordinates to determine and standardize our sites. We identified our test sites in red on the following maps:

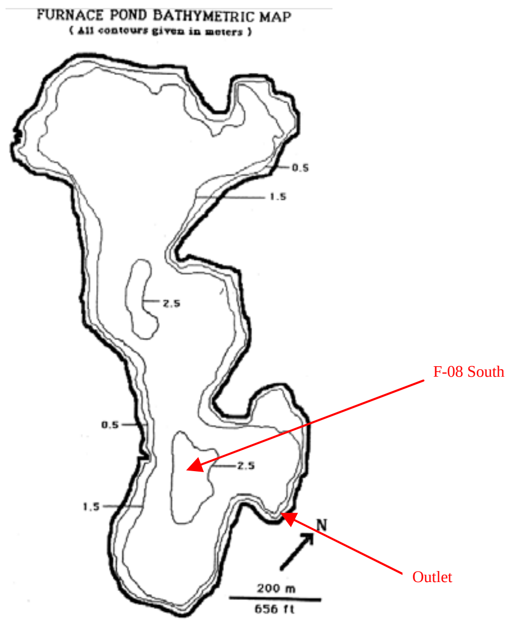
Map One: overall map that shows all of the ponds



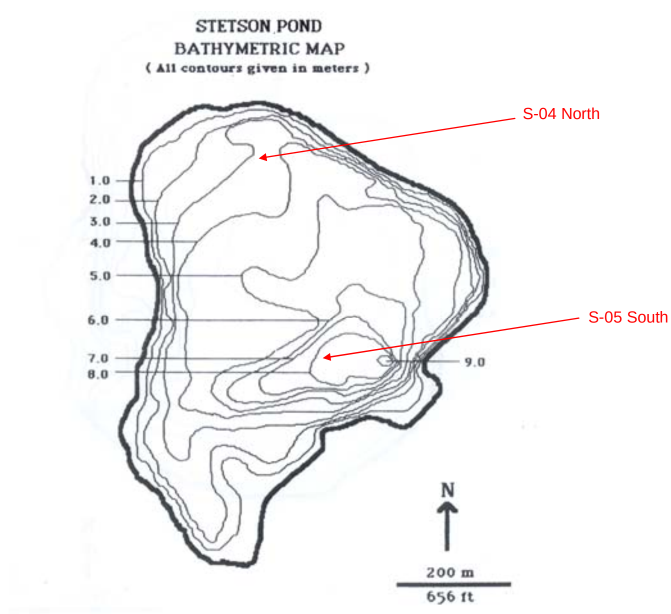
Map Two: Oldham Pond



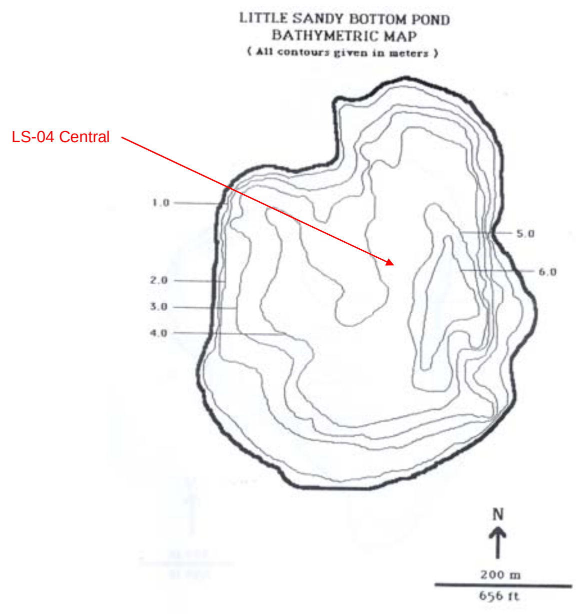
Map Three: Furnace Pond



Map Four: Stetson Pond



Map Five: Little Sandy Bottom Pond



Map Six: Hobomock Pond

Table 6.1. GPS coordinates for sample sites

Waterbody	Name	Description	Latitude	Longitude
Oldham Pond	Tributary A		42^0 04.217 N	70^0 50.640 W
	Tributary B		42^0 04.172 N	70^0 50.669 W
	Country Lane	Upstream of culvert	42^0 04.496 N	70^0 50.724 W
	O-08	Southeast Pembroke Side	42^0 03.645 N	70^0 49.910 W
	Outlet		42^0 03.550 N	70^0 49.976 W
Furnace Pond	F-08	South	42^0 03.233 N	70^0 49.315 W
	Outlet		42^0 03.186 N	70^0 49.182 W
Stetson Pond	S-04	North	42^0 01.882 N	70^0 49.779 W
	S-05	South	42^0 01.741 N	70^0 49.330 W
Little Sandy Pond	LS-04	Central	42^0 02.495 N	70^0 50.055 W
Hobomock Pond	H-02	Central	42^0 03.393 N	70^0 48.618 W

In conjunction with the field sampling measures at Furnace and Oldham Ponds, a land use based model and a lake response model utilizing subwatershed characteristics and the Simple Method to model pollutant loadings. Modeling will be performed for both existing conditions and buildout conditions, while also roughly estimating how much of the load might be corrected through specific measures. Existing land uses within the watershed will be obtained through MassGIS files and local GIS information as available and input into the model to estimate phosphorus loads from the watershed. The model will account for loadings associated with stormwater runoff from each type of land use as well as septic systems within proximity of the ponds. Other inputs such as flow from active cranberry bogs, phosphorus from internal recycling and phosphorus from baseflow will also be estimated for use in the model. The modeling effort will be supported by a windshield survey of the watershed to review changes in the Furnace and Oldham Pond watersheds that have occurred since the 2000 and 2001 studies and to identify specific pollution sources that may require more attention in the proposed modeling and possible sites for BMP locations.

Realistic, achievable water quality goals that promote the recreational and wildlife use of the ponds will be set for phosphorus within Oldham and Furnace Ponds. The required load reduction to meet these goals under existing and buildout conditions will be calculated using the model. Based on the needed reductions and available watershed information, specific BMPs will be identified to reduce phosphorus loadings to the desired levels. 30% engineering designs will be prepared for the top 3-5 structural improvements. Monthly and quarterly project status reports will be prepared and submitted to MassDEP per the new ARRA reporting requirements, as well as a final project report per grant guidelines and required copies.

A draft and final watershed restoration plan will be prepared outlining the findings and include recommendations for proposed BMPs to meet the defined water quality goals. Costs and phosphorus removal will be defined for each recommended BMP and presented as cost per pound of phosphorus removed. Recommendations will be prioritized and a 10-year implementation schedule will be performed for Oldham and Furnace Ponds.

Table 6.2. Anticipated Schedule Please update and assume QAPP will be approved for January 2010 start.

Activity	J	F	M	A	M	J	J	A	S	O	N	D	J
Finalize *General QAPP Adoption Form*	XX	XX	XX										
Meeting with agency representatives		XX											
Meeting with Water Quality Team			XX										
Equipment inventory, purchase, inspection and testing			XX	XX									
Field training and database training				XX	XX	XX – Ongoing -- XX							
Meeting with analytical laboratory			XX										
Field reconnaissance			XX	XX									
Sampling surveys						XX	XX	XX	XX				
Data entry						XX	XX	XX	XX				
Data review and validation							XX	XX	XX	XX			
Field audit(s)						XX	XX	XX	XX				
Modeling and analysis							XX	XX	XX	XX			
Draft report and watershed restoration plan											XX	XX	
Engineering designs											XX	XX	
Final report and watershed restoration plan												XX	
Prior year final report		XX	XX										
Data uploads to website			XX	XX									
Reporting	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

7. Data Quality Objectives

The following quality control measures and data quality objectives shall be employed for the Pembroke Ponds Project .

Overall sampling precision will be estimated by the following

- ✓ Taking duplicate field measurements (instruments) at least once per pond annually.
- ✓ Collecting duplicate field samples at least once per pond annually.
- ✓ Utilize QC procedures including field duplicates and duplicate measurements for meters to validate readings

Accuracy of results will be estimated or confirmed by the following

- ✓ All samples submitted to Analytical Balance Corp. Laboratories. Department of Environmental Protection State Certification No. M-MA022 see certification in appendix E
- ✓ Review of all data and results to verify accuracy and identify discrepancies or outlier data as outlined in section 23

Data Representativeness will be met by the following:

- ✓ Test sites are selected to be representative of typical conditions for the water body**.** The temperatures and oxygen levels at our four foot testing depth are likely to be affected by nutrient uptake, temperature gradients and other factors
- ✓ Any abnormal or episodic conditions that may affect the representativeness of sample data are noted and maintained as metadata**.**
- ✓ Other sites chosen as possible locations of point source contamination have been identified and noted.
- ✓ Results from all sites will not be extrapolated to other, unmonitored, portions of the water body or watershed.

Comparability of project data among sites and with that of others will be enhanced by the following:

- ✓ Using established protocols
- ✓ Documenting methods, analysis, sampling sites, times and dates, sample storage and transfer, as well as laboratories and identification specialists used so that future surveys can produce comparable data by following similar procedures.

Data Completeness goals shall be:

- ✓ At least 80% of the anticipated number of samples will be collected, analyzed and used
- ✓ Tracked by keeping detailed and complete sample and survey records
- ✓ Summarized via a report detailing number of anticipated samples, number of valid results, and percent completion for each parameter
- ✓ Tracking water quality control requirements by keeping accurate records

Data Completeness - Measurements Completed by PWA

Parameter	Number of valid measurements anticipated	Number of valid measurements needed to reach 80% completeness
pH	Oldham 5 sites x 4 months	27
Water Temperature	Furnace 2 sites x 4 months	27
Dissolved oxygen	Stetson 2 sites x 2 months	27
Secchi Disk	Hobomock Suspended	27
Salinity	Little Sandy 1 site x 1 month	27
Conductivity	Total Anticipated measurements for each parameter = 33	27
		27
Additional field duplicates of each measurement	Total Anticipated measurements for each parameter = 24	24 Anticipate one QC per pond

Data Completeness - Samples Collected and Delivered to Analytical Balance Labs.

Parameter per sample bottle	Number of valid samples anticipated	Number of valid samples needed to reach 80% completeness
Chloride	Oldham 5 sites x 4 months	27
Total Phosphorous (P)	Furnace 2 sites x 4 months	27
Turbidity	Stetson 2 sites x 2 months	27
Alkalinity	Hobomock Suspended Little Sandy 1 site x 1 month Total Anticipated samples for each parameter = 33	27
TK Nitrogen		20
Nitrite/nitrogen	Nitrogen series will be tested once per year per pond There are 5 parameters with a total of 4 anticipated samples for each parameter =	20
Nitrate/nitrogen		20
Ammonia-nitrogen		20
Total Nitrogen	A total of 20 Calculated by the lab	20
Duplicate sample marked as a blind sample	Total Anticipated samples for each parameter = 16	16 - Anticipate one blind duplicate sample per pond

A Duplicate sample will be collected and compared to results for an actual sample to verify testing consistency and technique. Duplicate samples are blind to the lab.

Quality control samples only include:
- ✓ Alkalinity
- ✓ Chloride
- ✓ Turbidity
- ✓ Total P

Table 7.1 provides sampling data quality objectives. Minimum detection limits were provided by Analytical Balance Lab. This table is based on the table in the October 2001 MA Volunteer Monitor's Guidebook to Quality Assurance Project Plans

Criteria that will be used to prioritize areas for future site BMPs or watershed restoration will include the extent of water quality impacts addressed, type of pollutant being remediated, public visibility and awareness, area required to construct a BMP that sufficiently treats stormwater, property ownership issues, cost to implement or construct BMP, and maintenance frequency and costs. Criteria will then be weighted for each area based on associated benefits. Areas with the highest ranking will be the highest priority locations. Each BMP location will be prioritized based on the previously mentioned criteria ranked as follows:

Criteria and Prioritization

Point Value	Water Quality Impact Addressed	Type of Pollutant Addressed	Public Visibility and Awareness	Area Required	Property Ownership Issues	Cost of Design and Construction	Maintenance Concerns
3	Large Improvement Expected	Phosphorus	High Visibility (downtown, high profile)	Minimal Area Required (<0.25 acres)	Owned by Town, Undeveloped	Highly Cost Effective	Low (>5 year frequency / low cost)
2	Moderate Improvement Expected	Nitrogen / Dissolved Oxygen	Medium Visibility (e.g. secondary road)	Medium Area Required (0.25 - 1 acre)	Owned by Other, Undeveloped	Moderately Cost Effective	Medium (2- 5 year frequency / moderate cost)
1	Minimal Improvement Expected	Turbidity and Other Pollutants	Low Visibility (e.g. woods, underground BMP)	Large Area Required (>1 acre)	Developed Land	Minimally Cost Effective	High (<1 - 2 year frequency / high cost)

Values and criteria may change from the above-mentioned parameters, and any changes made will be detailed in the final report.

- Water Quality Impact Addressed: BMPs that are expected to provide a larger water quality improvement as outlined in the Massachusetts Stormwater Handbook will rank highest whereas those providing a smaller improvement will rank lower.
- Type of Pollutant Addressed: pollutants of primary concern and those referenced on the 303(d) List of Impaired Waters rank highest. More than one selection is possible.

- Public Visibility and Awareness: BMPs constructed in highly visible areas and those that offer public education opportunities (e.g. raingardens, gravel wetland), rank highest whereas those in a less public place or located underground (e.g. swirl separators) rank lower.
- Area Required: BMPs that require a smaller area rank highest whereas those requiring a larger area rank lower.
- Available Property / Ownership Issues: property that is either already town-owned or easily acquired will rank highest whereas areas that have no room for development will rank lower.
- Cost of Construction: BMPs which are cheapest to design and construct will rank highest, whereas more expensive BMPs will rank lower.
- Maintenance Concerns: BMPs which require less frequent maintenance, or maintenance is not expected to be costly will rank highest, whereas those requiring more frequent or expensive maintenance will rank lower.

Modeling Objectives and Project Decisions

The primary purpose of this project is to develop a long-term watershed restoration plan for both Oldham and Furnace Pond by utilizing a quantitative approach. This approach will prioritize future watershed protection activities to obtain the most cost effective pollutant removal, while estimating the anticipated improvements. The study will focus on where the pollutants are coming from and how much need to be removed under both existing and buildout conditions to reduce in-lake phosphorus levels to meet recreational goals.

Data will be used to assess the most appropriate sites for structural BMP construction in terms of the beneficial impact on surface water quality. MA DEP will use the data to assess the performance of projects it funds through their respective grant programs. The data will also be available to other interested parties, such as the Pembroke Watershed Association, and for regional reporting purposes.

New Data Measurement Performance Criteria / Existing Data Acceptance Criteria

Model calibration, validation, sensitivity and uncertainty are described in Sections 22 and 23 of this QAPP.

Table 7.1. Data Quality Objective

Indicator	Units	Water Quality Limit	Minimum Detection Limit	Accuracy	Overall Precision	EPA Method	Approx. Potential Range
Dissolved Oxygen	mg/l	6.0[1]	0.0	+0.5	<0.5 mg/l Difference between duplicates	N/A	0.5-15.0
Water Temp.	°F	68[1]	0.0	±0.5 °	+/- 0.5 °C	N/A	0.0-90.0
Conductivity	µS/cm	Back-ground	0.5	± 5% of known QC standard.	10% RPD	N/A	10-2000 (fresh water)
pH	pH units	6.5-8.3[1]	na	+0.2 of QC standard	+ 0.2	N/A	4.0-10.0
Salinity	psu	250[3]	0.1	80-120% recovery of seawater standard of known conductivity	20% RPD	N/A	
Total Phosphorous (water)	mg/l P	0.008[2]	0. 01	80-120% recovery for QC standard and lab fortified matrix	20% RPD	SM 4500-P B/E	0.01-0.50
Nitrite Nitrogen	mg/l N	1[4]	0.05	80-120% recovery for QC standard and lab fortified matrix	+/- 0.02 if <0.1 mg/l or 20% RPD if > 0.1 mg/l	SM 4110B	0.05-3.0
Nitrate Nitrogen	mg/l N	10[3]	0.01	80-120% recovery for QC standard and lab fortified matrix	+/- 0.02 if <0.1 mg/l or 20% RPD if > 0.1 mg/l	SM 4110B	.01-3.0
T. Kjeldahl Nitrogen	mg/l N	0.38[2]	0.5	80-120% recovery for QC standard and lab fortified matrix	20% RPD	EPA 351.2	0.50-3.0
Total Nitrogen	mg/L	0.32[2]	This is a calculation				
Alkalinity	mg/l	20[3]	4.0	80-120% recovery for QC standard and lab fortified matrix	+/- 2.0 mg/l if <20 mg/l or 20% RPD if > 20 mg/l	EPA 310.2	4.0-25.0
Chloride	ug/l	2.9[2]	2.0	80-120% recovery of seawater standard of known conductivity	20% RPD	SM 4110B	2.0-60.0
Ammonia-Nitrogen	mg/l	0.254[3]	0.10	80-120% recovery for QC standard and lab fortified matrix	+/- 0.01 if <0.1 mg/l or 20% RPD if > 0.1 mg/l	EPA 350.1	0.10-0.50
Turbidity	NTU	3.04[2]	0.25	90-110% recovery of turbidity standard	+/- 0.5 NTU if < 1 NTU or 20%RPD if > 1.0 NTU	SM 2130B	0-200
Secchi disk Transparency	ft	14.8[2]	0.5	NA	+/- 0.5 ft for duplicate readings	N/A	0.0-30.0

1. 314 CMR 4.00 Massachusetts Surface Water Quality Standards.
2. EPA Eco-Region Nutrient Criteria, Eco-Region XIV.
3. EPA National Recommended Water Quality Standards
4. EPA Quality Criteria for Water

8. Training Requirements

Training in the following general areas shall be conducted as part of the Pembroke Ponds Project

- ✓ Field Safety
- ✓ Water sample collection
- ✓ Filling out field sheets
- ✓ Recordkeeping and documentation
- ✓ Electronic Meters
- ✓ Instructor Training

Project training shall take place as specified in PWA Volunteer Training Manual see Appendix.

All training activities shall be documented by:

- ✓ Training forms signed by the Instructors
- ✓ Documented in a final report
- ✓ Documented in a Water Quality Qualification Report

Data entry, database management, record keeping, documentation and report writing are under the authority of the Program Monitoring Coordinator and Field Coordinator.

Modeling will be done by Comprehensive Environmental. Staff familiar with both landuse and lake response models will perform modeling, including calculations, coefficient approximations, and accuracy checks. Although no special training is required to perform modeling, experienced personnel with knowledge of the underlying principles of the model will oversee development and application of the spreadsheet model used in this study.

9. Documentation and Records

The following general documentation procedures will be followed to ensure that adequate and acceptable level of records is kept:

- ✓ Document survey and sample information using Field Sheets
- ✓ Document sample custody at all times using Chain-of-Custody Forms, including lab samples on ice/in fridge until lab delivery
- ✓ Track sample identification using sample labels
- ✓ Document lab results using lab reports
- ✓ Document QC requirements using the water quality control checklist

The specific forms to be used for the PWA water project are listed and described in Table 9.1. See sample forms in appendix. The Program Monitoring Coordinator will ensure that all sample containers are acceptable for use.

Modeling Documentation

Documentation of this project will be kept on file by the MA DEP, the Town of Pembroke, Pembroke Watershed Association, and Comprehensive Environmental Inc. (CEI). The Modeling Coordinator will be responsible for assembling and maintaining project documents and records. Modeling data will be stored in a Microsoft Excel spreadsheet. Summary data will be tabulated into various tables and graphs and presented in the draft and final reports. Maps generated from MassGIS, aerial, and other data sources will be stored in an electronic format. Hard copies will be included in the final report. Other aspects of the modeling effort will be documented in a narrative and stored in Microsoft Word format.

Monthly and quarterly reports will document work from the most recent reporting round. The final report will document procedures and findings for the entire project. All reports will be submitted to the Town of Pembroke, Pembroke Watershed Association, EPA and MA DEP for approval.

Storage

The central storage location for all final project deliverables is the Comprehensive Environmental office in Marlborough, MA. Files will be maintained at this location for a minimum period of 5 years. Electronic files will be stored on servers at Comprehensive Environmental. Servers are secure and backed up several times per week. Electronic data will be stored for a minimum of five years.

QAPP Distribution

Upon approval by MA DEP and EPA, the approved QAPP will be distributed to those specified on the Distribution List as outlined in Section 1.3. Distribution will be done via email, with hardcopies available to CEI staff and the Pembroke Watershed Association. Any updates will be sent via email.

Table 9.1. Project-Specific Datasheets, Labels, Laboratory and Voucher Forms

Documentation Type	Form Name	How Used?	Example in Appendix C
Sample Collection Records	Water Sample Collection Data Sheet	All forms renumbered as to location. Volunteers fill in forms with prompted questions. Signed and witnessed, dated and timed	Yes
	Quality Control checklist		Yes
	Sample Bottle Label		Yes
	Sample Bottle Cap	Monitoring program coordinator labels the cap of the bottle with location code of sample	No
Laboratory Records	Analytical Balance Chain of Custody	Monitoring program coordinator completes location and analysis required sections Volunteers signoff on completion of sample and chain of custody	Yes
	Laboratory report	Returned to Program Monitoring Coordinator with analysis data from samples to be entered into database.	Yes
Training Records	Qualification / Requalification Sampling Competency	Checklist for Field Coordinator	Yes
Calibration Records	Calibration log	Log sheet to document instrument calibration prior to each test	Yes

Table 9.2. Meter calibration records

Equipment	Parameter	Acceptance Criteria	Procedure	Frequency of Calibration	Corrective Action	Person Responsible
YSI Model 85	Dissolved Oxygen	+/- 0.3 mg/l	See Owners manual provided in Appendix F	Before the testing season and prior to the start of testing	Recalibrate	Program Monitoring Coordinator
	Conductivity	+/- 0.005 mS/cm				
	Salinity	+/- 0.3 mg/l				
	Temperature	+/- 0.3 mg/l				
YSI EcoSense pH100	pH	+/- 0.2				
	Temperature	+/- 0.3 mg/l				

10. Sampling Process

The following sampling safety and design principles shall be followed for the Pembroke Ponds project**:**

Sampling Safety

- ✓ Personal safety shall be a primary consideration in selection of sampling sites and dates.
- ✓ No sampling shall occur when personal safety is thought to be compromised.
- ✓ The Program Monitoring Coordinator/ Field Coordinator and Pond Captain shall confer before each sampling event to decide whether conditions pose a threat to safety of field volunteers, and will cancel/postpone sampling when necessary.
- ✓ Sampling shall take place in teams of two or more.
- ✓ Samplers shall wear life vests when sampling from boats
- ✓ Samplers shall wear proper clothing to protect against the elements as applicable, especially footwear and raingear.
- ✓ Tests are conducted from boats provided by volunteers, who are responsible for safe operation and their own maintenance. The operator also monitors proper positioning for the testing, utilizing the GPS.

Rational for Selection of Sampling Sites

We had originally determined sampling sites for each pond to match those sites identified by BayState Environmental Consultants Inc. in a diagnostic and feasibility study completed in 1993. Other sites were chosen to monitor specific suspect point sources of pollution. Going forward we have reevaluated our testing processes and selected sites that we now believe are more representative of general pond conditions. Each site has been marked on bathymetric maps with GPS coordinates -- see Section 6. It is believed that subsequent monitoring of each location would give the broadest, most comprehensive profile of water quality for the desired parameters.

Types of Indicators

Chemical and physical indicators will be used in this study. Refer to Section 6 (Project/Task Description) and Section 7 (Measurement Quality Objectives) for the specific data or parameters forms see Appendix C (Water Sample Collection Data Sheet).

Sampling Frequency

The testing season will be during the period June through September. Sampling frequency is determined by the Program Monitoring Coordinator. Current schedule is monthly for Oldham and Furnace ponds, twice for Stetson and once for Little Sandy Bottom . Testing is suspended on Hobomock pond. Actual waypoints will be located with a GPS unit. Other non scheduled tests may be conducted throughout the year if deemed warranted. The entire testing schedule is subject to weather conditions.

Site Access

Access to the ponds and sampling waypoints will be from private residences of the team members using their own boats.

11. Sampling Method Requirements

All sample collections for the Pembroke Pond project shall follow detailed methods on how samples will be collected and preserved and/or follow the Standard Operating Procedures (SOPs) as follows

- ✓ Copies of standard operating procedures (SOPs) are in Appendix D –Water Quality Testing and Qualification Procedure Manual.
- ✓ Pre-coordination will occur with project lab(s) to ensure that sample collection procedures meet lab needs
  Analytical Balance Corp. M-MA022 (Appendix E)
  422 West Grove Street
  Middleboro, MA 02346
- ✓ Internal laboratory SOP numbers are as follows:
  1. Turbidity – 109
  2. Ammonia – 113
  3. Total Phosphorus – 117
  4. TKN – 139
  5. Chloride – 140
  6. Nitrate – 140
  7. Nitrite – 140
  8. Alkalinity – 141

One sample bottle is delivered to the lab for each site within 24 hours (on ice in the interim). The lab splits the samples and uses acid preservation as necessary. Special care will be taken during sampling not to spill any preservatives contained in bottles. Bottles containing preservatives will not be inverted while uncovered, or filled and then emptied.

Table 11.1. Field Sample Collection Methods

Sample Type	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation
Meter YSI Model 85	Separate readings are displayed for each of the following: ✓ DO ✓ Conductivity ✓ Temperature ✓ Salinity	N/A - direct measurement with probe	N/A - direct measurement with probe	N/A
pH meter YSI pH 100	Separate readings are displayed for each of the following: ✓ pH ✓ Temperature	N/A - direct measurement with probe	N/A - direct measurement with probe	N/A

Sample Type	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation
Secchi Disk	Water Clarity	Secchi disk lowered from boat, extinction depth recorded using view scope. If Secchi disk is equal to or greater than maximum depth - Secchi is noted as “>max depth” If there is significant current or boat drift measurements is not taken	N/A	N/A

Table 11.2. Laboratory Sample Collection Methods

Sample Type	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Holding Times
Grab	Water quality indicators: ✓ Nitrogen series ✓ Total Phosphorus ✓ Ammonia ✓ Chloride ✓ Turbidity ✓ Alkalinity	Lab provided bottle and on site rinsing.	1 Liter Sample bottle for each site	Coolers and ice packs for immediate storage and delivery to the lab. The lab accepts the samples and splits out sub-samples. These samples are acid preserved by ABC Labs if necessary per their protocols.	Nitrogen: 48 hours TP: 28 days Ammonia: 28 days Chloride: 28 days Turbidity: 48 hours Alkalinity: 14 days

12. Sample Handling and Custody Requirements

All sample handling and custody procedures shall be in compliance with project Standard Operating Procedures for each indicator. The following procedures shall be followed for the Pembroke Pond Project.

Sample container labels shall be attached to dry bottles, with the following information:

- ✓ Site ID#
- ✓ Sample type
- ✓ Date and time
- ✓ Name of sampler
- ✓ Name of organization conducting sample.
- ✓ Example of label is found in the Appendix C
- ✓ Chain of custody forms shall be prepared and completed in all cases. (see Appendix C)
- ✓ The whereabouts of all samples shall be known at all times.

The following steps shall be taken to avoid sample mislabeling.

- ✓ Pre-labeled bottles checked by volunteer sampler before sampling session
- ✓ Witness signs off each bottle after collection accomplished.
- ✓ Sample bottle caps are marked with site number using permanent marker
- ✓ A clean, dry label is completed and applied after bottle is wiped dry

The following steps shall be taken for sample handling

- ✓ Samples are to be placed in a cooler with ice as soon as possible after being taken.
- ✓ Samples are to be kept iced until delivered to lab.

13. Analytical Methods Requirements

All analytical methods used in the PWA ponds project, including methods used by laboratories performing analyses for the project, shall be based on standardized laboratory methods.
All analytical methods used for this project are provided in Appendix E (Certified Parameters list). Analytical Balance Corp supplies this information with each sample report please see Analytical Balance Manual on file with EPA-NE and MA DEP QA Officer. Analytical Balance State Certification Number M-MA022 (see Appendix E)

14. Quality Control Procedures

The following quality control procedures for the Pembroke Pond Project shall be followed.

Water Quality samples

- ✓ Program Monitoring Coordinator randomly designates that a blind duplicate sample will be collected at the same site

Procedures for each QC step checked above are

- ✓ The volunteer collects a grab sample , and a second volunteer collects another grab sample at the same location and time
- ✓ Lab QC protocols shall be discussed with the lab prior to sampling to ensure acceptability

Water Quality measurements

- ✓ Program Monitoring Coordinator randomly designates that duplicate measurements will be taken
- ✓ Program Monitoring Coordinator will designate sample sites where both meters are to be used and results cross checked for QC.
- ✓ In the event only one meter is available, QC will be accomplished by having two separate testers perform the meter samples at the same site and compare results.
- ✓ Meters are calibrated to manufacturer's standards prior to each test cycle.
- ✓ Secchi disk QC will be accomplished by taking a reading and immediately having a different person taking another reading at the same site
- ✓ A Quality Control checklist will be completed and turned in to the Field Monitoring Coordinator (See appendix C)

15. Instrument/Equipment Inspection and Testing

The following instrument/equipment inspection and testing methods shall be followed for the PWA Pembroke Ponds project:

- ✓ Prior to the testing season the Field Coordinator and Program Monitoring Coordinator will calibrate and test all instruments and perform maintenance as required.
- ✓ Maintenance shall occur as needed. Maintenance will be performed by the Project Field Coordinator and the Quality Assurance Officer.
- ✓ Detailed inspection, maintenance and calibration procedures are described in manufacture's SOPs contained in Appendix F. *https://www.ysi.com/portal/page/portal/YSI_Environmental/Products/Product_Family/Product?productID=WQS_85*
- ✓ https://www.ysi.com/portal/page/portal/YSI_Environmental/Products/Product_Family/Product?productID=WQS_PH100

Table 15.1. Instrument/Equipment Inspection, Testing Procedures – Summary

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
Sample bottles	Before each use	Visual for integrity, cleanliness	Lab Prepped Rinsed at each site prior to use
Meters - YSI 85 - YSI 100	Before each use	Visual and Calibration	Proper Storage and Fresh Batteries as per User Manuals Recalibrate prior to each use. Calibration stand solutions must be replaced prior to expiration
GPS	Before each use	Visual for proper sequencing.	Cleaned and stored as per users manual instructions Fresh batteries as needed
Secchi Disk	Before each use	Visual for defects (as in rope)	Cleaning and storage
View scope	Before each use	Visual for integrity	Rinse after use and storage to prevent damage
Grab Sticks	Before each use	Visual for integrity, and cleanliness	Rinse before and after use

16. Instrumentation Calibration and Frequency

The following instrument calibration procedures will be followed for the Pembroke Pond Project:

- ✓ Instruments shall be calibrated before each use by the Field Monitoring Coordinator or Test Leader
- ✓ Detailed inspection, maintenance and calibration procedures are described in manufacture's SOPs contained in appendix F.
- ✓ If meter readings appear inconsistent, recalibration or retesting with a second meter is required
- ✓ A Calibration Log will be kept by the Field Coordinator noting calibrations completed, when, by whom, and dates done; all problems with calibration will be noted

Table 16.1. Instrumentation Calibration Procedures

Instrument	Inspection and Calibration Frequency	Standard of Calibration Instrument Used	Corrective Action
YSI and pH Meters	Before each sampling run	All solutions including buffers, probe solutions and external standards as per user's manual and training SOPs-- see appendix	Adjust instrument, clean electrodes, replace electrodes , replace membranes, following manufacturer's SOPs

17. Inspection & Acceptance Requirements for Supplies

The following procedures for procurement, inspection and acceptance of sampling, analytical and ancillary project supplies shall be followed for the Pembroke Pond Project:

A check is made to see that we have all the materials required to do the sampling that day. Test items include:

- ✓ Correct number of labeled bottles (including spare bottles)
- ✓ Field data sheets (see Appendix C)
- ✓ Quality Control checklist if required (see Appendix C)
- ✓ Cooler with ice or ice packs
- ✓ Sharpie for recording data.
- ✓ Copy of testing procedures (see Appendix D)
- ✓ Maps of sample sites (GPS locations)
- ✓ Necessary Data Sheets (see Appendix C)
- ✓ Meters, GPS, Secchi Disk and tape measure

Table 17.1. Supplies Inspection, Acceptance Procedures

Supplies	Inspection Frequency	Type of Inspection	Available Parts	Maintenance
Calibration Solutions	During each use	Visual inspection of quantity and expiration date	Fresh bottles of calibration solutions	Replace as needed referencing expiration dates
Bottles and labels	Before each use	Visual for integrity and damage	Spare bottles and labels	Proper storage and handling
Field and data sheets	Inspection before using	Visual	Spare copies	n/a
Life Jackets	Before each use	Visual for integrity and damage	spares	As needed
cooler	Before each use	Visual for cleanliness and ice or ice packs	n/a	As needed

18. Data Acquisition Requirements

The following information will be provided for the Pembroke Watershed Association water project:

- ✓ External data validity shall be documented as described in Table 18.1. The following data will be used. Data validity is described here:

Table 18.1. Non-Project Data Validity

Title or descriptive name of data document	Source of data	QAPP written? Y/N	Notes on known or unknown quality of data	Planned restrictions in use of the data due to questions about data quality
2008 through Present	Pembroke Watershed Association volunteer collection	Yes	QAPP approved by MADEP and EPA	No planned restrictions.
2005, 2006 and 2007 Water Quality Data	Collected under the SOPs of the Pembroke Watershed Association	No	Same procedures as now in use Good Confidence as to validity	Background Data for future comparison and analysis
2001 Survey by Comprehensive Environmental Inc	Independent Consultants	No	Undetermined	Findings were used to determine need for further monitoring
1993 BayState Environmental Consultants Inc.	Independent Consultants	No	Undetermined	Findings were used to determine need for further monitoring Establishment of monitoring waypoints

Maps will be prepared using MassGIS data layers to identify the general land features in the region, including subwatershed, lake, and land use type areas. Data such as groundwater information and topography will be obtained from the United States Geological Survey (USGS) and the United States Department of Agriculture (USDA). Current and historic aerial photographs will be obtained from the USGS and/or similar Town sources. Soils information will be obtained from the National Resources Conservation Services (NRCS). Rainfall information will be obtained from the NOAA National Weather Service website. Phosphorus export coefficients will be obtained from Wetzel, 1975 and Reckhow and Chapra, 1983. As available, the most up-to-date data will be used (with the exception of historic aerial photographs), with an effort made to choose images with the highest resolution possible.

Precision, bias, representativeness, and completeness within each model will be discussed in the final report. Calculations made, such as areas and land use sizes, will have little error as there is a large amount of information and data available on these types of variables. Data such as soils information is general in nature to a large area such as a watershed, and not necessarily specific to the underlying area such as that found at a specific structural BMP location. These types of data will have moderate error. Other assumptions, such as the use of coefficients, will have a larger degree of error, as concrete numbers are not available. Assumptions will be made using the best available information.

The above-referenced sources provide state or federal databases with accurate information suitable for this study. Data collected during this project will be used to prioritize future water quality improvements and used for comparison with future water quality monitoring efforts.

Additional field reconnaissance efforts will be performed by CEI staff familiar with the area and experienced in conducting a watershed assessment. Watershed data such as land use types and specific pollution sources that will require additional attention during modeling analysis will be compared to existing MassGIS data and incorporated into the report. Staff will also review changes in the watershed that have occurred since the completion of previous studies in 2001 that may be impacting the water quality of the ponds. Potential structural BMP locations will also be mapped and incorporated into final reports and maps.

19. Data Management

The following data management activities shall be followed for the Pembroke Watershed Association water project:

- ✓ Field samplers shall record data on field sheets, review them, sign and turn over to field coordinator.
- ✓ Field Coordinator shall review sheets and discuss with sampling team discrepancies in data acquisition, incompleteness of sheets, and provide needed corrective action.
- ✓ Pond Captain or Designated test leader shall fill out the chain-of-custody form for forwarding the processed samples to the laboratory.
- ✓ Test Leader and each person who transports samples shall also sign the custody form upon receipt of the samples.
- ✓ Chain of custody forms will follow samples to the lab and back to Program Monitoring Coordinator.
- ✓ Once laboratory analyses are complete, the laboratory personnel shall mail lab results to the Program Monitoring Coordinator or arrange for pickup.
- ✓ The Program Monitoring Coordinator and/or Data Management Coordinator will enter raw field and lab data into the project computer system.
- ✓ Computer-entered data shall then be compared with field sheets for accuracy. After data is entered by the Data Management Coordinator it is verified by the Field Auditor before compiling reports This is completed for all
- ✓ Original data sheets will be stored at central location for Pembroke Watershed Association with copies to field coordinator
- ✓ Disk back-ups and copies of the data sheets will be made and stored in a separate location designated by the Program Monitoring Coordinator. Copies provided to Field Coordinator.
- ✓ Documentation of data recording and handling, including all problems and corrective actions, shall be included in all preliminary and final reports.
- ✓ Examples of data forms and checklists are provided in Appendix.

Data management systems - spreadsheets, databases, statistical or graphical software packages, location of data records (paper and electronic), are described here:

Data is collected on a scheduled basis by teams of trained volunteers who follow specific instructions on the collection and submission of the water quality information. Each team collects samples from the same location in each pond, labels them with indelible marker and places in an iced cooler for delivery to Analytical Balance Laboratory Corp. Samples must be delivered to the lab within 24 hours.

Program Monitoring Coordinator reviews the data to determine if major changes have occurred since the last sampling and if any errors have resulted from the testing. If there are errors or discrepancies the Program Monitoring Coordinator will call the team who took the samples and discuss the results with them. If the discrepancies are pronounced, a new sample may be obtained. In any case, suitable inquiries determine the next step to be pursued.

Data is maintained on excel spreadsheet and is used to create Word documents, reports, and PowerPoint presentations. Final Reports contain all the raw data, analytical graphs and recommendations. The reports are distributed to parties on our distribution list and to the general public through our Web Site and copies maintained at the Pembroke Public Library.
Paper and electronic records are stored at the Pembroke Watershed Association central location. Backup copies are stored with the Field Coordinator and the Program Monitoring Coordinator.

Data Entry and Validation
Modeling calculations will be subject to an internal quality control process by the Modeling Coordinator and QA/QC Officer at Comprehensive Environmental, Inc. The data will be critically reviewed for reasonableness, correspondence with data quality objectives, appropriate qualification, censoring of suspect data, and that data has been entered correctly. Models used are as follows:

1. Land use based model
2. Lake response model
3. Simple Method

Modeling and calculations will be performed with the aid of a Microsoft Excel spreadsheet. Final results and summaries may be maintained and displayed in a Microsoft Excel spreadsheet. Final maps may be displayed in part by using ArcGIS maps if appropriate. The remainder of data will be described in a narrative format.

Data Storage
Electronic files with modeling, calculations, field reconnaissance results, sampling data, etc. will be maintained with Comprehensive Environmental, Inc. Electronic files associated with the final report including sampling results will be stored with CEI for distribution as appropriate. Electronic files are stored on secure servers which are backed up several times each week. Hard copies of reports will be distributed to the Town of Pembroke, Pembroke Watershed Association, MA DEP, and EPA as part of applicable reports.

20. Assessment and Response Actions

The Program Monitoring Coordinator, QA Officer and Field Coordinator will use the following process to identify and effectively address any issues that affect data quality, personal safety, and other important project components.

The Program Monitoring Coordinator and Field Coordinator will periodically check to see the following:

- ✓ Monitoring is occurring as planned;
- ✓ Sufficient written commentary and/or supporting photographs exist;
- ✓ Sufficient volunteers are available;
- ✓ Volunteers have been observed as they sample their sites;
- ✓ Samplers are collecting in accordance with project schedules;
- ✓ Data sheets and custody control sheets are being properly completed and signed off;
- ✓ Data are properly interpreted;
- ✓ Plans for dealing with adverse weather are in place;
- ✓ Retraining or other corrective action is implemented at the first hint of non compliance with the QAPP or SOPs;
- ✓ Labs are adhering to the requirements of the QAPP- use of State Certified Lab.
- ✓ Data management is being handled properly, i.e. data are entered on a timely basis, are properly backed up, are easily accessed, and raw data are properly stored in a safe place;
- ✓ Procedure for developing and reporting the results exists.

The Program Monitoring Coordinator shall confer with the Field Coordinator and the QA Officer as necessary to discuss any problems that occur and what corrective actions are needed to maintain project integrity. The Program Monitoring Coordinator, Field Coordinator and QA Officer shall meet at the end of the sampling season to review the draft report and discuss all aspects of the program including identifying necessary program modifications for future sampling activities. Corrections may include retraining volunteers, rewriting sampling instructions, replacement of volunteers, altering of schedules, sites, or methods or any other actions deemed necessary. If modifications require changes in the Quality Assurance Project Plan, these changes shall be submitted in writing to the MassDEP for review.

The Modeling Coordinator and QA/QC Officer will be responsible for review, oversight and follow-up on data quality and corrective actions throughout the project. Data assessments will be performed during the project as part of the monthly reporting efforts as required by the MA DEP 604(b) program. Assessments to be performed during the project will include:

- ✓ Evaluation of field reconnaissance observed issues
- ✓ Existing and current data variations
- ✓ Modeling assumption issues
- ✓ Model comparison difficulties

✓ Engineering design problem

The results of assessments will be documented and reported in the monthly and quarterly status reports. The final report will contain a summary of assessments, as well as actions taken to address issues. Reports will be provided to the Town of Pembroke, Pembroke Watershed Association, MA DEP, and EPA for review. CEI will incorporate revisions to the final report, based on review comments provided by these agencies.

21. Reports

The following reporting mechanisms will be used. The final report will describe the program's goals, methods, quality control, results, data interpretation, and recommendations and will include:

- ✓ Raw data
- ✓ QC data
- ✓ Associated metadata
- ✓ Flagged Questionable data

The final report will be sent to the QAPP and *General QAPP Adoption Form* distribution lists and submitted to CZM and/or MassDEP following MassDEP guidelines CN 0.74 *Recommended Content of 3rd Party Data* and CN 0.78 *Data Deliverable Guidelines for Grant Projects*.

Table 21.1 describes the reporting mechanism for this project's data, who is responsible for completion and distribution, and to whom each report will be distributed.

Table 21.1. Report Mechanisms, Responsibilities, and Distribution

Reporting Mechanism	By Whom	Distribution
Annual Water Quality Report	Program Monitoring Coordinator Field Coordinator Program QA Officer	Distribution list. Public by being posted on the PWA web site, being shared with the local media, by donating to town library.
Web Site	Webmaster	General Public
Press Release	PWA Executive Secretary	General Public

Comprehensive Environmental Inc. (CEI) will produce project reports with input from the Pembroke Watershed Association as required. Copies of reports will be distributed to the Town of Pembroke, PWA, MA DEP and EPA for review and comment prior to finalization and approval. Monthly and quarterly reports will document recent activities performed on the project.

Table 21.2 lists the reports that will be produced as a result of this project.

Table 21.2. Reports to Management

Report Type	Report Frequency	Parties Receiving Report
Monthly Progress Reports	Monthly for the duration of the project.	-Town of Pembroke -Pembroke Watershed Association -MA DEP -EPA
Quarterly Progress Reports	Quarterly for the duration of the project, due on December 21st, March 20th, June 20th, and September 20th.	-Town of Pembroke -Pembroke Watershed Association -MA DEP -EPA
Draft Project Report	At the conclusion of modeling and design.	-Town of Pembroke -Pembroke Watershed Association -MA DEP -EPA
Final Project Report	Upon receipt of comments on Draft Project Report	-Town of Pembroke -Pembroke Watershed Association -MA DEP -EPA

Monthly and Quarterly Reports

Brief monthly and quarterly reports will document activities performed within the previous reporting period. Reports will be submitted via email on a standard form. Reports will contain a summary and percentage of work completed by task during the reporting period, planned activities for the next quarter, a description of difficulties encountered and steps taken to address those difficulties, and an explanation of significant discrepancies between progress achieved and the level of progress that should have occurred based on the scope of services and timeline.

Draft and Final Reports

Final results will be incorporated into the final project report required by the MA DEP 604(b) Grant Program at the completion of the project. Comprehensive Environmental Inc. will be responsible for preparing the draft final project report, distributing the report, responding to comments, and finalizing the report. This report will contain the following:

- ✓ Executive Summary
- ✓ Project Introduction and Background
- ✓ Data Assessment
- ✓ Pollutant Modeling
- ✓ QA/QC Issues
- ✓ Recommendations and Conclusions
- ✓ Structural Engineering Designs (30%)
- ✓ References and Further Reading
- ✓ Figures, Tables and Appendices

Executive Summary
The executive summary will provide a summary of the entire report, condensed into a maximum of several pages, with a focus on the recommendations and conclusions.

Project Introduction and Background
A detailed description of the project will be provided, including a description of previous reports completed for the ponds under previous QAPPs. Project goals, objectives, methodology, assumptions, reasoning, etc. will be outlined.

Data Assessment
Applicable data obtained from past projects will be detailed. Field reconnaissance efforts and data from current sampling rounds will be summarized. Data such as watershed maps and sizes, land use data, anticipated flow rates, etc. will be summarized. Data sources will be provided, as well as the reasoning and methods used to acquire the data.

Pollutant Modeling
A detailed explanation of the pollutant modeling used will be provided. The report will document the modeling purpose, description, scope, approach and application. Model data sources, components, quality, validation performance, and variables used to obtain final results. Parameter assumptions, values, excluded data and sources will be documented in detail. Model calibration performance conditions will be analyzed, as well as future predictions for the buildout scenario. A summary of modeling results will be provided.

QA/QC Issues
Quality assurance and quality control issues encountered during the project pertaining to sampling or modeling will be summarized in narrative form. Methods taken to address issues encountered will be addressed.

Recommendations and Conclusions
An evaluation of load reduction measures will be provided, as well as final recommendations and conclusions to reduce phosphorus levels in the ponds and improve water quality. The final plan will outline proposed BMPs, estimated costs, and expected pollutant removal levels.

Structural Engineering Designs
Preliminary 30% designs and estimated construction costs will be prepared for the top five structural BMP improvements. Detail will be sufficient for s.319 grant funding.

References and Further Reading
References will be provided, as well as additional recommended reading sources.

Figures, Tables and Appendices
Supporting figures, tables and appendices will be provided.

22. Data Review, Validation and Verification Requirements

All project data, metadata and quality control data shall be critically reviewed by the Program Monitoring Coordinator and QA Officer to determine if there are any problems that compromise data usability.

The Program Monitoring Coordinator and the Field Coordinator will review field and laboratory data after each sampling run and take corrective actions if necessary. If there appears to be inconsistent data the Program Monitoring Coordinator will discuss with the sampling team the circumstances surrounding the sampling and what might have caused the problem. If they can resolve the problem, this will end the concern. If the problem can't be resolved then the Program Monitoring Coordinator will discuss the issue with the Field Coordinator and the QA Officer and together they will decide what remedial steps to take. At the end of the season the Program Monitoring Coordinating will share all data with the Field Coordinator and QC Officer to determine if the data appears to meet the objectives of the QAPP.

The following logs will be maintained by the Program Monitoring Coordinator and Field Coordinator to track performance and documentation

- ✓ Field sheets with results from Analytical, by pond and date
- ✓ QC sheets completed during sampling
- ✓ Chain of Custody forms with all signatures, times, dates
- ✓ QC logs by date including all QC activities, such as flagged data issues, remediation, corrective action plan, etc
- ✓ Calibration and Maintenance log

Phosphorus loadings will be estimated using a land use based model (The Simple Method) in combination with a lake response model (Reckhow Phosphorus Lake Model) to predict in-lake phosphorus concentrations based on the projected loadings. Phosphorus loads into the pond will be estimated using literature based loading coefficients for various land uses and pollutant sources. This information is based on stormwater sampling data collected from runoff from various types of land use and results in the total mass of phosphorus entering the pond from each type of land use. There is not enough water quality data to compare the model predicted loadings to the actual loadings to the pond, as an extensive amount of water quality and flow data would be needed to accurately calculate the loads associated with flows into the pond. However, lake-response models can be used to estimate the relationship between phosphorus loads and lake concentrations, such that the actual lake concentration can be used to predict the load to the pond or the load to the pond can be used to estimate a concentration. It is this relationship that will be used to calibrate the data. The modeled loadings from land use values will be compared to the expected loadings calculated based on the actual in-pond concentrations. Model input factors will then be adjusted until the predicted in-lake phosphorus concentrations are within 10% of the observed concentrations documented via the field monitoring program.

The modeling will be performed according to the following procedural steps:

Step 1: Land Use Model
Step 2: Lake Response Model

Step 3: Model Calibration
Step 4: Buildout Analysis
Step 5: Phosphorus Removal Solutions

Step 1: Land Use Model
Phosphorus loadings to the Lake will be determined based on the Simple Method. The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as follows:

$$\mathbf{L = 0.226 * R * C * A}$$

Where: L = Annual load (lbs)
0.226 = Unit conversion factor
C = Pollutant concentration (mg/l)
A = Area (acres)
R = Annual runoff (inches) $\mathbf{= P * P_j * (0.05 + 0.9 * I / 100)}$
P = Annual rainfall (in)
P_j = % of rainfall events producing runoff (assumed to be 90%)
I = Impervious cover percent (%)

Existing information sources available through local, state and federal sources will be used to estimate parameters for use in the model. Watershed (A) and lake area will be determined from topographic maps downloaded from USGS and MassGIS, and inserted into a computer aided drafting (CAD) based program or similar to determine actual areas. Precipitation for the area will be estimated from the NOAA National Weather Service website for the area.

Pollutant concentrations (C) will be obtained from the Simple Method for each type of land use (e.g., commercial, forest, high density residential, etc.) in the watershed. Areas for each land use will be calculated through GIS computer software.

Phosphorus loadings from septic systems and atmospheric deposition (direct precipitation) will be estimated from literature based coefficients for these sources. Phosphorus from atmospheric deposition is determined from lake area and an assumed phosphorus concentration of 0.2 kg/ha-yr in precipitation from Wetzel, 1975 and Reckhow and Chapra, 1983. Potential loadings from internal recycling will also be estimated using available inflow and outflow and Lake sampling data and considering the methods used in the 1993 Diagnostic Feasibility study.

By using the Simple Method and literature based coefficients, a total runoff and associated total phosphorus load to the Lake will be determined.

Step 2: Lake Response Model
The Reckhow Phosphorus Lake Model will be used to predict the in-lake concentration based on the loadings estimated in Step 1. The Reckhow steady-state lake model is expressed as:

$$\mathbf{P = L / (11.6 + 1.2 * qs)}$$

Where: L = annual areal phosphorus loading (g/m2-yr) **= W / As**

W = total phosphorus mass loading (includes stormwater, internal recycling, septic systems, and precipitation as determined through Step 1) (g/yr)
As = lake area (acres)
qs = areal water loading (m/yr), **qs = Q / As**
Q = inflow water volume to lake (m3/yr)

The total inflow water volume to the Lake (Q) will be calculated as:

$$\mathbf{Q = P * A_T - Evapotranspiration}$$

Where: P = total precipitation (ft)
A_T = total watershed area (sf)
Evapotranspiration = estimated at 40% of the total precipitation volume (Hanson, R.L.)

Step 3: Model Calibration
The difference between the modeled phosphorus load determined in Step 2 based on land use loading values and the expected loadings based on actual in-pond concentrations will be compared and a difference between observed and predicted noted. Calibration will then be performed by altering the input variables (e.g., land use loading concentrations) by the percent difference to match observed and predicted in-pond phosphorus concentrations close to one another using the limited data available. A 10% alteration of variables is considered reasonable to match observed and predicted values and/or a 10% difference in predicted versus observed in-pond concentrations without adjustment of variables. If greater than 10% alteration is needed, the reason for the greater alteration will be explored and explained. Model input reasoning will be explained in the final report, as well as any changes made to the variables. Calibration will continue until observed values vs. predicted values are within 10% of each other.

As the modeling approach presented in this QAPP is relying upon a simplistic model intended for planning purposes, the importance is to establish a relationship between loadings and in-pond concentrations on which to base decisions. This is a reliable method for comparing various areas (e.g., subwatersheds) and land uses to one another, as well as various sources to one another and also for determining the percent reduction necessary to achieve a water quality goal, regardless of whether the mass load is 100% accurate. Thus, the level of uncertainty in the exact loading value has little impact on how it is ultimately used; however, uncertainty will be evaluated as a function of the level of adjustment needed to calibrate the model. This simplified approach uses average data values, which will first be reviewed and examined to identify any outliers.

Documentation of model uncertainty will be outlined in a narrative form in the draft and final report. Data will be reviewed by the Modeling Coordinator, EPA Project Officer, and the MA DEP 604(b) Project Officer to determine if they meet the QAPP objectives and verify accuracy.

Step 4: Buildout Analysis
A buildout scenario will be prepared by overlaying existing land use with existing zoning and accounting for development restrictions such as protected lands and wetlands. The anticipated lands uses at buildout will be input into the model to determine loadings under buildout conditions. The buildout scenario will be used to develop load reduction measures necessary to meet water quality goals.

Step 5: Phosphorus Removal Solutions

Upon calibrating the model, the reductions necessary to meet water quality goals will be determined by adjusting the loadings downward until the desired in-lake concentration is achieved. CEI will tailor recommendations to meet these reductions, using literature based removal efficiencies, such as provided in the Massachusetts Stormwater Handbook.

23. Validation and Verification Methods

All project data and metadata are reviewed and approved as usable data or as un-usable when the data are questionable for any reason. The Field Coordinator and Monitoring coordinator will review the data collection sheets within 24 hours and Laboratory results forms upon receipt (generally 2 weeks) of data collection for completeness, accuracy, and precision according to the data quality objectives described in section 7. Data will be compared to historical data to verify reasonableness. Quality control data (field duplicates and meter QC readings) will also be used to determine accuracy and consistency in data. Data that is unexpected or outside of expected range, considered "outliers" will be flagged for further review. The Field coordinator and Monitoring coordinator will decide if data is usable based on all available reports, unusual field conditions, and may request resampling.

The Modeling Coordinator and QA/QC Officer will examine the data for logical consistency, as presented in Table 23-1. The Modeling Coordinator is familiar with running these types of scenarios and is experienced with computer simulation models. If inconsistencies are found, an attempt will be made to determine whether the data is in error. Apparent problems will be noted in the final reports as appropriate.

Table 23.1 Validation and Verification Procedures

Responsible Party	When	Activity	Possible Corrective Measures and Notification
Modeling Coordinator / QA/QC Officer	When model compilation has been completed. When model calibration has been performed.	Compare test results with targets or expected values. Spot-check calculations. Check for outliers.	Re-run calculations. Flag problems that are not correctable. Discuss outliers or errors in the final narrative.

Data validation and verification will occur as described in Table 23.2, and will include checks on:

- ✓ Completion of all fields on data sheets
- ✓ Missing data sheets
- ✓ Completeness of sampling runs (e.g. number of sites visited/samples taken vs. number proposed, were all parameters sampled/analyzed?)
- ✓ Completeness of QC checks (e.g. number and type of QC checks performed vs. number/type proposed)
- ✓ Number of samples exceeding QC limits for accuracy and precision and how far limits were exceeded.
- ✓ Field Coordinator and Program Monitoring Coordinator will examine all data sheets for completeness and reasonableness of results. If any inconsistent results are discovered, an action plan decision is generated which could include retesting, remedial training,

recalibration of equipment and retesting or a flag not to include specific data in the results.

✓ The chain of custody is reviewed to determine that appropriate standards are met

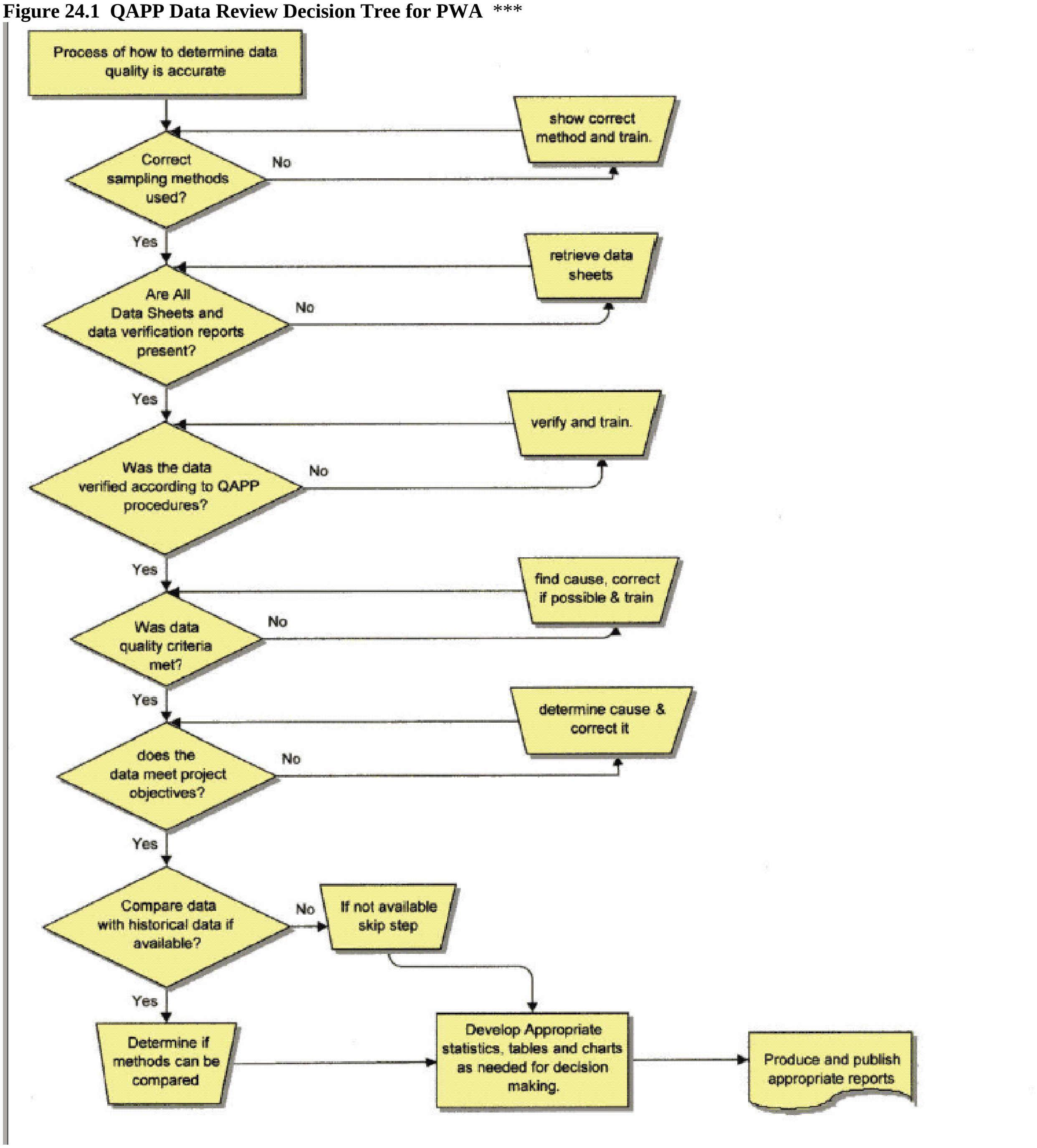
Table 23.2 Validation and Verification Methods

Verifier	**When**	**Activity**	**Possible Corrective measures and notification**
Field Coordinator and QA Officer	Prior to testing	Calibration of meters	Maintain calibration log If calibration fails - recalibrate - use an alternate meter - return for repair or replacement
Pond Captain or Team Leader	Monitoring day – when volunteers turn over data sheets	Collect, review volunteers field sheets for - Outlier data - Illegible entries - Missing data - Unusual conditions	Discuss with volunteers. Correct simple problems. Retrain as needed Locate missing sample sheets or data Data is flagged to indicate that it should not be entered in a database or used for decision making.
Program Monitoring Coordinator and Field Monitoring Coordinator	At end of Monitoring Day	Review chain of custody sheet for errors or omissions. Check samples for proper condition.	Discuss with volunteers Resample if possible Data is flagged to indicate that it should not be entered in a database or used for decision making
Data Management Coordinator and QA Officer	When QC data is reported	Compare number of QC tests performed vs. number planned Compare QC test results with targets or expected values.	Discuss with volunteers. Correct simple problems. Retrain as needed Report in QC log
Program Monitoring Coordinator and Field Coordinator	When results are received	Review results with field sheets Identify outlier data Identify action required Trend Results	Check field sheets for conditions Check holding times Develop action plan if necessary Questionable data is flagged to indicate that it should not be entered in a database or used for decision making

24. Reconciliation with Data Quality Objectives (DQO's)

Figure 24.1 describes how project data are compared to the program's data quality objectives and the mechanisms used to accomplish it. The Project Management Coordinator, Project Field Coordinator and Project QC Officer shall utilize the following decision tree as needed.

Figure 24.1 QAPP Data Review Decision Tree for PWA ***



*** As Adapted from Massachusetts Guidebook to Quality Assurance Project Plans

At the conclusion of the sampling season (i.e., after all in-season quality control checks, assessment actions, validation and verification checks and corrective actions have been taken), the resulting data set will be compared with the program's data quality objectives (DQO's).

This review will include, for each parameter, calculation of the following:

- ✓ Completeness goals: overall % of samples completed compared to number planned
- ✓ Percent of samples exceeding accuracy and precision limits
- ✓ Average departure from accuracy and precision targets.
- ✓ After reviewing these calculations, and taking into consideration such factors as clusters of unacceptable data (e.g. whether certain parameters, sites, dates, volunteer teams etc. produced poor results), the Program Monitoring Coordinator, QA Officer and TAC members will evaluate overall program attainment of the program's data quality objectives and determine what limitations to place on the use of the data, or if a revision of the DQO is allowable.

25. Literature Cited

The following studies were previously cited:

Baystate Environmental Consultants, Inc. (January 1993). Diagnostic/Feasibility Study for the Management of the Pembroke Ponds, Oldham, Furnace, Little Sandy Bottom and Stetson, Pembroke, Massachusetts.

Comprehensive Environmental, Inc. (November 2000). Oldham Pond Pollution Source Investigation and BMP Identification.

Comprehensive Environmental, Inc. (December, 2001). Furnace Pond Pollution Source Investigation and BMP Identification.

Table of Contents -- QAPP Appendices

A PWA Water Quality Team

B Training Process and Documentation

C Water Sample Collection Data Sheet
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Calibration Log

D Water Quality Testing and Qualification Procedure Manual

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Mass DEP Certified Parameter List

F YSI-85 Calibration / Maintenance SOP's
YSI EcoSense pH100 Calibration / Maintenance SOP's

Pembroke Watershed Association Water Quality Team

Chair of Water Quality Committee: Patti McCabe

Data Quality Manager and Coordinator: Charlie Banks

Pond Captains:
Furnace: Patti McCabe
Oldham: Charlie Banks
Little Sandy Bottom: Steve Downing
Stetson: Jim McClarnon and Fred Baker.
Hobomock: Andy Key

Qualified instructors for volunteer water quality training:
Charlie Banks, Patti McCabe. Jim McClarnon.

Qualified volunteer water samplers:
3 Instructors and 17 Volunteers

- Oldham Pond
  - Charlie Banks - Instructor
  - Hal Johnson
  - Tammy Stone
  - Norm Shepherd
  - Terry Banks
- Furnace Pond
  - Patti McCabe - Instructor
  - Chuck McCabe
  - Ray Holman
  - Deb Tranberg
  - Jerry Fusco
- Stetson Pond
  - Jim McLarnon - Instructor
  - Mitchell Cahill
  - Fred Baker
  - David Spaulding
  - Robert Shannon
- Little Sandy Bottom Pond
  - Arthur Boyle
  - Steven Downing
  - Becky Paul
- Hobomock Pond
  - Howard League
  - Andy Key
  - Jason Potrykus

B. Training Process and Documentation

Pembroke Watershed Association
Water Quality Testing Qualification/Requalification Program

Part I: Land Based training

1. Review of dissolved oxygen Meter calibration, set-up, and measurements
2. Review of Secchi disc measurements and use
3. Review of the sample forms for lab samples, DO, and Chain of Custody
4. Gather equipment and supplies for testing
5. Obtain and document preliminary information on sample forms

Part II: Safety Instruction

1. Describes and demonstrates standard boat safety with life preserver use, adherence to boat safety rules, general protection measures.
2. Identifies unsafe testing conditions and documents on forms
3. During actual testing portion of qualification demonstrates safety awareness of self and others on the boat and follows standard safety measures.

Part III: Obtain Samples and tests during actual tests, according to written procedures

1. Complete sample collection procedural requirements for a minimum of 3 sites
2. Complete DO tests for a minimum of 3 sites
3. Complete both sample and DO forms completely and properly for a minimum of 3 sites
4. Complete Secchi disc measurement and use of view scope for a minimum of 3 sites
5. Demonstrate proper use and storage of equipment and sampling bottles
6. Identify conditions in which sampling cannot be done
7. Act as tester, witness, and assistant in testing collection and documentation

Part IV: Documentation of Training

1. A member will be considered trained once they have successfully completed the above training requirements.
2. A Qualification/Requalification Sampling Competency sheet will be competed and signed by the instructor. It will then be turned in to the Field Monitoring Coordinator.
3. The Field Monitoring Coordinator will send the original signed Qualification/Requalification Sampling Competency sheet to PWA central storage and keep a copy for reference.

Pembroke Watershed Association

Qualification / Requalification Sampling Competency:

1. Completed water sample collection according to procedure: __________
2. Performed Secchi disc measurement according to procedure: __________
3. Completed DO measurement according to procedure: __________
4. Completed Sampling form and DO form per procedure: __________
5. Completed role of witness correctly: __________
6. Demonstrated safety and careful handling of equipment: __________
7. Verbalized correct safety and team behavior expected on boat: __________
8. Identified situations in which testing would not be possible or would require alternative plan: __________
9. Described chain of custody, storage, and transport of samples: __________

Name: ____________________________________ Date ____________________

Instructor ____
(print & sign)

C-1 Water Sample Collection Data Sheet

Pembroke Watershed Association

P. O. Box 368, Pembroke, MA 02359-0368

Water Sample Collection Data Sheet Date: ________

Sampling Station # ________ Watershed: ______________________________

Pond or River: ________________ GPS Location: ________________ ________________

Town: ____________________ Water level: __________ Ft.

Today's weather:____ Rainfall:_______in.

Yesterday's weather:____ Rainfall:_______in.

Day before's weather:____ Rainfall:_______in.

Site location: ______________________________________

Sample taken from: Boat, Bank, Wade, Dock, Other ______________

Water use: None, Fishing, Boating, Skiing, Swimming

Water color: Clear, Cloudy, Milky, Foam, Brown (muddy), Gray (silty), Tea, Green

Water odor: None, Sewage, Oil, Chlorine, Rotten egg, Other(describe)

Algal growth: None, 5%, 10%, 15%, 20%, 25%, 50%, 75%, >75% Algae Color Green, Blue Green

Bottom appearance: Not Visible, Sludge, Sand, Rock, Weeds, Mud, Other (describe) __________

Weed Growth in Sample area Not Visible, Submerged, Surface - % of weed growth ________

Water Characteristics: Large Wave, Small waves, Smooth, Still

Current at sample area: Fast, Slow, Still, None

Secchi Disk Transparency: Yes No Time:_______am / pm Depth__________ft.

Chemistry sample: Yes No Time:_______am / pm Depth_______ft. Bottle ID#. ________

DO Meter Sample: Time:_______am / pm

Depth 4 ft. DO ________ mg/l ________ % Water temp ________ °F / C

Conductivity ________ pH ________ Salinity __________

Depth 7 ft. DO ________ mg/l ________ % Water temp ________ °F / C

Depth _____ ft. DO ________ mg/l ________ % Water temp ________ °F / C

Depth at sample area: _________ Ft. Air temp:_________ °F / C Surface water temp:______ °F/ C

Comments: ____

____

____

____

Sample taker name: ______________________________ Date ________ Time ________
PRINT & SIGN

Witness: ______________________________ Date ________ Time ________
PRINT & SIGN

Water Sample Form revised 10/07

C-2 Sample Bottle Label

Analytical Balance
C O R P O R A T I O N
422 West Grove Street, Middleboro, MA 02346 • (508) 946-2225

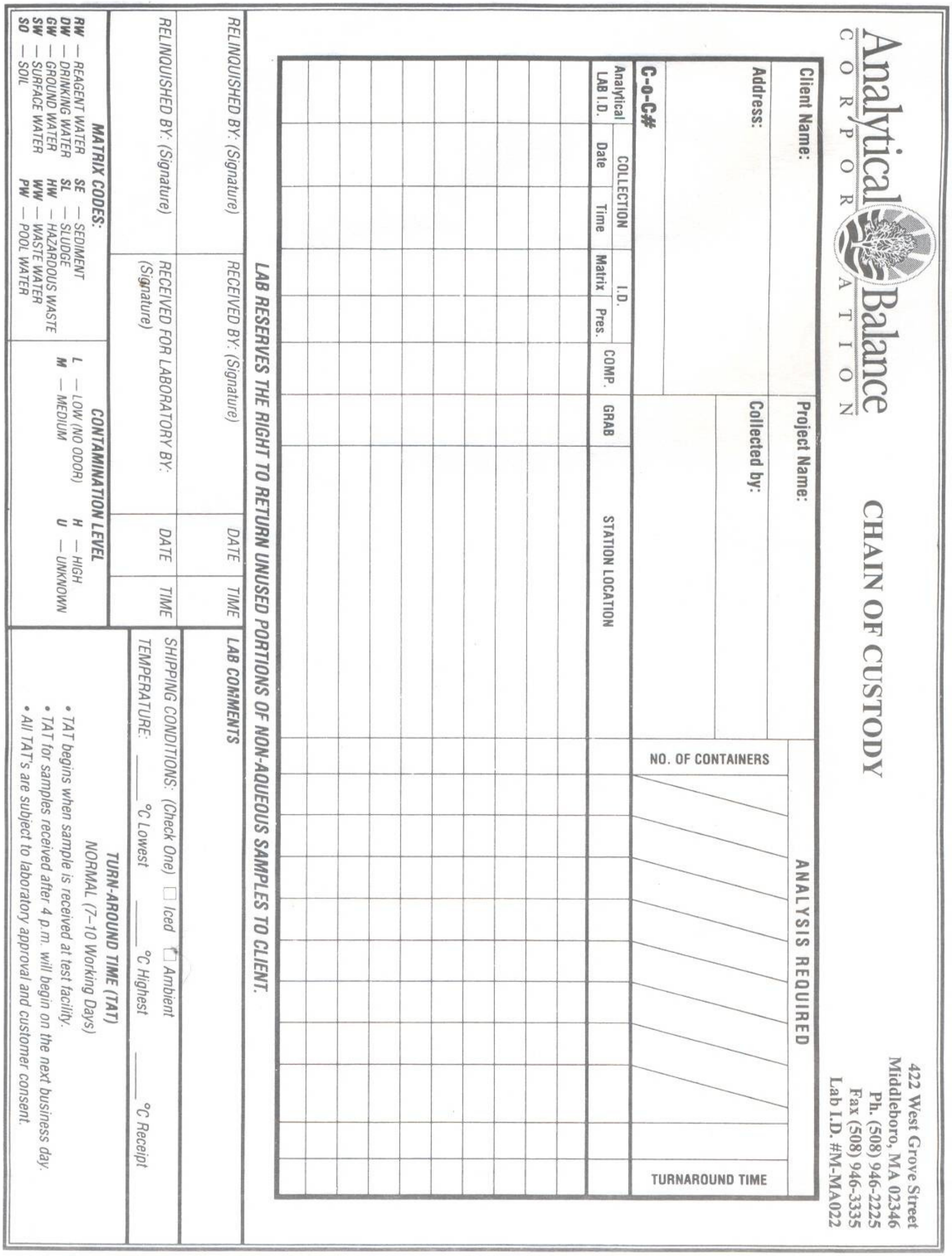
PROJECT NO		PROJECT NAME	
LOCATION			
DATE	TIME	GRAB ☐	COMPOSITE ☐
PRESERVATIVE		DEPTH/VOLUME	
LAB NO		FIELD ID NO	
ANALYSES REQUESTED/COMMENTS			
SAMPLER NAME			

Sample Completed form – DEMO

Analytical Balance
C O R P O R A T I O N
422 West Grove Street, Middleboro, MA 02346 • (508) 946-2225

PROJECT NO G-01		PROJECT NAME PWA	
LOCATION OLDHAM			
DATE 6/23/07	TIME 16	GRAB ✓	COMPOSITE ☐
PRESERVATIVE		DEPTH/VOLUME	
LAB NO		FIELD ID NO	
ANALYSES REQUESTED/COMMENTS			
SAMPLER NAME Charles E Banks			

C-3 Analytical Balance Chain of Custody Form



Analytical Balance Corporation

CHAIN OF CUSTODY

422 West Grove Street
Middleboro, MA 02346
Ph. (508) 946-2225
Fax (508) 946-3335
Lab I.D. #M-MA022

Client Name:
Project Name:
Address:
Collected by:
C-o-C#

ANALYSIS REQUIRED

Analytical LAB I.D.	COLLECTION Date	COLLECTION Time	I.D. Matrix	I.D. Pres.	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS									TURNAROUND TIME

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE	TIME
RELINQUISHED BY: (Signature)	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

LAB COMMENTS

SHIPPING CONDITIONS: (Check One) ☐ Iced ☐ Ambient
TEMPERATURE: ______°C Lowest ______°C Highest ______°C Receipt

MATRIX CODES:
RW — REAGENT WATER SE — SEDIMENT
DW — DRINKING WATER SL — SLUDGE
GW — GROUND WATER HW — HAZARDOUS WASTE
SW — SURFACE WATER WW — WASTE WATER
SO — SOIL PW — POOL WATER

CONTAMINATION LEVEL
L — LOW (NO ODOR) H — HIGH
M — MEDIUM U — UNKNOWN

TURN-AROUND TIME (TAT)
NORMAL (7–10 Working Days)
- TAT begins when sample is received at test facility.
- TAT for samples received after 4 p.m. will begin on the next business day.
- All TAT's are subject to laboratory approval and customer consent.

Sample Completed form – DEMO

Analytical Balance CORPORATION

CHAIN OF CUSTODY

422 West Grove Street
Middleboro, MA 02346
Ph. (508) 946-2225
Fax (508) 946-3335
Lab I.D. #M-MA022

Client Name: PEMBROKE WATERSHED ASSOC.

Address: PO Box 368 Pembroke MA 02359

Project Name: OLDHAM POND

Collected by: Test Leader

PO 05 - 123

C-o-C#

Analytical LAB I.D.	COLLECTION Date	COLLECTION Time	I.D. Matrix	I.D. Pres.	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Nitrity	Nitraty	TKN	Tutal Nitrogen	Tutal Phosphorus	AMMONIA	ALKALINITY	Chloride	Turbidity	TURNAROUND TIME
O-01	10/1/07	1015	SW			✓	O-01 SW	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
O-02	↓	1020	↓			✓	O-02 NW	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
O-03	↓	1025	↓			✓	O-03 NE	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
O-04	↓	1030	↓			✓	O-04 SE	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE	TIME
Test leader	Sample Courier		
RELINQUISHED BY: (Signature)	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

LAB COMMENTS

SHIPPING CONDITIONS: (Check One) ☐ *Iced* ☐ *Ambient*

TEMPERATURE: _____ *°C Lowest* _____ *°C Highest* _____ *°C Receipt*

MATRIX CODES:

- ***RW*** — *REAGENT WATER*
- ***DW*** — *DRINKING WATER*
- ***GW*** — *GROUND WATER*
- ***SW*** — *SURFACE WATER*
- ***SO*** — *SOIL*
- ***SE*** — *SEDIMENT*
- ***SL*** — *SLUDGE*
- ***HW*** — *HAZARDOUS WASTE*
- ***WW*** — *WASTE WATER*
- ***PW*** — *POOL WATER*

CONTAMINATION LEVEL

- ***L*** — *LOW (NO ODOR)*
- ***M*** — *MEDIUM*
- ***H*** — *HIGH*
- ***U*** — *UNKNOWN*

TURN-AROUND TIME (TAT)

NORMAL (7–10 Working Days)

- *TAT begins when sample is received at test facility.*
- *TAT for samples received after 4 p.m. will begin on the next business day.*
- *All TAT's are subject to laboratory approval and customer consent.*

C-4 Analytical Balance Certificate of Analysis

Betty Minichills
Pembroke Watershed Association
PO Box 368
Pembroke, MA 02359

CERTIFICATE OF ANALYSIS

COLLECTED BY:	S.MacInnes	REPORTED:	07/27/2005
TIME:	10:30	ORDER #:	G0573582
LOCATION:	Oldham Pond	SAMPLE DATE:	7/16/2005
	Camp Pembroke	DATE RECEIVED:	7/18/2005
	O-01	SAMPLE ID:	Grab
		DESCRIPTION:	WATER

RESULTS OF ANALYSIS

Parameter	Analytical Method	Date Analyzed	Units	Det Limit*	Result
Test Parameters				**LAB-ID#:**	**0573582-01**
Alkalinity 310.2	EPA 310.2	07/18/2005	mg/L	4	**21.4**
Ammonia, Nitrogen 350.1	EPA 350.1	07/20/2005	mg/L	0.1	**<0.10**
Chloride 4110B	SM 4110 B	07/18/2005	mg/L	4.0	**49.4**
Kjeldahl, Nitrogen	EPA 351.2	07/21/2005	mg/L	0.50	**1.71**
Nitrate, Nitrogen 4110B	SM 4110 B	07/18/2005	mg/L	0.20	**<0.20**
Nitrite, Nitrogen 4110B	SM 4110 B	07/18/2005	mg/L	0.10	**<0.10**
Nitrogen, Total	Calculation	07/21/2005	mg/L	1.0	**1.71**
pH	SM 4500 H+B	07/18/2005	S.U.	0-14	**8.2**
Phosphorus, Ortho	SM 4500P-B/E	07/18/2005	mg/L	1.0	**<1.0**
Phosphorus, Total	SM 4500-P B/E	07/20/2005	mg/L	0.01	**0.04**
Specific Conductance	SM 2510 B	07/18/2005	umhos/cm	1.5	**242**
Turbidity	SM 2130B	07/18/2005	NTU	0.25	**22**

Analytical Balance Corp., **422 West Grove Street, Middleboro, MA 02346 Ph: 508-946-2225** Page 1 of 6

	Pembroke Watershed Association

Qualification / Requalification Sampling Competency:

1. Completed water sample collection according to procedure: __________
2. Performed Secchi disc measurement according to procedure: __________
3. Completed DO measurement according to procedure: __________
4. Completed Sampling form and DO form per procedure: __________
5. Completed role of witness correctly: __________
6. Demonstrated safety and careful handling of equipment: __________
7. Verbalized correct safety and team behavior expected on boat: __________
8. Identified situations in which testing would not be possible or would require alternative plan: __________
9. Described chain of custody, storage, and transport of samples: __________

Certified by: ____

Print Name and Signature   Water Quality Committee

Appendix

C-6 Quality Control Checklist

Pembroke Watershed Association

Quality Control (QC) Checklist

One test sample per pond will be taken as quality control.

Water Sample QC;

- **Sample Bottle is to be labeled "B" for Blind .**
- **Time on the bottle is to be the time when the tests were finished.**
- **Actual location and time are to be noted on our form.**

Quality Control Sample # ____ Test date ________ Time _______

Pond ____

Actual Test Site (O-01, F-03 etc) ________________

Water Quality QC sample taken by _______________________

At the same site where we take a water sample for QC, an instrument QC will be completed. This will be accomplished by having two different testers do the Secchi disk reading and the instrument readings on the DO and pH meter.

Secchi disk _______ ft DO _________mg/l ________ % Water temp _______

Conductivity: ____ pH ____ Salinity ____________

Instrument QC readings completed by __________________________________

Witness ____

This form is to be completed and turned in to the Field Monitoring Coordinator

Modified 11/11/09

C-7 Calibration Log

Equipment will be calibrated annually in the spring and prior to the start of each test day, following manufacturer's recommended procedures

Annual spring calibration

Instrument	Date	Calibration	Person	Corrective action

Pre testing calibration

Instrument	Date	Calibration	Person	Corrective action

Pembroke Watershed Association

Water Quality Testing And Qualification

Procedure Manual

Revised December, 2009

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Pembroke Watershed Association

Protocols for Water Quality testing

General procedures

1. Water quality testing will be carried out by volunteers trained by the water quality committee. Volunteers will complete training as outlined in this training manual prior to performing water quality sampling. Testing will be carried out by a minimum of two people. Personnel and responsibilities are as follows:

   Program Monitoring Coordinator - Overall responsibility for the water quality testing program

   Field Monitoring Coordinator – Responsible for actual testing procedures and Quality Control procedures.

   Test Leader - The Field Monitoring Coordinator will appoint a Test Leader to coordinate testing on a specific pond. Under the direction of the Field Monitoring Coordinator the Test Leader is responsible for verification of testing procedures and proper completion of all paperwork. The Test leader will sign all forms as witness and sign the Chain of Custody forms. The Test Leader will also deliver all forms to the Field Monitoring Coordinator for collection and review

   Water Quality Team Member -
   Tester - follows procedures to take the actual samples.
   Assistant – Assists with Secchi Disk measurement or other testing as needed. Completes paperwork and verifies accuracy

   Data Management Coordinator – Maintains and verifies data integrity and accuracy. Creates spreadsheets, presentations and reports.

   Quality Assurance Officer - works with the Field Monitoring Coordinator to verify that samples are taken properly and that Quality Control procedures are followed.

   Boat Driver – Provides use of a privately owned boat to be used for testing. Responsible for all maintenance and safety.

2. Safety must be a major concern. All participants are required to wear life jackets whenever they are on board a boat that is under way and to follow the safety guidelines.

3. In the event of inclement weather the Program Monitoring Coordinator, Field Monitoring Coordinator or a properly appointed substitute will make the determination on whether or not to conduct the tests. If any test sites are omitted because of changes in conditions, the reasons must be documented.

4. Prior to the testing date, the Field Monitoring Coordinator will obtain purchase orders for the testing and make arrangements for the samples to be carried to Analytical Labs. Analytical Labs bottle labels and chain of custody forms are to be used for all tests.

Test Sampling General Information:

The number of Water Quality tests has been determined at the beginning of the testing year, depending on the condition and size of the ponds. In all cases we will conduct testing at the specified number of sites.
Testing will be as follows:

1. DO, conductivity, temperature and salinity using the YSI model 85 meter
2. Secchi disk using the Secchi disk and the view scope
3. pH using the YSI EcoSense pH100 meter
4. Chemical Grab sample – using the sample stick

Maximum Depth at each sample site shall be determined using the supplied depth finder. This depth is to be verified at one site by dropping the Secchi disk to the bottom and measuring. Note: This must be done after all other sampling to avoid roiling the bottom and contaminating the sample.

ALL water samples are to be placed in a cooler with ice or ice packs immediately after being taken and kept iced until delivered to the lab.

The test schedule will be as determined by the Program Monitoring Coordinator in cooperation with the Field Monitoring Coordinator.
See appendix # 1 for the current year testing schedule.

Test Sampling Procedure:

1. Obtain preliminary information and document on forms: This information is available on the following URL:
   http://www.weather.com/outlook/homeandgarden/home/pastweather/02359?locid=02359&when=-1
   - Weather conditions for the day of the test, including rainfall, if any
   - Weather conditions for the previous 2 days, including rainfall, if any
   - Actual water level of the pond (note location)

2. The testing equipment used for water quality testing is to be calibrated properly utilizing the manufacturer's calibration procedures. The test leader will work with the Field Monitoring Coordinator to ensure that this is done.

3. Utilize GPS to obtain correct location of test site. Sites are determined by the water quality committee and all tests are to be completed unless there is a safety issue. The test leader will make this determination. If a specific site or sites are not tested, the full reasons why will be written on the forms.

4. At test site: Obtain and document physical characteristics of the water, water conditions, presence of weeds and algae, and document on the appropriate form, using consensus and camera picture if necessary or significant.

5. Surface water temperature, air temperature, and total water depth at sampling area are to be collected and documented on the form.

6. Test bottle identifier should be written on cap with marker.
   a. Labeling of sampling bottle is to be completed and the bottle signed by the tester.
   b. To start the actual test the bottle is to be rinsed three times with surface water on the opposite side of boat from sampling area.
   c. The test stick must be rinsed clean before testing starts, with special emphasis on removing any algae or weeds fragments.

7. The following illustrates proper test procedures

First remove the cap and rinse the bottle three times on the opposite side of the boat.
place the bottle in the bottom of the test grab stick, secure it and place a cork in the mouth.

Note: sampler should be cleaned of all plant fragments, algal strands, etc. and rinsed prior to use

Special care must be taken that the inside of the cap and bottle are never touched.

The Bottle is lowered to a depth of 4 feet - all tests are to be done at this depth. Testing is to be done in a minimum of 6 feet, determined by use of the depth finder. This depth is to be cross checked by use of the secchi disk on one site.

If at a deep hole location and a second phosphorus sample is required, lower a second bottle to a depth 6 to 8 inches off of the bottom.

The string is pulled, filling the bottle at depth.

The bottle is moved back and forth to release any air and brought to the surface.

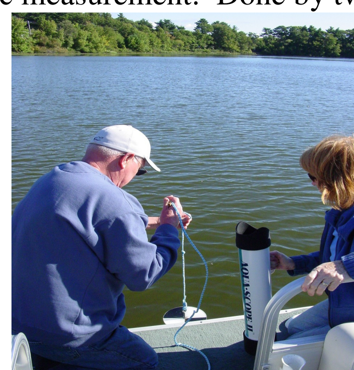
Bottle is to be inspected for any foreign material. If there is any foreign matter, the bottle is to be discarded and the test retaken with a new bottle.

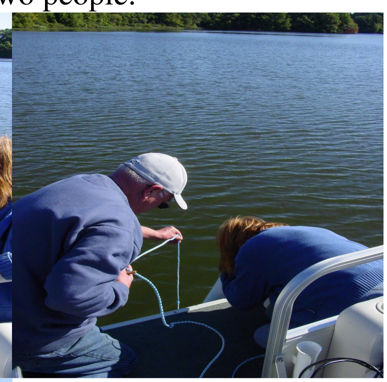
The cap is secured.

8. Dry bottle off, write site identifier on top using marker and bottle is placed in cooler with ice. After testing is finished, a clean dry label is completed and attached to the sampling bottle, tester signs label and sampling form.

9. Complete Secchi disc measurement: Done by two people:

One person lowers Secchi disc straight down in water while second person uses view scope and notes when Secchi disc is no longer visible.





First person places clip on Secchi disc rope at that point and measures length from clip to disc - record measurement and time on form. Secchi disc is used on shady side of boat to minimize effects of glare.

10. The YSI model 85 is used to test for DO, conductance, and salinity. Lower the probe to a depth of 4 feet. If at a deep hole location, perform temperature and DO readings at two-foot intervals. Document each reading on forms with sample time, temperature, and depth. A separate pH reading on the surface is required utilizing the YSI EcoSense pH100 meter.

11. Total Depth at site is measured utilizing the depth finder provided in the kit. To verify accuracy one site per test session will also utilize the Secchi disk to check depth. This must

be taken last so as not to stir up the bottom. Drop the Secchi disk down until it reaches the bottom, mark and measure the depth using the tape measure

12. The test leader will witness all data forms.

13. The following tests should always be requested from Analytical labs. They are to be entered on the Chain of custody form.

    - Turbidity
    - Total Phosphorous
    - Chloride
    - Alkalinity

    We will request that Analytical Labs test the Nitrogen series once a year per pond
    - Nitrate Nitrogen
    - TK Nitrogen
    - Nitrite Nitrogen
    - Total Nitrogen - calculated by the lab
    - Ammonia

Data Handling and Transporting Samples to the lab.

1. The test leader will verify completeness of all forms. All data forms are to be filled in completely. Bottle labels are also to be filled in completely and the test site number should be written on the top.

2. Sample bottles are to be placed in a cooler with ice or ice packs as soon as they are collected. The samples are to be kept iced or refrigerated until delivered to the lab.

3. All test sample forms are to be collected at the end of the tests for that pond. The original forms are to be turned in to the Field Monitoring Coordinator, who will then make copies and forward the original forms to central storage.

4. Chain of Custody forms are to be completed by the test leader. The purchase order number will be provided and is entered on the form. The Chain of Custody form MUST be signed by the test leader and whoever is transporting the samples. If custody of the samples changes, the persons involved must both sign off on the form. Once the samples reach the lab, they will return the pink copy of the form to the transporter along with new bottles. These are to be returned to the Field Monitoring Coordinator. The pink copy of the chain of custody will be turned over to central storage. Addendum # 3 A completed example of the bottle label and chain of custody forms is included in this document.

5. The test results will be mailed back to the PWA by the lab. Originals are to be turned over to the Field Monitoring Coordinator, who will then make copies and forward the original forms to central storage.

6. Copies of all test forms and results from Analytical will be given to the Data Management Coordinator, who will input the data into the spreadsheet and periodically provide copies for central storage.

Quality Control procedures:

We are required to take additional samples for quality control. We are taking a quality control sample once per pond per year. Quality control sampling is scheduled to assure that Test leaders and samplers have additional sampling bottles, the QC documentation forms, and follow the QC procedure when sampling.

Quality control procedure:
Chemical quality control will be accomplished by collecting a duplicate sample at one site, called a blind sample. This sample will be collected immediately after a sample has been taken at that site, and will be collected by a second sampler.
Meter and Secchi disc quality control will be accomplished by having a second sampler complete the meter readings and conduct the secchi disc reading. The first sampler acts as assistant (dropping the secchi disc, dropping the meter probe to required depth).
Documentation of sample collection and meter readings should be noted on the QC documentation form as well as the data sheet for that site.
"Blind" sample should be noted with time of collection on the chain of custody form.

Equipment and supplies needed for water quality testing:

The test leader should make visual inspection prior to testing to ensure that all required equipment is present in each kit.

1. Cooler for sampling storage include ice or frozen ice packs
2. GPS
3. DO meter (YSI model 85)
4. Sampling bottles (2 extra)
5. Marker for noting sampling area on cap
6. pens for documentation
7. testing stick - must be clean of all algae and weed fragments
8. tape measure for depth measurement
9. thermometer for air and surface water temperature measurements
10. Secchi disc
11. view scope
12. pH meter
13. clothes pin or clip
14. paper towels or towels for drying bottles
15. documentation forms for sampling and DO for all sites
16. chain of custody forms - include correct PO Number
17. clip board for forms
18. camera: take pictures of unusual or significant physical findings (prefer digital)
19. A copy of these testing procedures, sunscreen and beverages
20. Depth Finder and personal flotation device
21. Extra bottle labels

Pembroke Watershed Association

P. O. Box 368, Pembroke, MA 02359-0368

Water Sample Collection Data Sheet

Date: (1) ________

Sampling Station # (2) ________ Watershed: (3) ________________

Pond or River: (4) ________ GPS Location: (5) ________

Town: (5) ________ Water level: (7) ________ Ft.

Today's weather: (8) ________________ Rainfall:______in.

Yesterday's weather: (9) ________________ Rainfall:______in.

Day before's weather: (10) ________________ Rainfall:______in.

Site location: (11) ________________

Sample taken from: Boat, Bank, Wade, Dock, Other (12) ________

Water use:	13	None, Fishing, Boating, Skiing, Swimming
Water color:	14	Clear, Cloudy, Milky, Foam, Brown (muddy), Gray (silty), Tea, Green
Water odor:	15	None, Sewage, Oil, Chlorine, Rotten egg, Other(describe)
Algal growth:	16	None, 5%, 10%, 15%, 20%, 25%, 50%, 75%, >75% (16a) Algae Color Green, Blue Green
Bottom appearance:	17	Not Visible, Sludge, Sand, Rock, Weeds, Mud, Other (describe) ________
Weed Growth in Sample area	18	Not Visible, Submerged, Surface - % of weed growth (18a) ________
Water Characteristics:	19	Large Wave, Small waves, Smooth, Still
Current at sample area:	20	Fast, Slow, Still, None

Secchi Disk Transparency: Yes No Time:______am / pm Depth (21) ________ft.

Chemistry sample: (22) Time:______am / pm Depth______ft. Bottle ID#. ________

DO Meter Sample: (23) Time:______am / pm

Depth 4 ft. (24) DO ______ mg/l ______ % Water temp ______ ^{0}F / C

(25) Conductivity ______ pH ______ Salinity ______

Depth 7 ft. (26) DO ______ mg/l ______ % Water temp ______ ^{0}F / C

Depth ______ ft. (27) DO ______ mg/l ______ % Water temp ______ ^{0}F / C

Depth at sample area: (28) ______ Ft. Air temp:______ºF / C Surface water temp:______ºF/ C

Comments: (29) ________________________________

____

____

____

Sample taker name: (30) ________________ Date ________ Time ________
PRINT & SIGN

Witness: (31) ________________ Date ________ Time ________
PRINT & SIGN

Water Sample Form revised 10/07

1 Todays Date

2 Sampling Station - our site designation i.e. O-01

3 Watershed - South Coastal or Taunton

4 Name of Pond

5 GPS Readings for that site

6 Town Pembroke or Hanson

7 Water level - available on each pond

8 Todays weather and rainfall amount

9 Yesterdays weather and rainfall amount - available on internet

10 Two days prior weather and rainfall amount - available on internet

11 Site location - use our location code and description

12 Sample from - circle appropriate (will normally be from a boat)

13 Water use - Circle appropriate

14 Water Color - Circle appropriate

15 Water odor - Circle appropriate

16 Algal growth - Circle appropriate

16a If Algae exists, circle type

17 Bottom Appearance - circle appropriate

18 Weed Growth in sample area - Circle appropriate

18a If Weeds exist fill in %

19 Water Characteristics- Circle appropriate

20 Current at sample area - Circle appropriate

21 Secchi Disk - Time and Depth

22 Chemistry sample is yes - fill in date, time & Bottle ID

23 DO sample time

24 DO sampling from Meter - DO in mg/l and % time of sample and water temp at sample depth for 4 foot

25 Fill in all readings for Conductivity, pH and Salinity or mark n/a

26 DO sampling from Meter - DO in mg/l and % time of sample and water temp at sample depth for 7 foot

27 Fill in as above if a deeper sample is taken

28 Total Depth at sample area , air temp and surface water temp. Note - This should be done last

29 Comments

30 Sample taker must sign and date

31 Witness must sign and date

** http://www.weather.com/outlook/driving/interstate/pastweather/02359?from=36hr_topnav_driving

This is an example of a completed form showing several possible comments

Pembroke Watershed Association

P. O. Box 368, Pembroke, MA 02359-0368

Water Sample Collection Data Sheet

Date: 10/14/2007

Sampling Station # O-01 Watershed: South Coastal

Pond or River: Oldham GPS Location: 42^0 04.330 N / 70^0 50.048 W

Town: Hanson Water level: 55.6 Ft.

Today's weather: Sunny Rainfall: 0 in.

Yesterday's weather: Sunny Rainfall: 0 in.

Day before's weather: Rain Rainfall: 1.5 in.

Site location: O-01 Northwest side of pond

Sample taken from: Boat, Bank, Wade, Dock, Other ______

Water use: None, Fishing, Boating, Skiing, Swimming

Water color: Clear, Cloudy, Milky, Foam, Brown (muddy), Gray (silty), Tea, Green

Water odor: None, Sewage, Oil, Chlorine, Rotten egg, Other(describe)

Algal growth: None, 5%, 10%, 15%, 20%, 25%, 50%, 75%, >75% Algae Color Green, Blue Green

Bottom appearance: Not Visible, Sludge, Sand, Rock, Weeds, Mud, Other (describe) ______

Weed Growth in Sample area Not Visible, Submerged, Surface - % of weed growth ______

Water Characteristics: Large Wave, Small waves, Smooth, Still

Current at sample area: Fast, Slow, Still, None

Secchi Disk Transparency: Yes No Time: 11 20 am / pm Depth 1.3 ft.

Chemistry sample: Yes No Time: 11 25 am / pm Depth 4 ft. Bottle ID#. O-01

DO Meter Sample: Time: 11 30 am / pm

Depth 4 ft. DO 8.93 mg/l 115.4 % Water temp 24.8 ^{0}F / C

Conductivity 218 pH 6.9 Salinity .1

Depth 7 ft. DO NA mg/l ____ % Water temp ____ ^{0}F / C

Depth ____ ft. DO NA mg/l ____ % Water temp ____ ^{0}F / C

Depth at sample area: 6 Ft. Air temp: 87 ^{0}F / C Surface water temp: 75 ^{0}F / C

Comments: Heavy weeds with 50' invasive weeds on shore
Heavy wind and waves

Sample taker name: John Tester (PRINT & SIGN) John Tester Date 10/14/07 Time 1145

Witness: Jim Witness (PRINT & SIGN) Jim Witness Date 10/14/07 Time 1145

Water Sample Form revised 10/07

These are completed examples of the Bottle label

Analytical Balance
CORPORATION
422 West Grove Street, Middleboro, MA 02346 • (508) 946-2225

PROJECT NO G-01	PROJECT NAME PWA
LOCATION OLDHAM	
DATE 6/23/07 TIME 16^00	GRAB ✓ COMPOSITE
PRESERVATIVE	DEPTH/VOLUME
LAB NO	FIELD ID NO
ANALYSES REQUESTED/COMMENTS	
SAMPLER NAME Charles E Banks	

And the Chain of Custody form. Note that the purchase order number is required on the form.

The chain of custody form must be signed by the responsible test leader and the transporter. Each separate person who becomes responsible for the test samples MUST sign the form.

We will always request tests from Analytical Labs for:

- Turbidity
- Total Phosphorous
- Chloride
- Alkalinity

Nitrogen series - to be taken once per pond per testing year

- Nitrate Nitrogen
- Nitrite Nitrogen
- Ammonia
- TK Nitrogen
- Total Nitrogen - calculated by the lab

Conductance should only be included if necessary. Note that Analytical labs requires us to include the time of the sample

Analytical Balance CORPORATION

CHAIN OF CUSTODY

422 West Grove Street
Middleboro, MA 02346
Ph. (508) 946-2225
Fax (508) 946-3335
Lab I.D. #M-MA022

Client Name: PEMBROKE WATERSHED ASSOC.

Address: PO Box 368, Pembroke MA 02359

Project Name: OLDHAM POND

Collected by: Test Leader

PO 05 - 123

C-o-C#

Analytical LAB I.D.	COLLECTION Date	COLLECTION Time	I.D. Matrix	I.D. Pres.	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Nitrite	Nitrate	TKN	Total Nitrogen	Total Phosphorus	Ammonia	Alkalinity	Chloride	Turbidity	TURNAROUND TIME
0-01	10/1/07	1015	SW			✓	0-01 SW	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
0-02		1020				✓	0-02 NW	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
0-03		1025				✓	0-03 NE	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
0-04		1030				✓	0-04 SE	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE	TIME
Test leader	Sample Courier		
RELINQUISHED BY: (Signature)	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

LAB COMMENTS

SHIPPING CONDITIONS: (Check One) ☐ Iced ☐ Ambient

TEMPERATURE: ______°C Lowest ______°C Highest ______°C Receipt

MATRIX CODES:

RW — REAGENT WATER
DW — DRINKING WATER
GW — GROUND WATER
SW — SURFACE WATER
SO — SOIL
SE — SEDIMENT
SL — SLUDGE
HW — HAZARDOUS WASTE
WW — WASTE WATER
PW — POOL WATER

CONTAMINATION LEVEL

L — LOW (NO ODOR)
M — MEDIUM
H — HIGH
U — UNKNOWN

TURN-AROUND TIME (TAT)

NORMAL (7–10 Working Days)

- TAT begins when sample is received at test facility.
- TAT for samples received after 4 p.m. will begin on the next business day.
- All TAT's are subject to laboratory approval and customer consent.

What are we testing for?

- **Nitrogen -** is a fundamental nutrient and is required by all living plants and animals for building proteins
  Measured in mg/liter
  - Natural range is between 0.1 and 2 mg/l
  - For concentrations >5 mg/l negative impact is certain

- **Phosphorus -** is normally scarce in a normal aquatic environment, is necessary for plant growth, and is abundant on land.
  Measured in mg/liter
  - Concentration should be between .01 and .1 mg/l
  - For concentrations >.05 mg/l impact is light
  - For concentrations >.10 mg/l negative impact is certain

- Note: marked increase in Nitrogen or Phosphorous loads in a pond will encourage the proliferation of algae, fueling an overpopulation of bacteria that eat the decomposing algae. Less light diffuses through the water, impacting aquatic plant life. Aquatic life and algae compete for dissolved oxygen, and oxygen levels will plummet, resulting in eutrophic conditions and loss of habitat.

- **Turbidity:** The amount of suspended solids in the water.
  - Measured in NTU (Nephelometric Turbidity units)
  - Level should be between 1.0 and 10.0 NTU
  - Turbidity directly effects transparency (clarity) of the water

- **Dissolved Oxygen (DO):** The amount of oxygen in the water
  - Measured in mg/liter
  - Fish need a DO level >6.0 for warm water species, >7.0 for cold water species
  - DO levels will be higher near the surface due to wind effects, therefore should be measured at a minimum depth of 4 feet

- **pH and Alkalinity:** ability of water to handle acid and basic solutions
  - A pH of 7.0 is neutral, a higher pH means alkaline, a lower pH means acidic.
  - Pond water pH should range between 6.5 and 8.5
  - Alkalinity refers to the ability of the body of water to neutralize incoming acids from precipitation or discharges. Low alkalinity indicates low buffering ability.

- **Secchi Disk Transparency:** directly relates to turbidity, measures clarity.
  - Measured in feet
  - Water clarity: how far down can a Secchi disc be seen.
  - Expected depth should be > 10 feet, with high water quality exceeding 16 feet

- **Other:** Chloride, Salinity and Ammonia are also included

GPS Coordinates for Test Sites Determined by Field GPS

Oldham Pond

Tributary A			**42^0 04.217 N**	**70^0 50.640 W**
Tributary B			**42^0 04.172 N**	**70^0 50.669 W**
Country Lane	**Upstream of culvert**		**42^0 04.496 N**	**70^0 50.724 W**
O-08	**Southeast**	**Pembroke Side**	**42^0 03.645 N**	**70^0 49.910 W**
Outlet			**42 03.550 N**	**70 49.976 W**

Furnace Pond

Outlet		**42^0 03.186 N**	**70^0 49.182 W**
F-08	**South**	**42^0 03.233 N**	**70^0 49.315 W**

Stetson Pond

S-04	**North**	**42^0 01.882 N**	**70^0 49.779 W**
S-05	**South**	**42^0 01.741 N**	**70^0 49.330 W**

Little Sandy Pond

LS-04	**Central**	**42^0 02.495 N**	**70^0 50.055 W**

Hobomock Pond

H-02	**Central**	**42^0 03.393 N**	**70^0 48.618 W**

Pembroke Watershed Association
Water Quality Testing Qualification/Requalification Program

Part I: Land Based training

Review of dissolved oxygen Meter calibration, set-up, and measurements
Review of Secchi disc measurements and use
Review of the sample forms for lab samples, DO, and Chain of Custody
Gather equipment and supplies for testing
Obtain and document preliminary information on sample forms

Part II: Safety Instruction

Describes and demonstrates standard boat safety with life preserver use, adherence to boat safety rules, general protection measures.
Identifies unsafe testing conditions and documents on forms
During actual testing portion of qualification demonstrates safety awareness of self and others on the boat and follows standard safety measures.

Part III: Obtain Samples and tests during actual tests, according to written procedures

Complete sample collection procedural requirements for a minimum of 3 sites
Complete DO tests for a minimum of 3 sites
Complete both sample and DO forms completely and properly for a minimum of 3 sites
Complete Secchi disc measurement and use of view scope for a minimum of 3 sites
Demonstrate proper use and storage of equipment and sampling bottles
Identify conditions in which sampling cannot be done
Act as tester, witness, and assistant in testing collection and documentation

Part IV: Documentation of Training

A member will be considered trained once they have successfully completed the above training requirements.
A Qualification/Requalification Sampling Competency sheet will be competed and signed by the instructor. It will then be turned in to the Field Monitoring Coordinator.
The Field Monitoring Coordinator will send the original signed Qualification/Requalification Sampling Competency sheet to PWA central storage and keep a copy for reference.

Addendum # 1

Testing schedule for the 2010 testing year (June 2010 – September 2010).

We will conduct a total of 33 tests

Furnace Pond (94085) – 103 Acres

3 test sites. This pond will be tested monthly from June through September. 12 tests

Oldham Pond (94114) - 232 Acres

4 test sites. This pond will be tested monthly from June through September. 16 tests

Stetson Pond (62182) – 88.2 Acres

2 test sites This pond will be tested in June and August . 4 tests

Hobomock Pond (94177) – Category 2 – 12.7 Acres

Testing is suspended due to Hydrilla infestation

Little Sandy Pond (94085)– Category 2 - 56.1 Acres

1 test site. This pond will be tested in August - 1 test

The following categories are those identified in the Massachusetts year 2008 Integrated List of waters

Category 5 are "Waters requiring a TMDL"

Category 4c are waters where "Impairment not caused by a pollutant"

Category 2 "attaining some uses – others not assessed"

Furnace Pond (94085) – Category 5 - Organic enrichment/low DO

Oldham Pond (94114) – Category 4c - Exotic species

Stetson Pond (62182) – Category 5 – Nutrients, Organic enrichment/low DO, Exotic species

Hobomock Pond (94177) – Category 2

Little Sandy Pond (94085)– Category 2

Pembroke Watershed Association

Qualification / Requalification Sampling Competency:

1. Completed water sample collection according to procedure: __________
2. Performed Secchi disc measurement according to procedure: __________
3. Completed DO measurement according to procedure: __________

10. Completed Sampling form and DO form per procedure: __________
11. Completed role of witness correctly: __________
12. Demonstrated safety and careful handling of equipment: __________
13. Verbalized correct safety and team behavior expected on boat: __________
14. Identified situations in which testing would not be possible or would require alternative plan: __________
15. Described chain of custody, storage, and transport of samples: __________

Name: ____________________________________ Date ____________________

Instructor ____
(print & sign)

E-1 Analytical Balance State Certification

The Commonwealth of Massachusetts

Department of Environmental Protection

Division of Environmental Analysis
Senator William X. Wall Experiment Station

certifies

M-MA022 **ANALYTICAL BALANCE CORP**
422 WEST GROVE ST
MIDDLEBOROUGH, MA 02346-0000

Laboratory Director: **Robert E. Bentley**

for the analysis of **NON POTABLE WATER (CHEMISTRY)**
POTABLE WATER (CHEMISTRY)
POTABLE WATER (MICROBIOLOGY)
pursuant to 310 CMR 42.00

This certificate supersedes all previous Massachusetts certificates issued to this laboratory. The laboratory is regulated by and shall be responsible for being in compliance with Massachusetts regulations at 310 CMR 42.00.

This certificate is valid only when accompanied by the latest dated Certified Parameter List as issued by the Massachusetts D.E.P. Contact the Division of Environmental Analysis to verify the current certification status of the laboratory.

Certification is no guarantee of the validity of the data. This certification is subject to unannounced laboratory inspections.

Issued: **01 JUL 2006**
Expires: **30 JUN 2007**

Director, Division of Environmental Analysis

E-2 Mass DEP Certified Parameter List

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Certified Parameter List as of: 01 JUL 2006

M-MA022 ANALYTICAL BALANCE CORP
MIDDLEBOROUGH MA

NON POTABLE WATER (CHEMISTRY) **Effective Date** 01 JUL 2006 **Expiration Date** 30 JUN 2007

Analytes and Methods

ALUMINUM	SM 3113B
ALUMINUM	EPA 200.8
ANTIMONY	SM 3113B
ANTIMONY	EPA 200.8
ARSENIC	SM 3113B
ARSENIC	EPA 200.8
BERYLLIUM	EPA 3113B
BERYLLIUM	EPA 200.8
CADMIUM	SM 3113B
CADMIUM	EPA 200.8
CHROMIUM	SM 3113B
CHROMIUM	EPA 200.8
COBALT	EPA 200.8
COPPER	SM 3111B
COPPER	EPA 200.8
IRON	SM 3111B
LEAD	SM 3113B
LEAD	EPA 200.8
MANGANESE	SM 3111B
MANGANESE	EPA 200.8
MOLYBDENUM	EPA 200.8
NICKEL	SM 3113B
NICKEL	EPA 200.8
SELENIUM	SM 3113B
SELENIUM	EPA 200.8
SILVER	SM 3111B
SILVER	EPA 200.8
THALLIUM	EPA 200.8
VANADIUM	EPA 200.8
ZINC	SM 3111B
ZINC	EPA 200.8
PH	SM 4500-H-B
SPECIFIC CONDUCTIVITY	SM 2510B
TOTAL DISSOLVED SOLIDS	SM 2540C
HARDNESS (CACO3), TOTAL	SM 2340B
HARDNESS (CACO3), TOTAL	SM 2340C
CALCIUM	SM 3111B
CALCIUM	SM 3500-CA-D
MAGNESIUM	SM 3111B
SODIUM	SM 3111B
POTASSIUM	SM 3111B
ALKALINITY, TOTAL	SM 2320B
ALKALINITY, TOTAL	EPA 310.2
CHLORIDE	SM 4500-CL-B
CHLORIDE	SM 4110B
SULFATE	SM 4110B
AMMONIA-N	EPA 350.1
NITRATE-N	SM 4110B
KJELDAHL-N	EPA 351.2
ORTHOPHOSPHATE	SM 4500-P-E
ORTHOPHOSPHATE	SM 4110B
PHOSPHORUS, TOTAL	SM 4500-P-B,E
CHEMICAL OXYGEN DEMAND	* HACH METHOD 8000
BIOCHEMICAL OXYGEN DEMAND	SM 5210B
CYANIDE, TOTAL	SM 4500-CN-C,E
NON-FILTERABLE RESIDUE	SM 2540D
CHLORINE, TOTAL RESIDUAL	SM 4500-CL-G
OIL AND GREASE	EPA 413.1
* OIL AND GREASE	EPA 1664
VOLATILE HALOCARBONS	EPA 624
VOLATILE AROMATICS	EPA 624

June 22, 2006 *** Provisional Certification** **Page 1 of 2**

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Certified Parameter List as of: 01 JUL 2006

M-MA022 ANALYTICAL BALANCE CORP
MIDDLEBOROUGH MA

POTABLE WATER (CHEMISTRY) Effective Date 01 JUL 2006 Expiration Date 30 JUN 2007

Analytes and Methods

ANTIMONY	EPA 200.8
ANTIMONY	SM 3113B
ARSENIC	EPA 200.8
ARSENIC	SM 3113B
BARIUM	EPA 200.8
BARIUM	SM 3113B
BERYLLIUM	EPA 200.8
BERYLLIUM	SM 3113B
CADMIUM	EPA 200.8
CADMIUM	SM 3113B
CHROMIUM	EPA 200.8
CHROMIUM	SM 3113B
COPPER	EPA 200.8
COPPER	SM 3111B
LEAD	EPA 200.8
LEAD	SM 3113B
MERCURY	EPA 200.8
NICKEL	EPA 200.8
NICKEL	SM 3113B
SELENIUM	EPA 200.8
SELENIUM	SM 3113B
THALLIUM	EPA 200.8
THALLIUM	EPA 200.9
NITRATE-N	SM 4110B
NITRATE-N	SM 4500-NO3-D
NITRITE-N	SM 4110B
NITRITE-N	SM 4500-NO2-B
FLUORIDE	SM 4110B
FLUORIDE	SM 4500-F-C
SODIUM	SM 3111B
SULFATE	SM 4110B
CYANIDE, TOTAL	SM 4500-CN-C,E
CYANIDE, TOTAL	SM 4500-CN-F
TURBIDITY	SM 2130B
CHLORINE, RESIDUAL FREE	SM 4500-CL-G
CALCIUM	SM 3500-CA-D
CALCIUM	SM 3111B
ALKALINITY, TOTAL	SM 2320B
TOTAL DISSOLVED SOLIDS	SM 2540C
PH	SM 4500-H-B
TRIHALOMETHANES	EPA 524.2
VOLATILE ORGANIC COMPOUNDS	EPA 524.2

June 22, 2006 * Provisional Certification Page 2 of 2

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Certified Parameter List as of: 01 JUL 2006

M-MA022 **ANALYTICAL BALANCE CORP**
MIDDLEBOROUGH MA

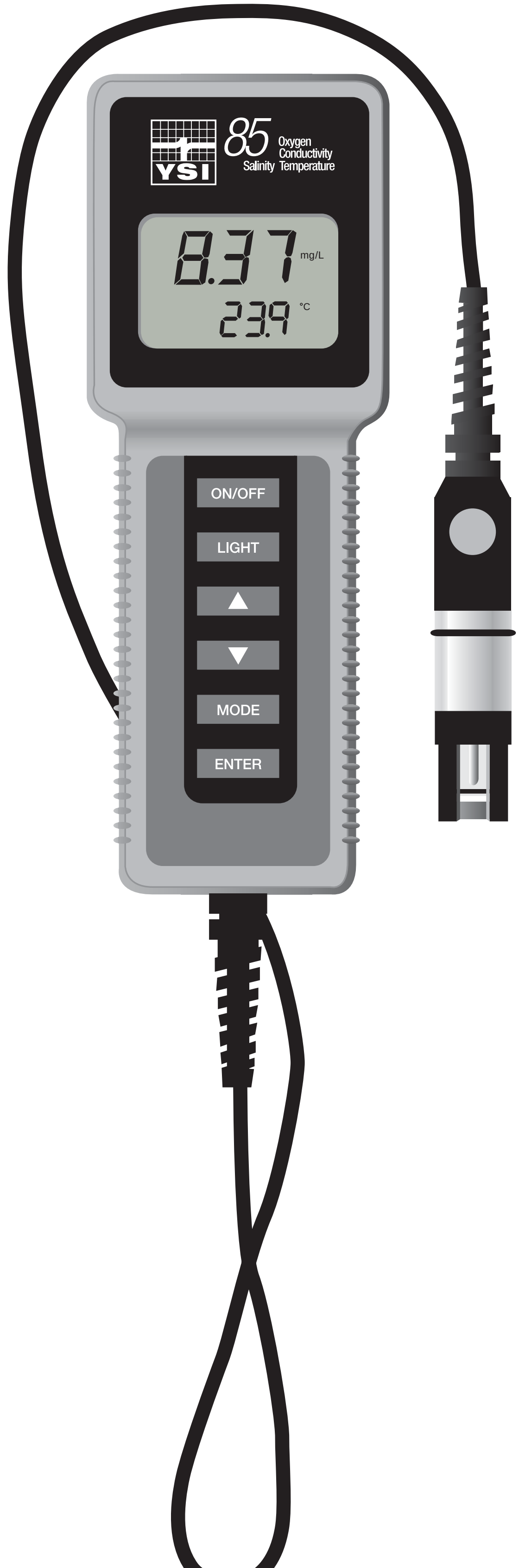
POTABLE WATER (MICROBIOLOGY)	Effective Date	01 JUL 2006	Expiration Date	30 JUN 2007

Analytes and Methods

HETEROTROPHIC PLATE COUNT	SM9215B
TOTAL COLIFORM	MF-SM9222B
TOTAL COLIFORM	ENZ. SUB. SM9223
FECAL COLIFORM	MF-SM9222D
E. COLI	EC-MUG-SM9221F
E. COLI	ENZ. SUB. SM9223

June 22, 2006 * Provisional Certification Page 1 of 1

YSI *incorporated*



YSI Model 85

Handheld Oxygen, Conductivity, Salinity, and Temperature System

Operations Manual

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SECTION 1 INTRODUCTION

The YSI Model 85 Handheld Dissolved Oxygen, Conductivity, Salinity and Temperature System is a rugged, micro-processor based, digital meter with an attached YSI combination conductivity and dissolved oxygen probe.

The YSI Model 85 is designed for use in field, lab, and process control applications as well as for environmental, aquaculture, and industrial uses. The Model 85 is available with cable lengths of either 10, 25, 50 or 100 feet. The body of the probe has been manufactured with stainless steel to add rugged durability and sinking weight. The probe also utilizes our easy to install cap membranes for measuring dissolved oxygen.

The YSI Model 85 probe is a non-detachable, combination sensor designed specifically for the YSI Model 85 Handheld System. The conductivity portion is a four-electrode cell with a cell constant of 5.0/cm ±4%. The dissolved oxygen portion is a polargraphic Clark type sensor.

The Model 85's microprocessor allows the system to be easily calibrated for dissolved oxygen or conductivity with the press of a few buttons. Additionally, the microprocessor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the conductivity cell constant and function of the instrument circuitry.
The system simultaneously displays temperature (in °C), along with one of the following parameters: dissolved oxygen in either mg/L (milligrams per liter) or % air saturation; conductivity; temperature compensated conductivity; (in µS/cm or mS/cm), and salinity (in parts per thousand {ppt}).

The system requires only a single calibration regardless of which dissolved oxygen display you use. The calibration of conductivity is not required but is available. A single calibration will adjust the instrument, regardless if you are reading conductivity or temperature compensated conductivity. You can switch between all of these parameters with the push of a single key.

A calibration\storage chamber is built into the instrument case. A small sponge in the chamber can be moistened to provide a water saturated air environment that is ideal for air calibration of the dissolved oxygen probe. This chamber also provides a convenient place to store the probe when the system is not in use, and provides protection for the electrodes within the conductivity probe. The Model 85 case is also waterproof (rated to IP65). You can operate your Model 85 in the rain without damage to the instrument.

Six AA-size alkaline batteries power the instrument. A new set of alkaline batteries will provide approximately 100 hours of continuous operation. When batteries need to be replaced, the LCD will display a **"LO BAT"** message.

SECTION 2 PREPARING THE METER

2.1 UNPACKING

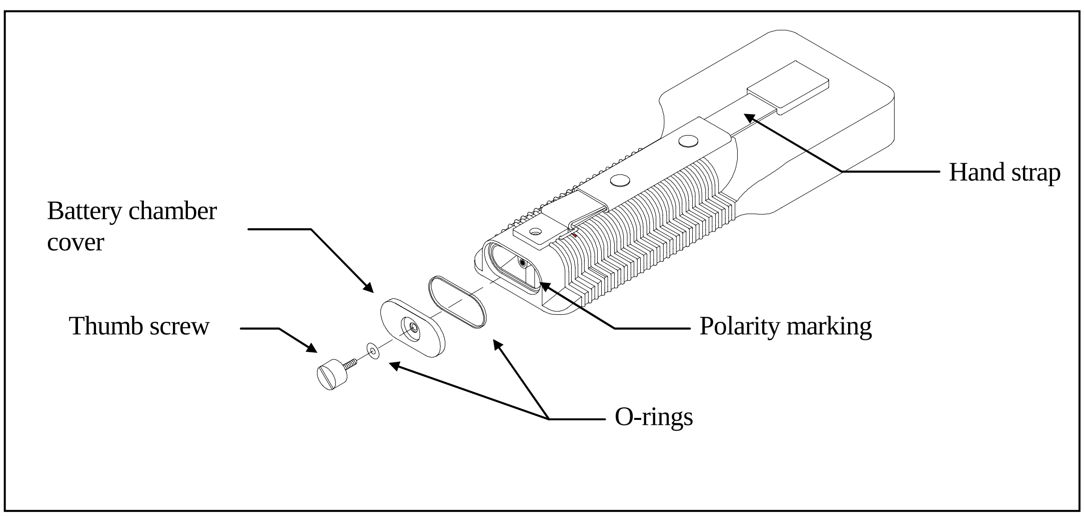
When you unpack your new YSI Model 85 Handheld Dissolved Oxygen, Conductivity, Salinity and Temperature System for the first time, check the packing list to make sure you have received everything you should have. If there is anything missing or damaged, call the dealer from whom you purchased the Model 85. If you do not know which of our authorized dealers sold the system to you, call YSI Customer Service at 800-765-4974 or 937-767-7241, and we'll be happy to help you.

2.2 WARRANTY CARD

Before you do anything else, please complete the Warranty Card and return it to YSI. This will record your purchase of this quality instrument in our computer system. Once your purchase is recorded, you will receive prompt, efficient service in the event any part of your YSI Model 85 should ever need repair and we will be able to quickly verify the warranty period.

2.3 BATTERIES

There are a few things you must do to prepare your YSI Model 85 for use. First, locate the six AA-size alkaline batteries that were included in your purchase. Use a screwdriver or a small coin to remove the thumbscrew on the bottom of the instrument. This thumbscrew holds the battery-chamber cover in place. The battery-chamber cover is marked with the words "OPEN" and "CLOSE."



NOTE: On some models, the battery cover thumbscrew may be unscrewed by hand (a screwdriver may not be required).

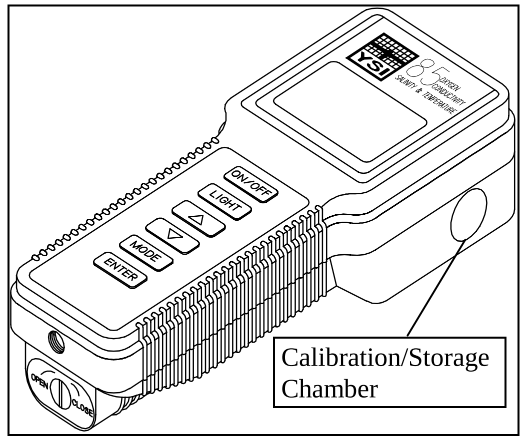
There is a small label inside each of the two battery-chamber sleeves. These labels illustrate the correct way to install the batteries into each sleeve of the battery-chamber.

NOTE: It is very important that the batteries be installed ONLY as illustrated. The instrument will not function and may be damaged if the batteries are installed incorrectly.

Turn the instrument on by pressing and releasing the **ON/OFF** button on the front of the instrument. The liquid crystal display (LCD) should come on. Allow a few seconds for the instrument to complete its diagnostic routine. Notice that the instrument will display the specific cell constant of the conductivity probe during this diagnostic routine. If the instrument does not operate, consult the section entitled Troubleshooting.

You may also want to take the instrument into a dark room and with the instrument ON, hold down the **LIGHT** button. The instrument backlight should illuminate the LCD so that the display can be easily read.

2.4 CALIBRATION/STORAGE CHAMBER



The Model 85 has a convenient calibration storage chamber built into the instruments' side. This chamber provides an ideal storage area for the probe during transport and extended non-use. If you look into the chamber you should notice a small round sponge in the bottom of the chamber. Carefully put 3 to 6 drops of clean water into the sponge. Turn the instrument over and allow any excess water to drain out of the chamber. The wet sponge creates a 100% water saturated air environment for the probe, which is ideal for dissolved oxygen calibration.

2.5 HAND STRAP

The hand strap is designed to allow comfortable operation of the Model 85 with minimum effort. If the hand strap is adjusted correctly, it is unlikely that the instrument will be easily dropped or bumped from your hand. See figure on previous page.

To adjust the hand strap on the back of the meter, unsnap the vinyl cover and pull the two Velcro strips apart. Place your hand between the meter and the strap and adjust the strap length so that your hand is snugly held in place. Press the two Velcro strips back together and snap the vinyl cover back into place.

2.6 THE METER CASE

The meter case is sealed at the factory and is not intended to be opened, except by authorized service technicians. Do not attempt to separate the two halves of the meter case as this may damage the instrument, break the waterproof seal, and will void the manufacturer's warranty.

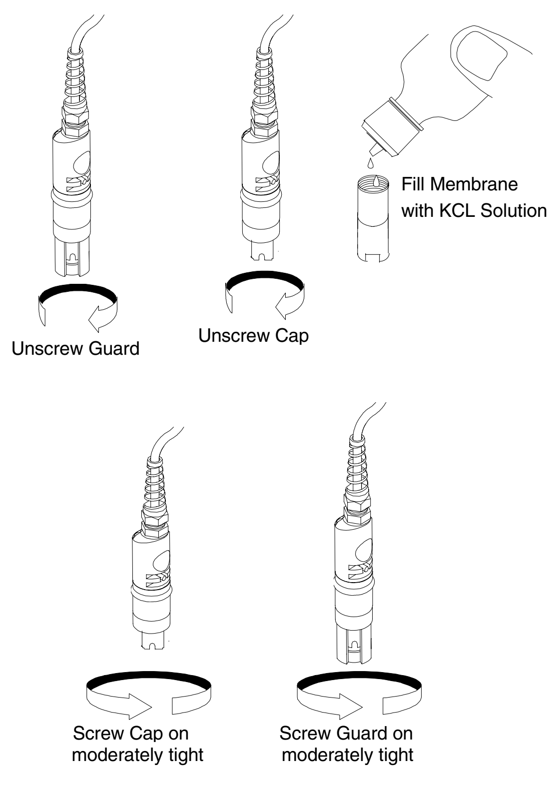
SECTION 3 PREPARING THE PROBE

The YSI Model 85 dissolved oxygen probe is shipped dry. The protective membrane cap on the probe tip must be removed and replaced with KCl solution and a new membrane cap before using the probe. Follow the instructions below to install KCl solution and the new membrane cap.

3.1 MEMBRANE CAP INSTALLATION

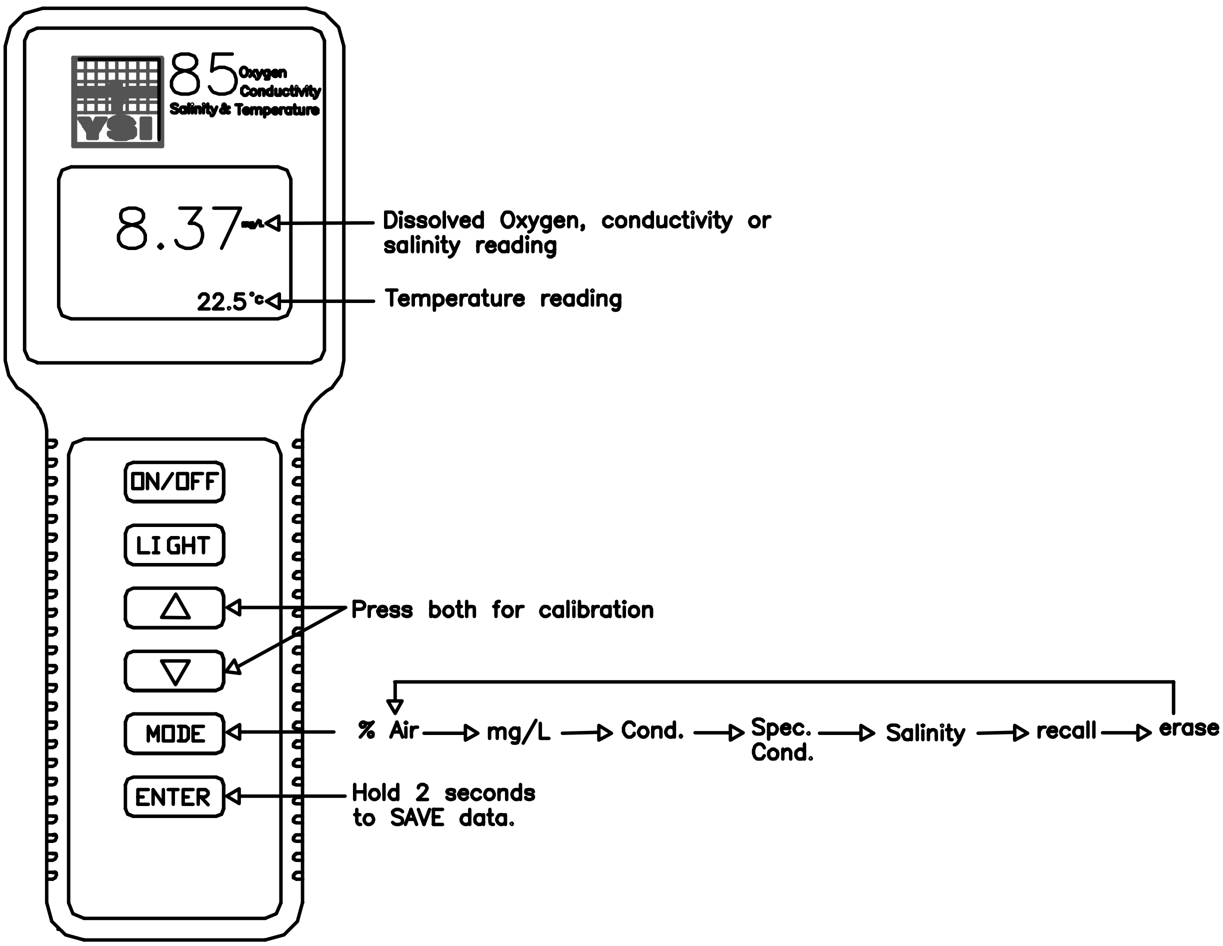
To install a new membrane on your YSI Model 85 dissolved oxygen probe:

1. Unscrew and remove the probe sensor guard.
2. Unscrew and remove the old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water.
4. Prepare the electrolyte according to the directions on the KCl solution bottle.
5. Hold the membrane cap and fill it at least 1/2 full with the electrolyte solution.
6. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.
7. Screw the probe sensor guard on moderately tight.



SECTION 4 OVERVIEW OF OPERATION

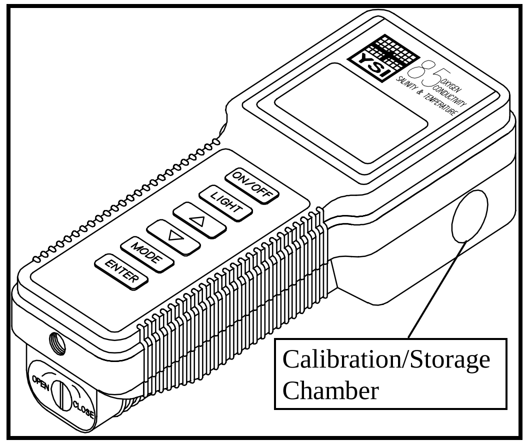
The following diagram is an overview of the operation of the Model 85. See the following sections for details of operation.



SECTION 5 CALIBRATION

5.1 CALIBRATION OF DISSOLVED OXYGEN

To accurately calibrate the YSI Model 85 you will need to know the approximate altitude of the region in which you are located.



1. Ensure that the sponge inside the instrument's calibration chamber is wet. Insert the probe into the calibration chamber.

2. Turn the instrument on by pressing the **ON/OFF** button on the front of the instrument. Press the **MODE** button until dissolved oxygen is displayed in mg/L or %. Wait for the dissolved oxygen and temperature readings to stabilize (usually 15 minutes is required).

3. Use two fingers to press and release both the **UP ARROW** and **DOWN ARROW** buttons at the same time.

4. The LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude. When the proper altitude appears on the LCD, press the **ENTER** button once.

EXAMPLE: Entering the number 12 here indicates 1200 feet.

5. The Model 85 should now display **CAL** in the lower left of the display, the calibration value should be displayed in the lower right of the display and the current % reading (before calibration) should be on the main display. Make sure that the current % reading (large display) is stable, then press the **ENTER** button. The display should read **SAVE** then should return to the Normal Operation Mode.

Each time the Model 85 is turned off, it may be necessary to re-calibrate before taking measurements. All calibrations should be completed at a temperature which is as close as possible to the sample temperature. Dissolved oxygen readings are only as good as the calibration.

5.2 CALIBRATION OF CONDUCTIVITY

IMPORTANT: System calibration is rarely required because of the factory calibration of the YSI Model 85. However, from time to time it is wise to check the system calibration and make adjustments when necessary.

Prior to calibration of the YSI Model 85, it is important to remember the following:

1. Always use clean, properly stored, NIST traceable calibration solutions (see Accessories and Replacement Parts). When filling a calibration container prior to performing the calibration procedures, make certain that the level of calibrant buffers is high enough in the container to cover the entire probe. Gently agitate the probe to remove any bubbles in the conductivity cell.
2. Rinse the probe with distilled water (and wipe dry) between changes of calibration solutions.
3. During calibration, allow the probe time to stabilize with regard to temperature (approximately 60 seconds) before proceeding with the calibration process. The readings after calibration are only as good as the calibration itself.
4. Perform sensor calibration at a temperature as close to 25°C as possible. This will minimize any temperature compensation error.

Follow these steps to perform an accurate calibration of the YSI Model 85:

1. Turn the instrument on and allow it to complete its self-test procedure.
2. Select a calibration solution that is most similar to the sample you will be measuring.
    - For sea water choose a 50 mS/cm conductivity standard (YSI Catalog# 3169)
    - For fresh water choose a 1 mS/cm conductivity standard (YSI Catalog# 3167)
    - For brackish water choose a 10 mS/cm conductivity standard (YSI Catalog # 3168)
3. Place at least 3 inches of solution in a clean glass beaker.
4. Use the **MODE** button to advance the instrument to display conductivity.
5. Insert the probe into the beaker deep enough so that the oval-shaped hole on the side of the probe is completely covered. Do not rest the probe on the bottom of the container -- suspend it above the bottom at least 1/4 inch.
6. Allow at least 60 seconds for the temperature reading to become stable.
7. Move the probe vigorously from side to side to dislodge any air bubbles from the electrodes.
8. Press and release the **UP ARROW** and **DOWN ARROW** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display to indicate that the instrument is now in Calibration mode.

9. Use the **UP ARROW** or **DOWN ARROW** button to adjust the reading on the display until it matches the value of the calibration solution you are using.
10. Once the display reads the exact value of the calibration solution being used (the instrument will make the appropriate compensation for temperature variation from 25°C), press the **ENTER** button once. The word “**SAVE”** will flash across the display for a second indicating that the calibration has been accepted.

The YSI Model 85 is designed to retain its last conductivity calibration permanently. Therefore, there is no need to calibrate the instrument after battery changes or power down.

SECTION 6 ADVANCED CONDUCTIVITY SETUP

The default settings of the YSI Model 85 are appropriate for the vast majority of measurement applications. However, some measurement applications require very specific measurement criteria. For that reason, we have made the YSI Model 85 flexible to accommodate these "advanced users."

If, for example, you are using the YSI Model 85 for a process control application that requires that the conductivity readings be compensated to 20 ^{o}C instead of 25 ^{o}C -- this is the section to read. Or, if your application for the YSI Model 85 involves the measurement of a very specific saline solution, the default temperature coefficient may need to be changed to get the very best measurement of that specific salt.

IMPORTANT: There is never a need to enter Advanced Setup Mode unless your special measurement application calls for a change in reference temperature and or temperature coefficient. Therefore, unless you are certain that your application requires a change to one or both of these criteria, do not modify the default reference temperature (25^{o}C) or the default temperature coefficient (1.91%).

6.1 CHANGING THE TEMPERATURE COEFFICIENT

Follow these steps to modify the temperature coefficient of the Model 85.

1. Turn the instrument on and wait for it to complete its self-test procedure.
2. Use the **MODE** button to advance the instrument to display conductivity.
3. Press and release both the **DOWN ARROW** and the **MODE** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display. The large portion of the display will show **1.91 %** (or a value set previously using Advanced Setup).

4. Use the **UP ARROW** or **DOWN ARROW** button to change the value to the desired new temperature coefficient.
5. Press the **ENTER** button. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
6. Press the **MODE** button to return to normal operation; the CAL symbol will disappear from the display.

6.2 CHANGING THE REFERENCE TEMPERATURE

Follow these steps to modify the reference temperature of the Model 85.

1. Turn the instrument on and wait for it to complete its self-test procedure.
2. Use the **MODE** button to advance the instrument to display conductivity.
3. Press and release both the **DOWN ARROW** and the **MODE** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display. The large portion of the display will show **1.91 %** (or a value set previously using Advanced Setup).

4. Press and release the **MODE** button; the large portion of the display will show **25.0C** (or a value set previously using Advanced Setup).
5. Use the **UP ARROW** or **DOWN ARROW** button to change the value to the desired new reference temperature (any value between 15 °C and 25 °C is acceptable).
6. Press the **ENTER** button. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
7. The instrument will automatically return to normal operation mode.

6.3 CHANGING FROM AUTORANGING TO MANUAL RANGING

If your application is easier to perform using a manual range that you select, the YSI Model 85 allows you to turn off the default autoranging feature. While you are making conductivity or temperature compensated conductivity measurements, simply press and release the **UP ARROW** button. Each additional press of the **UP ARROW** button will cycle the Model 85 to a different manual range until you return again to autoranging. Five pushes of the **UP ARROW** button will cycle the Model 85 through the four manual ranges and return the instrument to autoranging.

NOTE: You may see an error message in some manual ranges if the manual range selected is not adequate for the sample you are measuring. If this happens, simply press and release the **UP ARROW** button again until a range is selected which is suitable for your sample. If you get lost and don't know if you're in a manual range or autoranging, simply turn the instrument off and back on. Also note that the conductivity units will flash while you are in manual range. The instrument will always default to autoranging when first turned on.

The four ranges of the YSI Model 85 are:

Range 1	Range 2	Range 3	Range 4
0 to 499.9 µS/cm	0 to 4999 µS/cm	0 to 49.99 mS/cm	0 to 200.0 mS/cm

SECTION 7 MAKING MEASUREMENTS

7.1 TURNING THE INSTRUMENT ON

Once the batteries are installed correctly, press the **ON/OFF** button. The instrument will activate all segments of the display for a few seconds, which will be followed by a self-test procedure that will last for several more seconds. During this power on self-test sequence, the instrument's microprocessor is verifying that the instrument is working properly. The Model 85 will display the cell constant of the conductivity probe when the self-test is complete. If the instrument were to detect an internal problem, the display would show a **continuous** error message. See the section entitled Troubleshooting for a list of these error messages.

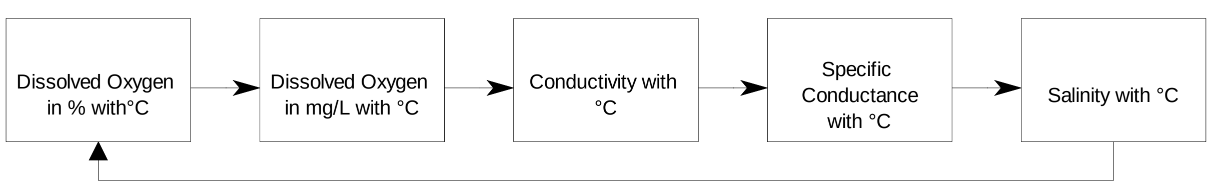
7.2 THE MEASUREMENT MODES OF THE MODEL 85

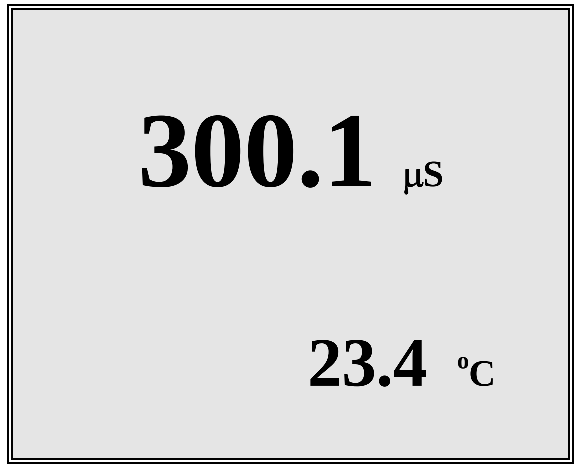
The Model 85 is designed to provide six distinct measurements:

- **Dissolved Oxygen %** -- A measurement of oxygen in percent of saturation.
- **Dissolved Oxygen mg/L** -- A measurement of oxygen in mg/L
- **Conductivity** -- A measurement of the conductive material in the liquid sample without regard to temperature
- **Specific Conductance** -- Also known as temperature compensated conductivity which automatically adjusts the reading to a calculated value which would have been read if the sample had been at 25^{o} C (or some other reference temperature which you choose). See Advanced Setup.
- **Temperature** -- which is always displayed.
- **Salinity** -- A calculation done by the instrument electronics, based upon the conductivity and temperature readings.

NOTE: When you turn the Model 85 off, it will "remember" which mode you used last and will return to that mode the next time the instrument is turned on.

To choose one of the measurement modes above (temperature is always displayed) simply press and release the **MODE** button. Carefully observe the small legends at the far right side of the LCD.





If the instrument is reading **Specific Conductance** the large numbers on the display will be followed by either a **µS** or an **mS.** Additionally the small portion of the display will show the **^{o} C** flashing on and off.

If the instrument is reading **Conductivity** (not temperature compensated) the large numbers on the display will be followed by either a **µS** or an **mS.** Additionally the small portion of the display will show the **^{o} C** **NOT** flashing.

If the instrument is reading **Dissolved Oxygen** the large numbers on the display will be followed by either a mg/L or %. It is important to remember that the dissolved oxygen probe is stirring dependent. This is due to the consumption of oxygen at the sensor tip during measurement. When taking dissolved oxygen measurements the probe must be moved through the sample at a rate of 1 foot per second to provide adequate stirring.

If the instrument is reading **Salinity** the large numbers on the display will be followed by a **ppt.**

7.3 AUTORANGING & RANGE SEARCHING

The YSI Model 85 is an autoranging instrument. This means that regardless of the conductivity or salinity of the solution (within the specifications of the instrument) all you need to do to get the most accurate reading is to put the probe in the sample. This feature makes the Model 85 as simple as possible to operate.

When you first place the Model 85 probe into a sample or calibration solution, and again when you first remove the probe the instrument will go into a range search mode that may take as long as 5 seconds. During some range searches the instrument display will flash **rANG** to indicate its movement from one range to another. The length of the range search depends on the number of ranges that must be searched in order to find the correct range for the sample. During the range search, the instrument will appear to freeze on a given reading for a few seconds then, once the range is located, will pinpoint the exact reading on the display. The display may also switch to **00.0** for a second or two during a range search before it selects the proper range.

7.4 THE BACKLIGHT

At times it may be necessary to take measurements with the Model 85 in dark or poorly lit areas. To help in this situation, the Model 85 comes equipped with a backlight that will illuminate the display so that it can be easily read. To activate the backlight, press and hold the **LIGHT** button. The display will remain lit as long as the button is depressed. When you release it, the light goes out to preserve battery life.

SECTION 8 SAVING DATA

The Model 85 is equipped with non-volatile memory that is capable of storing up to 50 different sets of readings. Non-volatile means that you do not need to worry that your data will be lost due to a power failure or power interrupt. The Model 85 will also assign a site identity number to each set of readings to allow easy review of the data. This feature is useful in situations where transcribing data is difficult or not available.

8.1 SAVING DATA TO MEMORY

1. While any parameter is displayed on the screen depress the **ENTER** button and hold for approximately 2 seconds. The meter will flash **SAVE** on the display along with the current site identity being used.

2. When all 50 sites are full the display will flash **FULL** on the screen. This message will remain on the screen (even after power down) until a button is pushed.

Once you have acknowledged the memory is full, any subsequent saved data will begin overwriting existing data starting with site #1.

8.2 RECALLING STORED DATA

1. To put the Model 85 into the **RECALL** mode depress the **MODE** button repeatedly until **rcl** is displayed on the screen along with the site ID number in the lower right corner. (see figure #1)

2. Depress the **ENTER** button to review the last set of data that was saved. The Model 85 will display the dissolved oxygen in % saturation and temperature. Another press of the **ENTER** button will display the dissolved oxygen in mg/L and the temperature.

Depress the **ENTER** button again and again to review the conductivity, specific conductivity and salinity readings. All of which are displayed with the temperature.

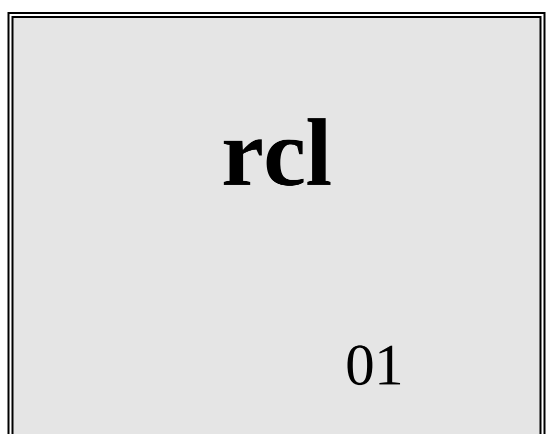


figure #1

3. Depress the **UP ARROW** button to increment through the saved sets of data.

4. Depress the **DOWN ARROW** button to decrement through the saved sets of data.

5. When the correct site ID# is displayed, press the **ENTER** button to display the data.

6. When you have finished recalling data, press the **MODE** button to return to normal operation.

NOTE: The Model 85 will recall data as a list. When the **UP ARROW** is depressed the Model 85 will display the Site ID# for the previously recorded date. For example: If you are reviewing Site ID# 5 and the **UP ARROW** is depressed the Model 85 will display Site ID# 4. If you are reviewing Site ID# 5 and Site ID# 5 was the last set of data stored the **DOWN ARROW** button will display Site ID# 1.

Here is an example of the Model 85 memory.
Site ID #1
Site ID #2
Site ID #3 ← If the **UP ARROW** button was pressed the Model 85 would display Site ID #2
Site ID #4
Site ID #5

8.3 ERASING STORED DATA

1. To erase the data that is stored into the Model 85's memory, depress the **MODE** button repeatedly until the Model 85 displays **ErAS** on the screen. (see figure #2)

2. Depress and hold the **DOWN ARROW** and **ENTER** buttons simultaneously for approximately 5 seconds.

3. The Model 85 flashing DONE on the display for 1 to 2 seconds indicates successful erasure. The instrument will automatically change to normal operation after completion.

IMPORTANT: Data in all 50 site ID's will be erased completely and will be lost forever. Do not use the erase function until all recorded data has been transcribed to an archive outside the Model 85.

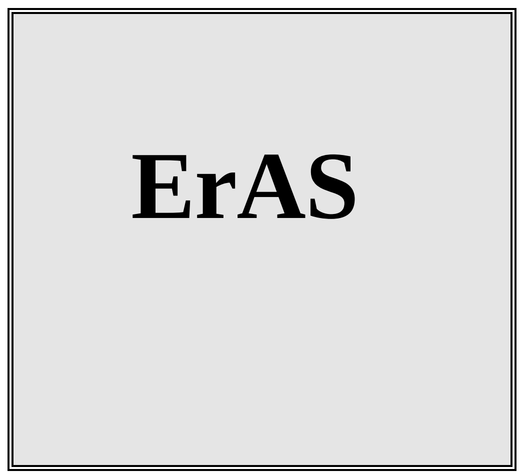


figure #2

SECTION 9 MAINTENANCE

9.1 CLEANING AND STORAGE

The single most important requirement for accurate and reproducible results in conductivity measurement is a clean cell. A dirty cell will change the conductivity of a solution by contaminating it.

NOTE: ALWAYS RINSE THE CONDUCTIVITY CELL WITH CLEAN WATER AFTER EACH USE.

To clean the conductivity cell:

1. Dip the cell in cleaning solution and agitate for two to three minutes. Any one of the foaming acid tile cleaners, such as Dow Chemical Bathroom Cleaner, will clean the cell adequately. When a stronger cleaning preparation is required, use a solution of 1:1 isopropyl alcohol and 1 N HCl. Remove the cell from the cleaning solution.

2. Use the nylon brush (supplied) to dislodge any contaminants from inside the electrode chamber.

3. Repeat steps one and two until the cell is completely clean. Rinse the cell thoroughly in deionized, or clean tap water.

4. Store the conductivity cell in the meter storage chamber.

NOTE: See Section 11, Dissolved Oxygen Probe Precautions for instructions on cleaning the dissolved oxygen electrodes.

SECTION 10 PRINCIPLES OF OPERATION

The dissolved oxygen sensor utilizes an oxygen permeable membrane that covers an electrolytic cell consisting of a gold cathode and a porous silver anode. This membrane acts as a diffusion barrier and an isolation barrier preventing fouling of the cathode surface by impurities in the environment. Upon entering the cell through the membrane, oxygen is reduced at an applied potential of -0.8 V referenced to the silver electrode. The reduction current at the cathode is directly proportional to the partial pressure of oxygen in liquid (expressed as %-air saturation) which is proportional to the concentration of dissolved oxygen (in mg/L) at a particular temperature. Thus the same partial pressure of oxygen (% air-saturation) in liquid gives different concentrations of dissolved oxygen (mg/L) at different temperatures because of the different solubility's of oxygen at different temperatures.

The conductivity cell utilizes four pure nickel electrodes for the measurement of solution conductance. Two of the electrodes are current driven, and two are used to measure the voltage drop. The measured voltage drop is then converted into a conductance value in milli-Siemens (millimhos). To convert this value to a conductivity (specific conductance) value in milli-Siemens per cm (mS/cm), the conductance is multiplied by the cell constant that has units of reciprocal cm (cm^{-1}). The cell constant for the Model 85 conductivity cell is 5.0/cm $\pm$ 4%. For most applications, the cell constant is automatically determined (or confirmed) with each deployment of the system when the calibration procedure is followed. Solutions with conductivity's of 1.00, 10.0, 50.0, and 100.0 mS/cm, which have been prepared in accordance with recommendation 56-1981 of the Organisation Internationale de Métrologie Légale (OIML) are available from YSI. The instrument output is in µS/cm or mS/cm for both conductivity and specific conductance. The multiplication of cell constant times conductance is carried out automatically by the software.

10.1 TEMPERATURE EFFECT ON CONDUCTIVITY

The conductivity of solutions of ionic species is highly dependent on temperature, varying as much as 3% for each change of one degree Celsius (temperature coefficient = 3%/C). In addition, the temperature coefficient itself varies with the nature of the ionic species present.

Because the exact composition of a natural media is usually not known, it is best to report a conductivity at a particular temperature, e.g. 20.2 mS/cm at 14 C. However, in many cases, it is also useful to compensate for the temperature dependence in order to determine at a glance if gross changes are occurring in the ionic content of the medium over time. For this reason, the Model 85 software also allows the user to output conductivity data in either raw or temperature compensated form. If "Conductivity" is selected, values of conductivity that are NOT compensated for temperature are output to the display. If "Specific Conductance" is selected, the Model 85 uses the temperature and raw conductivity values associated with each determination to generate a specific conductance value compensated to a user selected reference temperature (see Advanced Setup) between 15 C and 25 C. Additionally the user can select any temperature coefficient from 0% to 4% (see Advanced Setup). Using the Model 85 default reference temperature and temperature coefficient (25 C and 1.91%), the calculation is carried out as in equation (1) below:

$$\text{Specific Conductance } (25°C) = \frac{\text{Conductivity}}{1 + TC * (T - 25)}$$

As noted above, unless the solution being measured consists of pure KCl in water, this temperature compensated value will be somewhat inaccurate, but the equation with a value of TC = 0.0191 will provide a close approximation for solutions of many common salts such as NaCl and NH_4Cl and for seawater.

Salinity is determined automatically from the Model 85 conductivity readings according to algorithms found in Standard Methods for the Examination of Water and Wastewater (ed. 1989). The use of the Practical Salinity Scale 1978 results in values which are unitless, since the measurements are carried out in reference to the conductivity of standard seawater at 15 C. However, the unitless salinity values are very close to those determined by the previously-used method where the mass of dissolved salts in a given mass of water (parts per thousand) was reported. Hence, the designation "ppt" is reported by the instrument to provide a more conventional output. For further information on conductivity and the above standard information, refer to the ASTM document, Standard Methods of Test for Electrical Conductivity of Water and Industrial Wastewater, ASTM Designation D1125-82, and OIML Recommendation Number 56. ASTM symbols for conductivity, cell constant, and path length differ from those preferred in the general literature and also from those used in this manual.

SECTION 11 DISCUSSION OF MEASUREMENT ERRORS

11.1 DISSOLVED OXYGEN MEASUREMENT ERRORS

There are three basic types of error. Type 1 errors are related to limitations of instrument design and tolerances of instrument components. These are chiefly the meter linearity and the resistor tolerances. Type 2 errors are due to basic probe accuracy tolerances, chiefly background signal, probe linearity, and variations in membrane temperature coefficient. Type 3 errors are related to the operator's ability to determine the conditions at the time of calibration. If calibration is performed against more accurately known conditions, type 3 errors are appropriately reduced.

The sample calculations that follow are for a near extreme set of conditions.

TYPE 1 ERRORS

A. Meter linearity error: ±1% of full scale reading, or ±0.15 mg/l

B. Component and circuitry error: ±0.05 mg/l

TYPE 2 ERRORS

A. Temperature compensation for membrane temperature coefficient: ±0.03 mg/l

B. Temperature measurement errors: A maximum ±0.2°C probe error is equal to ±0.14 mg/l

TYPE 3 ERRORS

A. Altitude:

A 1000-foot change in altitude is equal to an error of approximately 3% at the 10 mg/l level.

B. Humidity:

Errors occur if calibration is performed at less than 100% humidity. The error varies with the temperature as follows:

TEMPERATURE	ERROR
0^oC	0.02 mg/l
10^oC	0.05 mg/l
20^oC	0.12 mg/l
30^oC	0.27 mg/l
40^oC	0.68 mg/l

APPROXIMATING THE ERROR

It is unlikely that the actual error in any measurement will be the maximum possible error. A better error approximation is obtained using a root mean squared (r.m.s.) calculation:

$$\text{r.m.s. error} = \pm[1a^2 + 1b^2 + 2a^2 + 2b^2 + 3a^2 + 3b^2]^{½} \text{ mg/l}$$

11.2 CONDUCTIVITY MEASUREMENT ERRORS

System accuracy for conductivity measurements is equal to the sum of the errors contributed by the environment and the various components of the measurement setup. These include:

- Instrument accuracy
- Cell-constant error
- Solution temperature offset
- Cell contamination (including air bubbles)
- Electrical noise
- Galvanic effects

Only the first three are of major concern for typical measurements, although the user should also be careful to see that cells are clean and maintained in good condition at all times.

Instrument Accuracy = ± .5% maximum
The accuracy specified for the range being used is the worst case instrument error.

Cell-Constant Error = ± .5% maximum
Although YSI cells are warranted to be accurate to within one percent, you should still determine the exact cell constant of your particular cell. Contamination or physical damage to the cell can alter the cell constant. Performing a calibration will eliminate any error that might arise because of cell constant change.

YSI cells are calibrated to within one percent of the stated cell constant at a single point. We consider these products to be usefully linear over most instrument ranges. The cell constant can be calibrated to ±0.35% accuracy with YSI conductivity calibrator solutions.

Temperature Error = ± 1% maximum
The solution temperature error is the product of the temperature coefficient and the temperature offset from 25 C, expressed as a percentage of the reading that would have been obtained at 25 C. The error is not necessarily a linear function of temperature. The statement of error is derived from a 25 C temperature offset and a 3%/ C temperature coefficient.

Total Error
Considering only the above three factors, system accuracy under worst case conditions will be ±2%, although the actual error will be considerably less if recommended and properly calibrated cells and instrument ranges are used. Additional errors, which can essentially be eliminated with proper handling, are described below.

Cell Contamination
This error is usually due to contamination of the solution being measured, which occurs when solution is carried-over from the last solution measured. Thus, the instrument might be correctly reporting the conductivity seen, but the reading does not accurately represent the value of the bulk

solution. Errors will be most serious when low conductivity solutions are contaminated by carry-over from high conductivity solutions, and can then be of an order of magnitude or more.

Follow the cleaning instructions carefully before attempting low conductivity measurements with a cell of unknown history or one that has been previously used in higher value solutions.

An entirely different form of contamination sometimes occurs due to a buildup of foreign material directly on cell electrodes. While rare, such deposits have, on occasion, markedly reduced the effectiveness of the electrodes. The result is an erroneously low conductance reading.

Electrical-Noise Errors
Electrical noise can be a problem in any measurement range, but will contribute the most error and be the most difficult to eliminate when operating in the lowest ranges. The noise may be either line-conducted or radiated or both, and may require, grounding, shielding, or both.

Galvanic and Miscellaneous Effects
In addition to the error sources described above, there is another class of contributors that can be ignored for all but the most meticulous of laboratory measurements. These errors are always small and are generally completely masked by the error budget for cell-constant calibration, instrument accuracy, etc. Examples range from parasitic reactance associated with the solution container and its proximity to external objects to the minor galvanic effects resulting from oxide formation or deposition on electrodes. Only trial and error in the actual measurement environment can be suggested as an approach to reduce such errors. If the reading does not change as the setup is adjusted, errors due to such factors can be considered too small to see.

11.3 DISSOLVED OXYGEN PROBE PRECAUTIONS

1. Membrane life depends on usage. Membranes will last a long time if installed properly and treated with care. Erratic readings are a result of loose, wrinkled, damaged, or fouled membranes, or from large (more than 1/8" diameter) bubbles in the electrolyte reservoir. If erratic readings or evidence of membrane damage occurs, you should replace the membrane and the KCl solution. The average replacement interval is two to four weeks.

2. If the membrane is coated with oxygen consuming (e.g. bacteria) or oxygen evolving organisms (e.g. algae), erroneous readings may occur.

3. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the probe. If you suspect erroneous readings, it may be necessary to determine if these gases are the cause.

4. Avoid any environment that contains substances that may attack the probe materials. Some of these substances are concentrated acids, caustics, and strong solvents. The probe materials that come in contact with the sample include FEP Teflon, stainless steel, epoxy, polyetherimide and the polyurethane cable covering.

5. For correct probe operation, the gold cathode must always be bright. If it is tarnished (which can result from contact with certain gases) or plated with silver, the gold surface must be restored. To restore the cathode, you may either return the instrument to the factory or clean it using the YSI 5238 probe reconditioning kit. Never use chemicals or abrasives not supplied with this kit.

NOTE: Model 85 probes built before July, 1996 (serial numbers starting with 96F or lower), should be cleaned with the sanding disc mounted on a FLAT surface. Do NOT use the curved tool provided in the 5238 probe reconditioning kit on these probes.

6. It is also possible for the silver anode to become contaminated, which will prevent successful calibration. To clean the anode, remove the membrane and soak the probe overnight in 3% ammonium hydroxide. Next, rinse the sensor tip with deionized water, add new KCl solution, and install a new membrane. Turn the instrument on and allow the system to stabilize for at least 30 minutes. If, after several hours, you are still unable to calibrate, return the YSI Model 85 system to an authorized service center for service.

7. To keep the electrolyte from drying out, store the probe in the calibration chamber with the small piece of sponge.

SECTION 12 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	ACTION
1. Instrument will not turn on	A. Low battery voltage B. Batteries installed wrong C. Meter requires service	A. Replace batteries B. Check battery polarity. C. Return system for service
2. Instrument will not calibrate (Dissolved Oxygen)	A. Membrane is fouled or damaged B. Probe anode is fouled or dark C. Probe cathode is tarnished D. System requires service	A. Replace membrane & KCl B. Clean anode C. Clean cathode D. Return system for service
3. Instrument will not calibrate (Conductivity)	A. Cell is contaminated	A. See “Maintenance” Section
4. Instrument "locks up"	A. Instrument has rec'd a shock B. Batteries are low or damaged C. System requires service	A & B. Remove battery lid, wait 15 seconds for reset, replace lid. C. Return system for service
5. Instrument readings are inaccurate (Dissolved Oxygen)	A. Cal altitude is incorrect B. Probe not in 100% O_2 saturated air during Cal procedure C. Membrane fouled or damaged D. Probe anode is fouled or dark E. Probe cathode is tarnished F. System requires service	A. Recalibrate w/correct value B. Moisten sponge & place in Cal chamber w/ probe & Recal C. Replace membrane D. Clean anode E. Clean cathode F. Return system for service
6. Instrument readings are inaccurate (Conductivity)	A. Calibration is required B. Cell is contaminated C. Tempco is set incorrectly D. Reference temperature incorrect E. Readings are or are not temperature compensated.	A. See “Calibration” Section B. See “Maintenance” Section C. See “Advanced Setup” Section D. See “Advanced Setup” Section E. See “Making Measurements” Section
7..LCD displays "LO BAT" Main display flashes “off”	A. Batteries are low or damaged	A. Replace batteries
8. Main Display reads “OVEr” (Secondary display reads “ovr”) (Secondary display reads “udr”)	A. Conductivity reading is >200 mS B. Temperature reading is >65°C C. Temperature reading is <-5°C D. Salinity reading is >80 ppt E. User cell constant cal K is >5.25 F. DO temperature is >46°C G. DO % saturation is >200% H. DO concentration is >20 mg/L	In all cases, check calibration values and procedures; check advanced setup settings. If each of these are set correctly, return instrument for service.
9. Main display reads “Undr”	A. User cell constant cal K is <4.9 B. DO current too low to calibrate	A. Recalibrate instrument using known good conductivity standard. Follow cell cleaning procedure in the Maintenance section. B. Replace membrane, clean probe
10. Main display reads “rErr”	A. Reading exceeds user selected manual range.	A. Use the mode key to select a higher or lower manual range, or set system to autoranging.
11. Main display reads “PErr”	A. User cell constant cal K is 0.0 B. Incorrect sequence of keystrokes.	A. See “Advanced Setup” section. B. Refer to manual section for step by step instruction for the function you are attempting.

SYMPTOM	POSSIBLE CAUSE	ACTION
12. Main display reads “LErr”	A. In temperature compensated conductivity mode, temperature exceeds the values computed using user defined temperature coefficient and/or reference temperature. B. In cell constant cal mode, temperature exceeds the values computed using user defined temperature coefficient and/or reference temperature.	A. & B. Adjust user defined tempco or reference temperature. (pg. 10)
13. Main display reads “Err” (Secondary display reads “ra”)	A. System has failed its RAM test check procedure.	A. Turn instrument OFF and back ON again. B. Return the system for service (pg. 26)
14. Main display reads “Err” (Secondary display reads “ro”)	A. System has failed its ROM test check procedure.	A. Turn instrument OFF and back ON again. B. Return the system for service (pg. 26)
15. Secondary display reads “rEr”	A. Temperature jumper is set to °F and reading is >199.9°F but <203°F.	A. Return the system for service. (pg. 26)
16. Main display reads “FAIL” (Secondary display reads “eep”)	A. EEPROM has failed to respond in time.	A. Return the system for service. (pg. 26)
17. Readings on main display don’t change	A. Meter is in recall mode.	A. Press **MODE** button to return to Normal Operation (pg. 12)

SECTION 13 WARRANTY AND REPAIR

YSI Model 85 Handheld Meters are warranted for two years from date of purchase by the end user against defects in materials and workmanship. YSI Model 85 probes and cables are warranted for one year from date of purchase by the end user against defects in material and workmanship. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by (i) failure to install, operate or use the product in accordance with YSI's written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

AUTHORIZED U.S. SERVICE CENTERS

Please visit www.ysi.com or contact YSI Technical Support for the nearest authorized service center.

YSI Incorporated • Technical Support • Phone: +1 937 767-7241 • 800 897-4151 • Fax: 937 767-1058 • Email: environmental@ysi.com

CLEANING INSTRUCTIONS

NOTE: Before they can be serviced, equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected. Biological contamination is presumed for any instrument, probe, or other device that has been used with body fluids or tissues, or with wastewater. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source.

If an instrument, probe, or other part is returned or presented for service without a Cleaning Certificate, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination, and certification has been completed. We will contact the sender for instructions as to the disposition of the equipment. Disposition costs will be the responsibility of the sender.

When service is required, either at the user's facility or at YSI, the following steps must be taken to insure the safety of our service personnel.

1. In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. 70% isopropyl alcohol or a solution of 1/4 cup bleach to 1-gallon tap water are suitable for most disinfecting. Instruments used with wastewater may be disinfected with .5% Lysol if this is more convenient to the user.
2. The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur.
3. If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
4. Any product being returned to the YSI Repair Center, should be packed securely to prevent damage.
5. Cleaning must be completed and certified on any product before returning it to YSI.

PACKING INSTRUCTIONS

1. Clean and decontaminate items to insure the safety of the handler.
2. Complete and include the Cleaning Certificate.
3. Place the product in a plastic bag to keep out dirt and packing material.
4. Use a large carton, preferably the original, and surround the product completely with packing material.
5. Insure for the replacement value of the product.

Cleaning Certificate

Organization ________________________________

Department ____

Address ____

City _______________ State _ Zip _______________

Country __________________ Phone ___________________

Model No. of Device _ Lot Number ______________

Contaminant (if known) _______________________________

Cleaning Agent(s) used _______________________________

Radioactive Decontamination Certified?

(Answer only if there has been radioactive exposure)

_____ Yes _____ No

Cleaning Certified By _________________________________

Name Date

SECTION 14 ACCESSORIES AND REPLACEMENT PARTS

The following parts and accessories are available from YSI or any Franchise Dealer authorized by YSI.

YSI ORDER NUMBER	DESCRIPTION
YSI 5906	Replacement Membrane Cap Kit (6 each)
YSI 5238	Probe Reconditioning Kit
YSI 3161	Conductivity Calibration Solution 1,000 μ/cm (1 Quart)
YSI 3163	Conductivity Calibration Solution 10,000 μ/cm (1 Quart)
YSI 3165	Conductivity Calibration Solution 100,000 μ/cm (1 Quart)
YSI 3167	Conductivity Calibration Solution 1,000 μ/cm (8 pints)
YSI 3168	Conductivity Calibration Solution 10,000 μ/cm (8 pints)
YSI 3169	Conductivity Calibration Solution 50,000 μ/cm (8 pints)
YSI 5520	Carrying Case
YSI 118510	Replacement Probe & Cable Assembly (10 feet)
YSI 118522	Replacement Probe & Cable Assembly (25 feet)
YSI 118527	Replacement Probe & Cable Assembly (50 feet)
YSI 118519	Replacement Probe and Cable Assembly (100 feet)
YSI 038501	Replacement Front Case Cover
YSI 055242	Replacement Rear Case Cover
YSI 055244	Replacement Battery Cover Kit
YSI 055204	Replacement Case Gasket and Screw
YSI 055219	Storage Chamber Sponge
YSI 030156	Main Board Assembly
YSI 038213	Replacement Electrode Cleaning Brush

APPENDIX A SPECIFICATIONS

Operating Environment

Medium: fresh, sea, or polluted water and most other liquid solutions.
Temperature: -5 to +65 °C
Depth: 0 to 10, 0 to 25, 0 to 50, or 0 to 100 feet (depending on cable length)

Storage Temperature: -10 to +50 °C

Material: ABS, Stainless Steel, and other materials

Dimensions:

Height:	9.5 inches	(24.13 cm)
Thickness:	2.2 inches	(5.6 cm)
Width:	3.5 inches max.	(8.89 cm)
Weight:	1.7 pounds (w/ 10’ cable)	(.77 kg)
Display:	2.3”W x 1.5”L	(5.8cm W x 3.8cm L)

Power: 9 VDC -6 AA-size Alkaline Batteries (included)
Approximately 100 hours operation from each new set of batteries

Water Tightness: Meets or exceeds IP65 standards

Extensive testing of the YSI Model 85 indicates the following typical performance:

Measurement	Range	Resolution	Accuracy
Conductivity	0 to 499.9 µS/cm	0.1 µS/cm	± .5% FS
	0 to 4999 µS/cm	1.0 µS/cm	± .5% FS
	0 to 49.99 mS/cm	.01 mS/cm	± .5% FS
	0 to 200.0 mS/cm	0.1 mS/cm	± .5% FS
Salinity	0 to 80 ppt	.1 ppt	± 2%, or ± 0.1 ppt
Temperature	-5 to +65 °C	0.1 °C	± 0.1 °C (±1 lsd)
Dissolved Oxygen	0 to 200 % Air Sat.	0.1% Air Saturation	± 2% Air Saturation
	0 to 20 mg/L	0.01 mg/L	± 0.3 mg/L

Adjustable Conductivity Reference Temperature: 15°C to 25°C

Adjustable Temperature Compensation Factor for Conductivity: 0% to 4%

Temperature Compensation: Automatic

Range: Autoranging for Dissolved Oxygen

User selected or Autoranging for Conductivity

APPENDIX B - TEMPERATURE CORRECTION DATA

Temperature Correction Data for Typical Solutions

A. Potassium Chloride** (KCl)

Concentration: 1 mole/liter		
C	mS/cm	%/ C (to 25 C)
0	65.10	1.67
5	73.89	1.70
10	82.97	1.72
15	92.33	1.75
20	101.97	1.77
25	111.90	1.80

Concentration: 1 x 10^{-1} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	7.13	1.78
5	8.22	1.80
10	9.34	1.83
15	10.48	1.85
20	11.65	1.88
25	12.86	1.90
30	14.10	1.93
35	15.38	1.96
37.5	16.04	1.98
40	16.70	1.99
45	18.05	2.02
50	19.43	2.04

Concentration: 1 x 10^{-2} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.773	1.81
5	0.892	1.84
10	1.015	1.87
15	1.143	1.90
20	1.275	1.93
25	1.412	1.96
30	1.553	1.99
35	1.697	2.02
37.5	1.771	2.03
40	1.845	2.05
45	1.997	2.07
50	2.151	2.09

Concentration: 1 x 10^{-3} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.080	1.84
5	0.092	1.88
10	0.105	1.92
15	0.119	1.96
20	0.133	1.99
25	0.147	2.02
30	0.162	2.05
35	0.178	2.07
37.5	0.186	2.08
40	0.194	2.09
45	0.210	2.11
50	0.226	2.13

** Charts developed by interpolating data from International Critical Tables, Vol. 6, pp. 229-253, McGraw-Hill Book Co., NY.

B. Sodium Chloride* (NaCl)

Saturated solutions at all temperatures		
C	mS/cm	%/ C (to 25 C)
0	134.50	1.86
5	155.55	1.91
10	177.90	1.95
15	201.40	1.99
20	225.92	2.02
25	251.30	2.05
30	277.40	2.08

Concentration: 0.5 mole/liter		
C	mS/cm	%/ C (to 25 C)
0	25.90	1.78
5	29.64	1.82
10	33.61	1.86
15	37.79	1.90
20	42.14	1.93
25	46.65	1.96
30	51.28	1.99
35	56.01	2.01
37.5	58.40	2.02
40	60.81	2.02
45	65.65	2.04
50	70.50	2.05

Concentration: 1 x 10^{-1} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	5.77	1.83
5	6.65	1.88
10	7.58	1.92
15	8.57	1.96
20	9.60	1.99
25	10.66	2.02
30	11.75	2.04
35	12.86	2.06
37.5	13.42	2.07
40	13.99	2.08
45	15.14	2.10
50	16.30	2.12

Concentration: 1 x 10^{-2} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.632	1.87
5	0.731	1.92
10	0.836	1.97
15	0.948	2.01
20	1.064	2.05
25	1.186	2.09
30	1.312	2.12
35	1.442	2.16
37.5	1.508	2.17
40	1.575	2.19
45	1.711	2.21
50	1.850	2.24

Concentration: 1 x 10^{-3} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.066	1.88
5	0.076	1.93
10	0.087	1.98
15	0.099	2.02
20	0.111	2.07
25	0.124	2.11
30	0.137	2.15
35	0.151	2.19
37.5	0.158	2.20
40	0.165	2.22
45	0.180	2.25
50	0.195	2.29

* Charts developed by interpolating data from the CRC Handbook of Chemistry and Physics, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.

C. Lithium Chloride* (LiCl)

Concentration: 1 mole/liter		
C	mS/cm	%/ C (to 25 C)
0	39.85	1.82
5	46.01	1.85
10	52.42	1.89
15	59.07	1.92
20	65.97	1.95
25	73.10	1.98
30	80.47	2.02
35	88.08	2.05
37.5	91.97	2.07
40	95.92	2.08
45	103.99	2.11
50	112.30	2.15

Concentration: 1 x 10^{-1} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	5.07	1.87
5	5.98	1.85
10	6.87	1.85
15	7.75	1.85
20	8.62	1.85
25	9.50	1.86
30	10.40	1.88
35	11.31	1.91
37.5	11.78	1.92
40	12.26	1.94
45	13.26	1.98
50	14.30	2.02

Concentration: 1 x 10^{-2} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.567	1.88
5	0.659	1.92
10	0.755	1.96
15	0.856	2.00
20	0.961	2.04
25	1.070	2.08
30	1.183	2.12
35	1.301	2.16
37.5	1.362	2.18
40	1.423	2.20
45	1.549	2.24
50	1.680	2.28

Concentration: 1 x 10^{-3} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.059	1.93
5	0.068	2.03
10	0.078	2.12
15	0.089	2.19
20	0.101	2.25
25	0.114	2.28
30	0.127	2.31
35	0.140	2.32
37.5	0.147	2.32
40	0.154	2.31
45	0.166	2.29
50	0.178	2.25

D. Potassium Nitrate** (KNO_3)

Concentration: 1 x 10^{-1} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	6.68	1.78
5	7.71	1.79
10	8.75	1.81
15	9.81	1.83
20	10.90	1.85
25	12.01	1.87
30	13.15	1.90
35	14.32	1.92
37.5	14.92	1.94
40	15.52	1.95
45	16.75	1.97
50	18.00	2.00

Concentration: 1 x 10^{-2} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.756	1.77
5	0.868	1.80
10	0.984	1.83
15	1.105	1.86
20	1.229	1.88
25	1.357	1.90
30	1.488	1.93
35	1.622	1.95
37.5	1.690	1.96
40	1.759	1.97
45	1.898	1.99
50	2.040	2.01

* Charts developed by interpolating data from the CRC Handbook of Chemistry and Physics, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.
** Charts developed by interpolating data from International Critical Tables, Vol. 6, pp. 229-253, McGraw-Hill Book Co., NY.

E. Ammonium Chloride* (NH_4Cl)

Concentration: 1 mole/liter		
C	mS/cm	%/ C (to 25 C)
0	64.10	1.60
5	74.36	1.53
10	83.77	1.45
15	92.35	1.37
20	100.10	1.29
25	107.00	1.21

Concentration: 1 x 10^{-1} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	6.96	1.82
5	7.98	1.88
10	9.09	1.93
15	10.27	1.97
20	11.50	2.00
25	12.78	2.03
30	14.09	2.06
35	15.43	2.07
37.5	16.10	2.08
40	16.78	2.08
45	18.12	2.09
50	19.45	2.09

Concentration: 1 x 10^{-2} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.764	1.84
5	0.889	1.86
10	1.015	1.88
15	1.144	1.91
20	1.277	1.94
25	1.414	1.97
30	1.557	2.02
35	1.706	2.06
37.5	1.782	2.08
40	1.860	2.10
45	2.020	2.14
50	2.186	2.18

Concentration: 1 x 10^{-3} mole/liter		
C	mS/cm	%/ C (to 25 C)
0	0.078	1.88
5	0.092	1.90
10	0.105	1.91
15	0.119	1.93
20	0.133	1.95
25	0.148	1.98
30	0.162	2.01
35	0.178	2.04
37.5	0.186	2.06
40	0.194	2.07
45	0.210	2.11
50	0.227	2.15

* Charts developed by interpolating data from the CRC Handbook of Chemistry and Physics, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.

APPENDIX C REQUIRED NOTICE

The Federal Communications Commission defines this product as a computing device and requires the following notice:

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. There is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- re-orient the receiving antenna
- relocate the computer with respect to the receiver
- move the computer away from the receiver
- plug the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 0004-000-00345-4.

APPENDIX D CONVERSION CHART

TO CONVERT FROM	TO	EQUATION
Feet	Meters	Multiply by 0.3048
Meters	Feet	Multiply by 3.2808399
Degrees Celsius	Degrees Fahrenheit	$(9/5\ ^{o}C)+32$
Degrees Fahrenheit	Degrees Celsius	$5/9\ (^{o}F-32)$
Milligrams per liter (mg/l)	Parts per million (ppm)	Multiply by 1

APPENDIX E OXYGEN SOLUBILITY TABLE

Table A: Solubility of Oxygen in mg/l in Water Exposed to Water-Saturated Air at 760 mm Hg Pressure.
Salinity = Measure of quantity of dissolved salts in water.
Chlorinity = Measure of chloride content, by mass, of water.
$S(^0/_{00}) = 1.80655 \times \text{Chlorinity} (^0/_{00})$

Temp °C	**Chlorinity:0 Salinity:0**	**5.0 ppt 9.0 ppt**	**10.0 ppt 18.1 ppt**	**15.0 ppt 27.1 ppt**	**20.0 ppt 36.1 ppt**	**25.0 ppt 45.2 ppt**
0.0	14.62	13.73	12.89	12.10	11.36	10.66
1.0	14.22	13.36	12.55	11.78	11.07	10.39
2.0	13.83	13.00	12.22	11.48	10.79	10.14
3.0	13.46	12.66	11.91	11.20	10.53	9.90
4.0	13.11	12.34	11.61	10.92	10.27	9.66
5.0	12.77	12.02	11.32	10.66	10.03	9.44
6.0	12.45	11.73	11.05	10.40	9.80	9.23
7.0	12.14	11.44	10.78	10.16	9.58	9.02
8.0	11.84	11.17	10.53	9.93	9.36	8.83
9.0	11.56	10.91	10.29	9.71	9.16	8.64
10.0	11.29	10.66	10.06	9.49	8.96	8.45
11.0	11.03	10.42	9.84	9.29	8.77	8.28
12.0	10.78	10.18	9.62	9.09	8.59	8.11
13.0	10.54	9.96	9.42	8.90	8.41	7.95
14.0	10.31	9.75	9.22	8.72	8.24	7.79
15.0	10.08	9.54	9.03	8.54	8.08	7.64
16.0	9.87	9.34	8.84	8.37	7.92	7.50
17.0	9.67	9.15	8.67	8.21	7.77	7.36
18.0	9.47	8.97	8.50	8.05	7.62	7.22
19.0	9.28	8.79	8.33	7.90	7.48	7.09
20.0	9.09	8.62	8.17	7.75	7.35	6.96
21.0	8.92	8.46	8.02	7.61	7.21	6.84
22.0	8.74	8.30	7.87	7.47	7.09	6.72
23.0	8.58	8.14	7.73	7.34	6.96	6.61

Temp °C	**Chlorinity:0 Salinity:0**	**5.0 ppt 9.0 ppt**	**10.0 ppt 18.1 ppt**	**15.0 ppt 27.1 ppt**	**20.0 ppt 36.1 ppt**	**25.0 ppt 45.2 ppt**
24.0	8.42	7.99	7.59	7.21	6.84	6.50
25.0	8.26	7.85	7.46	7.08	6.72	6.39
26.0	8.11	7.71	7.33	6.96	6.62	6.28
27.0	7.97	7.58	7.20	6.85	6.51	6.18
28.0	7.83	7.44	7.08	6.73	6.40	6.09
29.0	7.69	7.32	6.96	6.62	6.30	5.99
30.0	7.56	7.19	6.85	6.51	6.20	5.90
31.0	7.43	7.07	6.73	6.41	6.10	5.81
32.0	7.31	6.96	6.62	6.31	6.01	5.72
33.0	7.18	6.84	6.52	6.21	5.91	5.63
34.0	7.07	6.73	6.42	6.11	5.82	5.55
35.0	6.95	6.62	6.31	6.02	5.73	5.46
36.0	6.84	3.52	6.22	5.93	5.65	5.38
37.0	6.73	6.42	6.12	5.84	5.56	5.31
38.0	6.62	6.32	6.03	5.75	5.48	5.23
39.0	6.52	6.22	5.98	5.66	5.40	5.15
40.0	6.41	6.12	5.84	5.58	5.32	5.08
41.0	6.31	6.03	5.75	5.49	5.24	5.01
42.0	6.21	5.93	5.67	5.41	5.17	4.93
43.0	6.12	5.84	5.58	5.33	5.09	4.86
44.0	6.02	5.75	5.50	5.25	5.02	4.79
45.0	5.93	5.67	5.41	5.17	4.94	4.72

* This table is provided for your information only. It is **NOT** required when calibrating the Model 85 in accordance with the instructions outlined in the section entitled Calibration.

APPENDIX F   CALIBRATION VALUES TABLE

Table A: Calibration values for various atmospheric pressures and altitudes.
Note: This table is for your information only. It is not required for calibration.

Pressure Inches of Hg	Pressure mm Hg	Pressure kPA	Altitude in feet	Altitude in meters	Calibration Value in %
30.23	768	102.3	-276	-84	101
29.92	760	101.3	0	0	100
29.61	752	100.3	278	85	99
29.33	745	99.3	558	170	98
29.02	737	98.3	841	256	97
28.74	730	97.3	1126	343	96
28.43	722	96.3	1413	431	95
28.11	714	95.2	1703	519	94
27.83	707	94.2	1995	608	93
27.52	699	93.2	2290	698	92
27.24	692	92.2	2587	789	91
26.93	684	91.2	2887	880	90
26.61	676	90.2	3190	972	89
26.34	669	89.2	3496	1066	88
26.02	661	88.2	3804	1160	87
25.75	654	87.1	4115	1254	86
25.43	646	86.1	4430	1350	85
25.12	638	85.1	4747	1447	84
24.84	631	84.1	5067	1544	83
24.53	623	83.1	5391	1643	82
24.25	616	82.1	5717	1743	81
23.94	608	81.1	6047	1843	80
23.62	600	80.0	6381	1945	79
23.35	593	79.0	6717	2047	78
23.03	585	78.0	7058	2151	77
22.76	578	77.0	7401	2256	76
22.44	570	76.0	7749	2362	75
22.13	562	75.0	8100	2469	74
21.85	555	74.0	8455	2577	73
21.54	547	73.0	8815	2687	72
21.26	540	71.9	9178	2797	71
20.94	532	70.9	9545	2909	70
20.63	524	69.9	9917	3023	69
20.35	517	68.9	10293	3137	68

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November 1998

YSI Environmental

Operations Manual
YSI pH100

Portable pH, mV and Temperature Instrument

- **English**
- **Français**
- **Español**
- **Deutsch**
- **Italiano**

Pure Data for a Healthy Planet.®

WARRANTY

The YSI pH100 Instrument is warranted for one year from date of purchase by the end user against defects in materials and workmanship. YSI pH100 probes and cables are warranted for six months from date of purchase by the end user against defects in material and workmanship. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by: (i) failure to install, operate or use the product in accordance with YSI's written instructions; (ii) abuse or misuse of the product; (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure; (iv) any improper repairs to the product; (v) use by you of defective or improper components or parts in servicing or repairing the product; or (vi) modification of the product in any way not expressly authorized by YSI.

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GENERAL INTRODUCTION

The model pH100 is a precision tool that measures pH, mV and temperature. A built-in microprocessor stores, calculates and compensates for all parameters related to pH determinations including pH electrode temperature characteristics, electrode slope deviations and buffer solutions.

This unit has a splash-proof IP65 case. The mechanical touch keys are highly reliable with tactile and audio feedback. This meter uses one 9V battery. Re-calibration is not required when power is restored.

The front of the meter has a large LCD that displays pH or mV and temperature simultaneously along with user prompts and mode indicators. The unit prompts the user through calibration and measurement procedures.

An AUTOLOCK feature for both pH and mV measurements enables the unit to automatically sense the end point and "lock" the display to indicate the end point value of a measurement. The pH100 can also be used in non-AUTOLOCK mode. AUTOLOCK and user prompts help eliminate most errors in determining pH and mV values, resulting in precise, repeatable, error-free measurements.

The model pH100 is available with pH, mV, ORP and ATC (Automatic Temperature Compensation) probes. Other features include electrode offset recognition, electrode slope recognition, electrode efficiency display, built-in buffer coefficients, automatic or manual temperature compensation, long battery life, and 50/60 Hz AC noise rejection. This meter is universal, user-friendly, for field, industrial and laboratory applications.

INITIAL INSPECTION

Carefully unpack the unit and accessories, and inspect for shipping damages. Compare received parts with materials listed on the packing list. Notify YSI immediately of any damage or missing parts. Save all packing materials until satisfactory operation is confirmed.

SPLASH RESISTANCE

Though the pH100 meter is housed in a watertight case, DO NOT use it underwater. The splash-resistant case prevents permanent damage to the unit if accidentally dropped into non-corrosive solutions. Follow these steps immediately if the unit is immersed in any solution:

1. Rinse unit carefully with distilled water. After rinsing and drying, inspect and clean connectors to remove all contaminants that may affect probe connections.

2. Wait for the unit and probe to dry completely before resuming operation.

3. If the unit does not function correctly after steps 1 and 2, call YSI for possible repair or replacement (see Warranty).

BATTERY INSTALLATION

An initial display of “BAT” on the LCD indicates approximately one hour of battery life for unit operation within specifications. Replace battery when “BAT” appears on the LCD. (See Figure 1.)

To replace battery, remove the two battery cover screws and battery cover and o-ring. Replace the 9V battery. Replace battery cover and o-ring (align the o-ring properly to insure a good seal) and fasten the two battery cover screws for the splash-resistant feature.

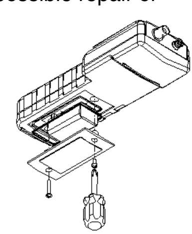

Figure 1.
Battery Installation

KEY FUNCTIONS OF THE MODEL pH100

1. **⏻:** Turns the unit ON or OFF. The pH calibration values are not erased when the unit is turned off. The unit powers up in the same status as when it was turned off. When the unit is not in use, turn it off to save battery life. For long term storage, remove the batteries.
2. **MODE:** Selects display mode. Press **MODE** to sequentially display pH-AUTOLOCK , mV-AUTOLOCK , pH, and mV. Calibration values are not affected by changing display mode.
3. **STAND** and **SLOPE Keys:** Used for dual-point pH calibration of the unit. Press and hold **STAND** while turning on the power to change buffer sets.
4. **Δ** and **∇ Keys:** Press to enter temperature values in manual (MAN) mode. These keys are inoperative when operating in ATC mode.
5. **MEA./EFF.:** Press to release the unit from AUTOLOCK status when operating in pH-AUTOLOCK or mV-AUTOLOCK mode. Press and hold for 5 seconds to display the electrode efficiency.
6. **ESC:** Press to clear the unit when an error signal appears; it clears all calibration values stored in internal memory. To prevent accidental clearing during normal use, the key does not respond unless pressed and held for 2 seconds. The key responds only when an error message displays.

   When **ESC** is pressed, all LCD elements light. After about 2 seconds, the unit enters pH-AUTOLOCK mode. “AUTOLOCK” displays and “STAND” begins to flash indicating the need for calibration. Press **ESC** only when errors occur that require unit re-calibration.

THE LCD DISPLAY

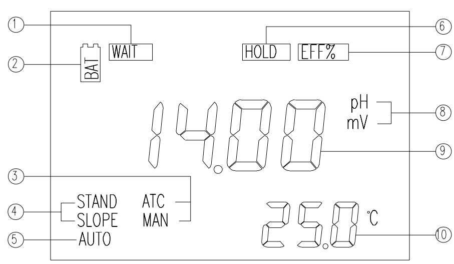

Figure 2. LCD Display

1. **WAIT:** Displays while unit waits for a stable reading or end point sensing.
2. **BAT:** Low battery indicator.
3. **ATC/MAN:** “ATC” displays if an ATC probe is connected. Otherwise, “MAN” displays.
4. **STAND/SLOPE:** “STAND” or “SLOPE” remains steady if the parameter has been calibrated. If either one has not been calibrated, it flashes.
5. **AUTO:** Autolock mode indicator.
6. **HOLD:** Indicates a reading is frozen during Autolock mode.
7. **EFF%:** Displays when the user views electrode efficiency. It is recommended to replace the electrode when efficiency is less than 75%.
8. **pH/mV :** Unit and mode indicators.
9. Main display for pH, mV and probe efficiency values.
10. **°C:** Temperature display.

OPERATIONAL PROCEDURES

Buffer Table Select

This unit has two buffer sets: 7.00,4.01,10.01pH and 6.86,4.00,9.18pH. To change the buffer set, turn off the unit, then press and hold **STAND** while turning on the power to change buffer sets. If the unit is uncalibrated and in pH mode, it displays “7.00” if the first set is active, and “6.86” if the second set is active.

pH Calibration

The pH100 uses a 2-point calibration. The first point must be a 6.86/7.00 buffer, and the second either a 4.00/4.01 or 9.18/10.01. These buffers can be purchased from a YSI representative.

1. Turn the unit on. Connect the pH electrode to the BNC connector and the ATC/Temp probe to the ATC/Temp connector of the unit; “ATC” displays. Press **MODE** until “pH” displays. Autolock may be on or off as desired.

2. **AUTOLOCK ON:** Place the pH and ATC/temp probes into the first buffer solution (either 7.00 or 6.98). Allow temperature readings to stabilize, then press “STAND” to calibrate. If **AUTOLOCK** is off, the first point has been calibrated. If **AUTOLOCK** is on, “WAIT” flashes until the unit detects a stable reading. Once the unit calibrates the first point, “STAND” displays steadily, and “SLOPE” flashes.

NOTE: If no temperature probe is connected, adjust the temperature reading to that of the first buffer using the ∆ or ∇ keys (0.0 to 60ºC) **BEFORE** pressing “STAND”.

3. Rinse the pH and ATC/temp probes in distilled water, then place into the second buffer solution (either 4.01/4.00 or 10.01/9.18). Allow temperature readings to stabilize, then press “SLOPE” to calibrate. If **AUTOLOCK** is off, the second point has been calibrated. If **AUTOLOCK** is on, “WAIT” flashes until the unit detects a stable reading. Once the unit calibrates the second point, both “STAND” and “SLOPE” display steadily.

NOTE: If no temperature probe is connected, adjust the temperature reading to that of the first buffer using the ∆ or ∇ keys (0.0 to 60ºC) **BEFORE** pressing “SLOPE”.

4. The unit calculates and compensates for the pH electrode slope deviation corresponding to the values of the two calibration buffers. The unit is now dual-point calibrated and ready for measurements. After calibration, press and hold **MEA. /EFF.** for about 5 seconds to display the new electrode efficiency.

Using the model pH160 Electrode Simulator

The model pH160 Electrode Simulator can be used to confirm proper instrument calibration. To use the simulator:

1. Install the 9V battery provided.

2. Attach the pH160 to the pH100. Turn both units on. The pH160 has a small switch to the right of the pH buttons.

3. In pH measurement mode, press one of the pH buffer simulator buttons on the pH160. The corresponding pH value should appear on both screens.

Note: Calibration with the pH simulator calibrates only the instrument - NOT the instrument and probe. For best accuracy, calibrate the pH instrument and probe together using buffer solutions.

pH Measurements

To take pH measurements, “STAND” and “SLOPE” must display steadily, indicating the unit is dual-point calibrated and ready for measurements. If “STAND” and “SLOPE” are blinking, perform a pH calibration before taking measurements.

1. Press **MODE** to enter pH mode with AUTOLOCK on or off as desired. For inherently unstable samples, the unit will not AUTOLOCK. Turn AUTOLOCK off in this case.

2. Rinse the pH electrode and/or ATC/temp probe with distilled water and immerse in the sample to be measured. Remove any air bubbles trapped around the probe by shaking or stirring the probe. Allow the pH and/or temperature to stabilize. If no ATC/temp probe is connected, “MAN” displays, indicating manual temperature compensation. Set unit to display the sample temperature by pressing the Δ and ∇ keys (-10.0 to 120°C). If an ATC/temp probe is connected “ATC” displays along with the sample temperature.

3. If AUTOLOCK is off, the pH value of the sample displays on the screen. If both pH and temperature readings are stable, take a reading. If AUTOLOCK is on, press **MEA./EFF.** “WAIT” flashes until the unit determines a stable pH reading.

Temperature Measurements

The model pH100 can measure temperature independently with the ATC/Temp probe without using the pH electrode. Place the ATC/Temp probe in the media to be measured. The measured temperature displays.

mV Measurements

1. Connect the optional combination mV electrode to the unit. Press **MODE** to enter mV mode with AUTOLOCK on or off as desired. For inherently unstable samples, the unit will not AUTOLOCK. Use mV mode with AUTOLOCK off in this case.

2. Rinse electrode with distilled water and immerse it in sample to be measured. If AUTOLOCK is off, the mV value of the sample will be displayed on the screen. If AUTOLOCK is on, press **MEA./EFF.** “WAIT” flashes until the unit determines a stable mV reading.

TROUBLESHOOTING

MAIN DISPLAY	POSSIBLE CAUSE	CORRECTIVE ACTION
Er 1	• pH electrode offset is greater/less than +/-1.5 pH. • **STAND** was pressed before the electrode and ATC/Temp probe settle to within ±1.5 pH of the buffer value. • pH electrode is faulty	• Replace the buffer and/or the pH electrode. Press **ESC.** • Allow sufficient time for the electrode and ATC/Temp probe to stabilize. • Return for service.
Er 2	• pH electrode slope is off by more than 30% of ideal slope. • **SLOPE** was pressed before the electrode and ATC/Temp probe settled to within 30% of the buffer value. • Buffer 4.00, 4.01, 9.18 or 10.01 is not correct.	• Check that the correct buffer is used and that the electrode slope is not off by more than 30% from the theoretical slope. • Allow sufficient time for the electrode and ATC/Temp probe to stabilize. • Replace the buffer and/or the pH electrode. Press **ESC**. • Return for service.
Er 3	• Temperature is out of the 0.0 to 60.0 °C range.	• Bring the buffer temperature within range. • Return for service.
OvEr/Undr	• Measured pH is out of the 16.00/-2.00 pH range. • Measured mV is out of the 1250/-2000 mV range. • Measured temperature is out of the -10/120 °C range.	• Bring the out of range unit into the correct measuring range. • If units are within proper range, return product for service.

SPECIFICATIONS

Display	Range	Accuracy	Resolution
pH	-2.00 to 16.00 pH	±0.1%, ±2 lsd	0.01 pH
mV	-1999 to 1250 mV	±0.1%, ±1 lsd	1 mV
Temperature °C	-10.0 to 120 °C	±0.5 °C	0.1 °C

pH Temp Compensation	AUTO/MANual -10.0 to 120.0 °C
pH Buffer Recognition	(4.01, 7.00 & 10.01) or (4.00, 6.86 & 9.18)
pH Buffer Calibration Temp. Range	0 to 60 °C
pH Electrode Offset Recognition	±90mV at pH 7.00 or 6.86
pH Electrode Slope Recognition	±30% at pH 4.00, 4.01, 9.18 or 10.01
Power	One 9V battery
Calibration Back-up	Yes
Audio Feedback	Yes, on all touch keys
Autolock Feature	Yes
Operating Temp. Range	0 to 50 °C
Operating Relative Humidity Range	up to 95%
ATC Probe	Thermistor, 10kΩ / 25 °C
Dimensions (W x D x H)	86 mm x 241 mm x 72 mm (3 in x 9.5 in x 2.8 in)
Weight (batteries included)	430 grams (1 lb)

RECOMMENDED SPARE PARTS LIST

PART #	DESCRIPTION
100-1	1-meter waterproof Y-cable with combo pH/reference junction & ATC electrodes.
100-4	4-meter waterproof Y-cable with combo pH/reference junction & ATC electrode.
110-1	pH electrode with 1-meter cable.
115-1	mV electrode with 1-meter cable.
130-1	ATC (temperature) electrode with 1-meter cable.
160	pH Simulator electrode.
180	pH carrying case, hard sided.
405	Instrument carrying case, soft sided.

Item #605367 • Drawing #A605367
Revision A • March 2003

GARANTIE

L'appareil YSI pH100 est garanti pour une période d'un an, à compter de la date d'achat par l'utilisateur final, contre tout défaut matériel et de fabrication. Les sondes et les câbles de l'YSI pH100 sont garantis pour une période de six mois, à compter de la date d'achat par l'utilisateur final, contre tout défaut matériel et de fabrication. Pendant la période de garantie, YSI s'engage à réparer ou à remplacer, gratuitement et à sa discrétion, tout produit qu'YSI peut établir comme étant couvert par la garantie.

Pour faire valoir cette garantie, écrivez ou appelez votre représentant YSI ou contactez le Service clientèle d'YSI à Yellow Springs, Ohio, États-Unis. Envoyez le produit et son justificatif d'achat en port payé au Centre de service homologué sélectionné par YSI. La réparation ou le remplacement seront effectués et le produit vous sera retourné en port payé. Les produits réparés ou remplacés sont garantis jusqu'à expiration de la période de garantie originale ou pour au moins 90 jours, à compter de la date de réparation ou de remplacement.

Limitation de garantie

Cette garantie ne s'applique pas aux produits YSI endommagés ou présentant des dysfonctionnements pour les raisons suivantes : (i) installation, exploitation ou utilisation du produit d'une façon non conforme aux instructions écrites d'YSI ; (ii) abus ou mésusage du produit ; (iii) manquement à l'entretien du produit conformément aux instructions écrites d'YSI ou aux procédures industrielles normales ; (iv) réparation non conforme du produit ; (v) utilisation par vous de pièces ou de composants défectueux ou non conformes lors de l'entretien ou de la réparation du produit, ou ; (vi) modification du produit d'une façon non expressément autorisée par YSI.

CETTE GARANTIE REMPLACE TOUTES LES AUTRES GARANTIES, EXPRESSES OU INDUITES, Y COMPRIS LES GARANTIES DE COMMERCIABILITÉ OU D'ADAPTATION À UN USAGE PARTICULIER. LA RESPONSABILITÉ D'YSI SELON LES TERMES DE CETTE GARANTIE SE LIMITE À LA RÉPARATION OU AU REMPLACEMENT DU PRODUIT, CONSTITUANT VOTRE SEUL ET UNIQUE RECOURS POUR TOUT PRODUIT DÉFECTUEUX COUVERT PAR CETTE GARANTIE. YSI NE POURRA EN AUCUN CAS ÊTRE TENU RESPONSABLE DE DOMMAGES SPÉCIAUX, INDIRECTS, ACCIDENTELS OU CONSÉCUTIFS RÉSULTANT DE L'UTILISATION DE TOUT PRODUIT DÉFECTUEUX COUVERT PAR CETTE GARANTIE.

COMMENT NOUS CONTACTER

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INTRODUCTION GÉNÉRALE

Le modèle pH100 est un instrument de précision mesurant le pH, les mV et la température. Un microprocesseur incorporé stocke, calcule et compense tous les paramètres relatifs aux déterminations liées au pH, y compris les caractéristiques de température de l'électrode de détection du pH, les écarts de pente de l'électrode et les solutions tampons.

L'appareil est doté d'un boîtier de protection contre les éclaboussures conforme à la norme IP65. Les touches mécaniques sont très fiables et produisent une réaction tactile et sonore. Cet appareil de mesure utilise une pile de 9 V. Aucun réétalonnage n'est nécessaire lorsque l'alimentation électrique est rétablie.

L'avant de l'appareil dispose d'un écran à cristaux liquides de grande taille affichant simultanément les mesures de pH, de millivoltage et de température, ainsi que les invites destinées à l'utilisateur et les indicateurs de mode. L'appareil émet des invites destinées à l'utilisateur lors des procédures d'étalonnage et de mesure.

Une fonctionnalité de verrouillage automatique AUTOLOCK, applicable aux mesures de pH et de millivoltage, permet à l'appareil de détecter automatiquement le point de virage et de verrouiller l'affichage pour indiquer la valeur du point de virage de la mesure. Le pH100 peut également être utilisé alors que le mode de verrouillage AUTOLOCK est désactivé. La fonctionnalité de verrouillage automatique et les invites permettent d'éliminer la plupart des erreurs de détermination des valeurs de pH et de millivoltage et d'obtenir des mesures précises, fiables et pouvant être répétées.

Le modèle pH100 est disponible avec des sondes à pH, millivoltage, potentiel redox et compensation automatique de la température (CAT). Parmi les autres fonctionnalités, on peut compter la reconnaissance du décalage de l'électrode, la reconnaissance de la pente de l'électrode, l'affichage de l'efficacité de l'électrode, des coefficients de tampon incorporés, la compensation automatique ou manuelle de la température, une pile longue durée et un dispositif d'atténuation du bruit C.A. à 50 ou 60 Hz. Cet appareil est convivial et particulièrement souple dans les applications sur le terrain, industrielles et en laboratoire.

INSPECTION INITIALE

Déballez soigneusement l'appareil et les accessoires et vérifiez qu'ils n'ont pas été endommagés lors de l'expédition. Comparez les pièces reçues aux matériaux répertoriés dans le bordereau d'emballage. Notifiez immédiatement YSI s'il s'avère que des pièces sont endommagées ou manquantes. Mettez de côté les matériaux d'emballage jusqu'à ce que le fonctionnement correct de l'appareil soit confirmé.

PROTECTION CONTRE LES ÉCLABOUSSURES

Bien que le modèle pH100 soit enfermé dans un boîtier étanche, NE l'utilisez PAS sous l'eau. Le boîtier résistant aux éclaboussures prévient les dommages permanents si l'appareil est accidentellement immergé dans des solutions non corrosives. Suivez immédiatement ces étapes si l'appareil est immergé dans une solution quelconque :

1. Rincez soigneusement l'appareil avec de l'eau distillée. Après le rinçage et le séchage, inspectez et nettoyez les connecteurs en vue d'éliminer tout contaminant pouvant affecter les connexions de la sonde.
2. Attendez que l'appareil et la sonde soient parfaitement secs avant de reprendre les opérations.
3. Si l'appareil ne fonctionne pas correctement après les étapes 1 et 2, appelez YSI en vue d'une réparation ou d'un remplacement éventuels (voir la Garantie).

INSTALLATION DE LA PILE

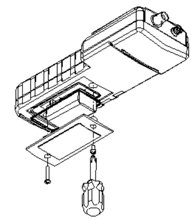

Figure 1.
Installation de la pile

Lorsque l'écran à cristaux liquides affiche pour la première fois « BAT », il reste environ une heure de fonctionnement sur pile selon les spécifications. Remplacez la pile lorsque l'indication « BAT » s'affiche sur l'écran. (Voir Figure 1.)

Pour remplacer la pile, enlevez les deux vis du compartiment ainsi que le couvercle et le joint torique. Remplacez la pile de 9 V. Replacez le couvercle et le joint torique (alignez le joint correctement afin d'assurer une bonne étanchéité) et revissez les deux vis du compartiment pour conserver une bonne résistance aux éclaboussures.

FONCTIONNALITÉS CLÉS DU MODÈLE pH100

1. **⏻ :** Met l'appareil hors ou sous tension. Les valeurs d'étalonnage du pH ne sont pas effacées lorsque l'appareil est mis hors tension. L'appareil démarre dans le même état que lorsqu'il a été mis hors tension. Lorsque l'appareil n'est pas utilisé, mettez-le hors tension pour économiser la pile. Enlevez les piles pour un entreposage prolongé.
2. **MODE :** Permet de sélectionner le mode d'affichage. Appuyez plusieurs fois sur **MODE** pour afficher successivement pH-AUTOLOCK (verrouillage automatique de la mesure du pH), Mv-AUTOLOCK (verrouillage automatique de la mesure du millivoltage), pH et mV. Les valeurs d'étalonnage ne sont pas affectées par le changement de mode d'affichage.
3. **Touches STAND** et **SLOPE** : Utilisées pour l'étalonnage en deux points du pH de l'appareil. Maintenez la touche **STAND** enfoncée tout en mettant l'appareil sous tension pour changer les jeux de tampons.
4. **Touches ∆** et **∇** : Appuyez sur ces touches pour entrer les valeurs de température en mode manuel (MAN). Ces touches sont inopérantes en mode CAT.
5. **MEA./EFF.** : Appuyez sur cette touche pour désactiver le verrouillage automatique lorsque l'appareil est en mode pH-AUTOLOCK ou mV-AUTOLOCK. Maintenez la touche enfoncée pendant 5 secondes pour afficher l'efficacité de l'électrode.
6. **ESC** : Appuyez sur cette touche pour effacer la mémoire de l'appareil lorsqu'un message d'erreur apparaît. Toutes les valeurs d'étalonnage stockées en mémoire interne sont effacées. Afin d'éviter un effacement accidentel lors d'un fonctionnement normal, la touche doit être maintenue enfoncée pendant 2 secondes pour être active. La touche n'est active que lorsqu'un message d'erreur est affiché.

   Lorsque la touche **ESC** est enfoncée, tous les éléments de l'écran à cristaux liquide s'allument. Au bout d'environ 2 secondes, l'appareil se met en mode pH-AUTOLOCK. La mention « AUTOLOCK » s'affiche et la mention « STAND » commence à clignoter, indiquant qu'un étalonnage est nécessaire. Appuyez sur la touche **ESC** uniquement lorsque surviennent des erreurs nécessitant un réétalonnage.

ÉCRAN À CRISTAUX LIQUIDES

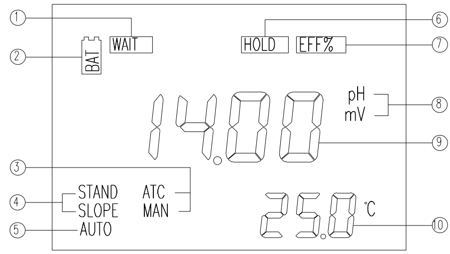

Figure 4. Écran à cristaux liquides

1. **WAIT** : S'affiche lorsque l'appareil attend une lecture stable ou la détection d'un point de virage.
2. **BAT** : Indicateur de pile déchargée.
3. **ATC/MAN** : La mention « ATC » s'affiche si une sonde à compensation automatique de la température est connectée. Sinon, la mention « MAN » est affichée.
4. **STAND/SLOPE** : Les mentions « STAND » et « SLOPE » restent allumées si le paramètre a été étalonné. Si l'un d'entre eux n'a pas été étalonné, la mention clignote.
5. **AUTO** : Indicateur de mode de verrouillage automatique.
6. **HOLD** : Indique qu'une lecture est gelée en mode de verrouillage automatique.
7. **EFF%** : S'affiche lorsque l'utilisateur vérifie l'efficacité de l'électrode. Nous vous recommandons de remplacer l'électrode lorsque la valeur d'efficacité est inférieure à 75 %.
8. **pH/mV** : Indicateurs d'unité et de mode.
9. Affichage principal pour les mesures de pH, de millivoltage et d'efficacité de l'électrode.
10. **°C** : Affichage de la température.

PROCÉDURES D'UTILISATION

Sélection du jeu de tampons

Cet appareil dispose de deux jeux de tampons : 7.00,4.01,10.01pH et 6.86,4.00,9.18pH. Pour changer de jeu de tampons, mettez l'appareil hors tension, puis maintenez la touche **STAND** enfoncée tout en remettant l'appareil sous tension. Si l'appareil n'est pas étalonné et en mode pH, il affiche « 7.00 » si le premier jeu est actif et « 6.86 » si le deuxième jeu est actif.

Étalonnage du pH

Le modèle pH100 utilise un étalonnage à deux points. Le premier point doit être le tampon 6.86/7.00 et le deuxième point 4.00/4.01 ou 9.18/10.01. Ces tampons peuvent être achetés chez un représentant YSI.

1. Mettez l'appareil sous tension. Connectez la sonde pH au connecteur BNC et la sonde CAT/Temp au connecteur CAT/Temp de l'appareil. La mention « ATC » s'affiche. Appuyez sur la touche **MODE** jusqu'à ce que la mention « pH » s'affiche. La fonction de verrouillage automatique peut être indifféremment activée ou désactivée.
2. **VERROUILAGE AUTOMATIQUE ACTIVÉ :** Placez les sondes pH et CAT/Temp dans la première solution tampon (7,00 ou 6,98). Laissez la lecture de température se stabiliser, puis appuyez sur la touche « STAND » pour étalonner. Si le verrouillage automatique (**AUTOLOCK**) est désactivé, le premier point est étalonné. Si le verrouillage automatique (**AUTOLOCK**) est activé, la mention « WAIT » clignote jusqu'à ce que l'appareil détecte une lecture stable. Une fois que l'appareil a effectué l'étalonnage du premier point, la mention « STAND » reste allumée et « SLOPE » clignote.

REMARQUE : Si aucune sonde de température n'est connectée, réglez la lecture de température sur celle du premier tampon à l'aide des touches Δ et ∇ (entre 0,0 et 60 °C) **AVANT** d'appuyer sur « STAND ».

3. Rincez les sondes pH et CAT/Temp avec de l'eau distillée, puis placez-les dans la deuxième solution tampon (4,01/4,00 ou 10,01/9,18) Laissez la lecture de température se stabiliser, puis appuyez sur la touche « SLOPE » pour étalonner. Si le verrouillage automatique (**AUTOLOCK**) est désactivé, le deuxième point est étalonné. Si le verrouillage automatique (**AUTOLOCK**) est activé, la mention « WAIT » clignote jusqu'à ce que l'appareil détecte une lecture stable. Une fois que l'appareil a effectué l'étalonnage du deuxième point, les mentions « STAND » et « SLOPE » restent toutes les deux allumées.

REMARQUE : Si aucune sonde de température n'est connectée, réglez la lecture de température sur celle du premier tampon à l'aide des touches Δ et ∇ (entre 0,0 et 60 °C) **AVANT** d'appuyer sur « SLOPE ».

4. L'appareil calcule et compense l'écart de pente de l'électrode pH correspondant aux valeurs des deux tampons d'étalonnage. L'appareil est maintenant étalonné en deux points et prêt à la prise de mesure. Après l'étalonnage, maintenez la touche **MEA. /EFF.** enfoncée pendant environ 5 secondes pour afficher la nouvelle efficacité de l'électrode.

Utilisation du simulateur d'électrode du modèle pH160

Le simulateur d'électrode du modèle pH160 peut être utilisé pour confirmer l'étalonnage correct de l'appareil. Pour utiliser le simulateur :

1. Installez la pile de 9 V fournie.

2. Connectez le pH160 au pH100. Mettez les deux appareils sous tension. Le pH160 est doté d'un petit interrupteur, situé à droite des touches de pH.

3. En mode de mesure du pH, appuyez sur une des touches de simulation de tampon pH du pH160. La valeur de pH correspondante doit s'afficher sur l'écran des deux appareils.

Remarque : Le simulateur de pH permet seulement d'étalonner l'appareil, PAS l'appareil et la sonde. Pour obtenir une meilleure précision, étalonnez le pH de l'appareil et de la sonde simultanément à l'aide de solutions tampons.

Mesures du pH

Pour effectuer des mesures de pH, les mentions « STAND » et « SLOPE » doivent rester allumées, indiquant que l'appareil a été étalonné en deux points et qu'il est prêt à effectuer des mesures. Si les mentions « STAND » et « SLOPE » clignotent, effectuez l'étalonnage du pH avant de prendre des mesures.

1. Appuyez sur la touche **MODE** pour entrer en mode pH et activez ou désactivez la fonction de verrouillage automatique, selon vos besoins. L'appareil ne pourra pas se verrouiller automatiquement si les caractéristiques inhérentes de l'échantillon mesuré sont instables. Dans ce cas, désactivez la fonction de verrouillage automatique.

2. Rincez l'électrode à pH et/ou la sonde CAT/Temp avec de l'eau distillée et plongez-la dans l'échantillon devant être mesuré. Enlevez toute bulle d'air se trouvant autour de la sonde en secouant ou en remuant la sonde. Laissez la lecture de pH et/ou de température se stabiliser. Si aucune sonde CAT/Temp n'est connectée, la mention « MAN » s'affiche, indiquant une compensation de température manuelle. Réglez l'appareil pour qu'il affiche la température de l'échantillon en appuyant sur les touches Δ et ∇ (-10,0 à 120 °C). Si une sonde CAT/Temp est connectée, la mention « ATC » s'affiche avec la température de l'échantillon.

3. Si la fonction de verrouillage automatique est désactivée, la valeur de pH de l'échantillon s'affiche sur l'écran. Si les lectures de pH et de température sont toutes les deux stables, notez les valeurs. Si la fonction de verrouillage automatique est activée, appuyez sur **MEA./EFF.** La mention « WAIT » s'affiche jusqu'à ce que l'appareil détecte une lecture de pH stable.

Mesures de température

Le modèle pH100 peut mesurer la température indépendamment avec la sonde CAT/Temp, sans utiliser l'électrode à pH. Placez la sonde CAT/Temp dans le liquide devant être mesuré. La mesure de température s'affiche.

Mesures de millivoltage

1. Connectez l'électrode de millivoltage optionnelle à l'appareil. Appuyez sur la touche **MODE** pour entrer en mode de mesure du millivoltage et activez ou désactivez la fonction de verrouillage automatique, selon vos besoins. L'appareil ne pourra pas se verrouiller automatiquement si les caractéristiques inhérentes de l'échantillon mesuré sont instables. Dans ce cas, utilisez le mode de mesure du millivoltage sans la fonction de verrouillage automatique.
2. Rincez l'électrode avec de l'eau distillée et immergez-la dans l'échantillon à mesurer. Si la fonction de verrouillage automatique est désactivée, la valeur de millivoltage de l'échantillon s'affiche sur l'écran. Si la fonction de verrouillage automatique est activée, appuyez sur **MEA./EFF.** La mention « WAIT » s'affiche jusqu'à ce que l'appareil détecte une lecture de millivoltage stable.

DÉPANNAGE

AFFICHAGE PRINCIPAL	CAUSE POSSIBLE	MESURE CORRECTIVE
Er 1	• Le décalage de l'électrode à pH est supérieur/inférieur à +/- 1,5 pH. • La touche **STAND** a été enfoncée avant que l'électrode et la sonde CAT/Temp ne se stabilisent dans une fourchette de ±1,5 pH de la valeur du tampon. • L'électrode à pH est défectueuse.	• Remplacez le tampon et/ou l'électrode à pH. Appuyez sur **ESC**. • Attendez suffisamment longtemps pour que l'électrode et la sonde CAT/Temp se stabilisent. • Retournez l'appareil au centre de service.
Er 2	• La pente de l'électrode à pH présente un écart de plus de 30 % par rapport à la pente idéale. • La touche **SLOPE** a été enfoncée avant que l'électrode et la sonde CAT/Temp ne se stabilisent dans une fourchette de 30 % de la valeur du tampon. • Le tampon 4,00, 4,01, 9,18 ou 10,01 n'est pas correct.	• Vérifiez que le tampon correct est utilisé et que la pente de l'électrode ne diffère pas de plus de 30 % de la pente théorique. • Attendez suffisamment longtemps pour que l'électrode et la sonde CAT/Temp se stabilisent. • Remplacez le tampon et/ou l'électrode à pH. Appuyez sur **ESC**. • Retournez l'appareil au centre de service.

Er 3	• La température dépasse les limites de 0,0 à 60 °C.	• Modifiez la température du tampon pour qu'elle soit dans les limites. • Retournez l'appareil au centre de service.
OvEr/Undr	• Le pH mesuré est hors des limites de 16,00/-2,00 pH. • Le millivoltage mesuré est hors des limites de 1250/-2000 mV. • Les températures mesurées sont hors des limites de -10/120 C.	• Amenez l'appareil hors limite dans les limites correctes de la fourchette de mesure. • Si les appareils se trouvent dans la fourchette correcte, retournez le produit au centre de service.

SPÉCIFICATIONS

Affichage	Fourchette	Précision	Résolution
pH	-2,00 à 16,00 pH	±0,1 %, ±2 lsd	0,01 pH
mV	-1999 à 1250 mV	±0,1 %, ±1 lsd	1 mV
Température °C	-10,0 à 120 °C	±0,5 °C	0,1 °C

Compensation de la température et du pH	AUTO/MANuel –10,0 à 120,0 °C
Reconnaissance du tampon à pH	(4,01, 7,00 et 10,01) ou (4,00, 6,86 et 9,18)
Fourchette de températures d'étalonnage du tampon à pH	0 à 60 °C
Reconnaissance du décalage de l'électrode à pH	±90 mV à 7,00 ou 6,86 pH
Reconnaissance de la pente de l'électrode à pH	±30 % à 4,00, 4,01, 9,18 ou 10,01 pH
Alimentation	Une pile de 9 V
Sauvegarde de l'étalonnage	Oui
Touches sonores	Oui, toutes les touches tactiles
Fonction de verrouillage automatique	Oui
Fourchette de températures de fonctionnement	0 à 50 °C
Limite d'humidité relative lors du fonctionnement	Jusqu'à 95 %
Sonde CAT	Thermistor, 10 kΩ / 25 °C
Dimensions (L x P x H)	86 mm x 241 mm x 72 mm
Poids (avec pile)	430 g

LISTE DES PIÈCES DÉTACHÉES RECOMMANDÉES

N° RÉF.	DESCRIPTION
100-1	Câble en Y étanche de 1 mètre avec combinaison d'électrodes à pH/jonction de référence et CAT.
100-4	Câble en Y étanche de 4 mètres avec combinaison d'électrodes à pH/jonction de référence et CAT.
110-1	Électrode à pH avec câble de 1 mètre.
115-1	Électrode à millivoltage avec câble de 1 mètre.
130-1	Électrode CAT (température) avec câble de 1 mètre.
160	Électrode de simulation de pH.
180	Sacoche de transport de solutions pH, flancs durs.
405	Sacoche de transport de l'appareil, flancs souples.

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GARANTÍA

El medidor YSI pH100 tiene un año de garantía contra defectos de materiales y fabricación, contado a partir de la fecha de compra por el usuario final. Las sondas y cables del medidor pH100 tienen seis meses de garantía contra defectos de materiales y fabricación, contados a partir de la fecha de compra por el usuario final. Durante el período de garantía, YSI reparará o reemplazará, según su criterio, sin coste alguno, cualquier producto que YSI determine que está cubierto por esta garantía.

Para hacer valer esta garantía, escriba o llame al representante local de YSI, o comuníquese con el Servicio de atención al cliente de YSI en Yellow Springs, Ohio, EE.UU. Envíe el producto y la factura de compra, con el flete prepagado, al centro de servicio técnico autorizado seleccionado por YSI. Se realizará la reparación necesaria o el reemplazo y el producto será enviado de vuelta, con el flete prepagado. Los productos reparados o reemplazados se garantizan durante el resto del período de la garantía original, o al menos durante 90 días contados a partir de la fecha de reparación o reemplazo.

Limitación de la garantía

Esta garantía no tendrá validez en caso de daños o fallos en el producto de YSI debido a lo siguiente: (i) la instalación, funcionamiento o utilización del producto de manera contraria a las instrucciones escritas suministradas por YSI; (ii) abuso o uso inadecuado del producto; (iii) falta de mantenimiento del producto de acuerdo con las instrucciones escritas suministradas por YSI o con los procedimientos estándares de la industria; (iv) cualquier reparación indebida realizada en el producto; (v) utilización por parte del usuario de componentes o repuestos defectuosos o inadecuados para el mantenimiento o reparación del producto; o (vi) cualquier modificación del producto no autorizada de manera expresa por YSI.

ESTA GARANTÍA SE OTORGA EN LUGAR DE CUALQUIER OTRA GARANTÍA, EXPLÍCITA O IMPLÍCITA, LO QUE INCLUYE TODA GARANTÍA DE COMERCIALIZACIÓN O IDONEIDAD PARA UN PROPÓSITO ESPECÍFICO. DE CONFORMIDAD CON ESTA GARANTÍA, LA RESPONSABILIDAD DE YSI SE LIMITA A LA REPARACIÓN O REEMPLAZO DEL PRODUCTO, LO CUAL SERÁ LA SOLUCIÓN ÚNICA Y EXCLUSIVA QUE TENDRÁ EL COMPRADOR POR CUALQUIER PRODUCTO DEFECTUOSO CUBIERTO POR ESTA GARANTÍA. EN NINGÚN CASO YSI SERÁ RESPONSABLE POR NINGÚN DAÑO CUANTIFICABLE, INDIRECTO, INCIDENTAL O CONSIGUIENTE QUE RESULTARA DE ALGÚN PRODUCTO DEFECTUOSO CUBIERTO POR ESTA GARANTÍA.

INFORMACIÓN DE CONTACTO

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INTRODUCCIÓN GENERAL

El modelo pH100 es una herramienta de precisión que mide pH, mV y temperatura. Tiene un microprocesador integrado que almacena, calcula y realiza la compensación de todos los parámetros relacionados con la determinación del pH, incluso las características de temperatura del electrodo de pH, desviaciones de la inclinación del electrodo y soluciones tampón.

Esta unidad cuenta con un estuche IP65 resistente a salpicaduras. Las teclas de contacto mecánico son muy confiables y al pulsarlas proporcionan una respuesta táctil y audible. Este medidor utiliza una pila de 9 voltios. No requiere nueva calibración cuando se restablece la corriente.

La parte delantera del medidor tiene una pantalla grande de cristal líquido que muestra simultáneamente el pH o mV y temperatura, junto con las indicaciones para el usuario y los indicadores del modo de funcionamiento. La unidad orienta al usuario durante los procedimientos de calibración y medición.

La característica AUTOLOCK (autobloqueo) para las mediciones de pH y mV permite que la unidad detecte automáticamente el punto terminal y que "fije" la pantalla para indicar el valor del punto terminal de la medición. El pH100 también se puede utilizar sin el modo AUTOLOCK (autobloqueo). El modo AUTOLOCK (autobloqueo) y las indicaciones para el usuario ayudan a eliminar la mayoría de los errores al determinar los valores de pH y mV, lo que da como resultado medidas precisas, repetibles y sin errores.

El modelo pH100 también está disponible con sondas para pH, mV, ORP y ATC (compensación automática de temperatura). Entre otras características se incluyen el reconocimiento de desfase del electrodo, reconocimiento de la inclinación del electrodo, pantalla de eficiencia del electrodo, coeficientes incorporados de las soluciones tampón, compensación automática o manual de temperatura, larga duración de la pila y rechazo de ruido de CA de 50/60 Hz. Este medidor es universal y fácil de usar en aplicaciones *in situ*, industriales y de laboratorio.

INSPECCIÓN INICIAL

Saque la unidad de su embalaje con cuidado y verifique que no haya sufrido daños durante el envío. Compare las piezas recibidas con los materiales enumerados en la lista de embalaje. Notifique inmediatamente a YSI en caso de que haya piezas faltantes o dañadas. Guarde todos los materiales de embalaje hasta que confirme que la unidad funciona satisfactoriamente.

RESISTENCIA A LAS SALPICADURAS

Aunque el medidor pH100 se encuentra en un estuche a prueba de agua, NO lo utilice bajo agua. Este tipo de estuche evita los daños permanentes en la unidad en caso de que caiga accidentalmente en soluciones no corrosivas. Siga estos pasos de inmediato si la unidad se inmerge en cualquier solución:

1. Enjuague la unidad cuidadosamente con agua destilada. Después del enjuague y secado, revise y limpie los conectores para eliminar cualquier contaminante que pueda afectar las conexiones de la sonda.
2. Espere hasta que la unidad y la sonda se sequen por completo antes de reanudar el funcionamiento.
3. Si la unidad no funciona correctamente después de realizar los pasos 1 y 2, comuníquese con YSI para su posible reparación o reemplazo (consulte la garantía).

INSTALACIÓN DE LA PILA

En la pantalla de cristal líquido aparecerá el mensaje de “BAT” (pila) para indicar que queda aproximadamente una hora de carga de la pila para el funcionamiento de la unidad según las especificaciones. Cambie la pila cuando aparezca el mensaje “BAT” (pila) en la pantalla de cristal líquido. (Vea la figura 1).

Para cambiar la pila, saque los dos tornillos de la tapa y luego retire la tapa y el aro tórico. Coloque una nueva pila de 9 voltios. Vuelva a colocar la tapa y el aro tórico (alinee este aro correctamente para garantizar un buen sellado) y ajuste los dos tornillos de la tapa para que funcione la protección contra salpicaduras.

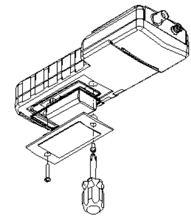

Figura 1.
Instalación de la pila

FUNCIONES PRINCIPALES DEL MODELO pH100

1. **⏻:** Para encender y apagar la unidad. Los valores de calibración de pH no se suprimen cuando se apaga la unidad. La unidad se enciende en el mismo estado en que se encontraba cuando se apagó. Cuando la unidad no esté en uso, apáguela para ahorrar carga de la pila. Para el almacenamiento a largo plazo debe quitar las pilas.
2. **MODE:** Selecciona el modo de la pantalla. Presione **MODE** para ver pH-AUTOLOCK, mV-AUTOLOCK, pH y mV de manera secuencial. Los valores de calibración no se ven afectados al cambiar el modo de la pantalla.
3. Teclas **STAND** y **SLOPE**: Se utilizan para la calibración de pH de dos puntos de la unidad. Pulse y mantenga pulsada la tecla **STAND** mientras enciende la energía para cambiar los juegos de tampones.
4. Teclas Δ y ∇: Pulse para introducir los valores de temperatura en el modo manual (MAN). Estas teclas no funcionan en el modo ATC.
5. **MEA./EFF.:** Pulse para liberar la unidad del estado AUTOLOCK (autobloqueo) cuando funciona en el modo pH-AUTOLOCK o mV-AUTOLOCK. Pulse y mantenga pulsada por 5 segundos para ver la eficiencia del electrodo.
6. **ESC:** Presione para despejar la unidad cuando aparezca una señal de error y suprimirá los valores de calibración almacenados en la memoria interna. Para evitar la supresión accidental durante el uso normal, las teclas no funcionan a menos que se pulsen durante 2 segundos. La tecla funciona solamente cuando aparece un mensaje de error.

   Cuando se pulsa **ESC**, todos los elementos de la pantalla de cristal líquido se iluminan. Después de 2 segundos la unidad entra en el modo pH-AUTOLOCK. “AUTOLOCK” aparece y “STAND” comienza a parpadear indicando la necesidad de realizar la calibración. Pulse **ESC** sólo cuando se produzcan errores que requieran la recalibración de la unidad.

PANTALLA DE CRISTAL LÍQUIDO

1. **WAIT:** Aparece cuando la unidad espera una lectura estable o medición del punto terminal.
2. **BAT:** Indicador de pila agotada.
3. **ATC/MAN:** “ATC” aparece si la sonda ATC está conectada. De lo contrario, aparece “MAN”.

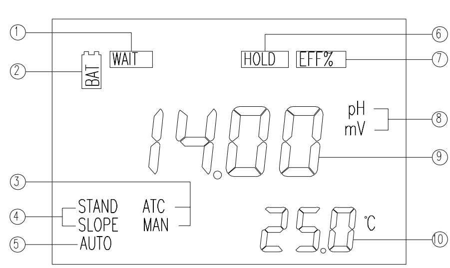

Figura 2. Pantalla de cristal líquido

4. **STAND/SLOPE:** “STAND” o “SLOPE” permanecen fijamente si el parámetro se calibró. Si alguno de los dos no se ha calibrado, parpadea.
5. **AUTO:** Indicador del modo Autolock (autobloqueo).
6. **HOLD:** Indica que la lectura se mantiene durante el modo Autolock (autobloqueo).
7. **EFF%:** Aparece cuando el usuario visualiza la eficiencia del electrodo. Se recomienda reemplazar el electrodo cuando la eficiencia es inferior a 75%.
8. **pH/mV:** Indicadores de la unidad y de modo.
9. Pantalla principal para los valores de pH, mV y eficiencia de la sonda.
10. **°C:** Indicador de la temperatura.

PROCEDIMIENTOS DE FUNCIONAMIENTO

Selección de la tabla de la solución tampón

La unidad cuenta con dos juegos de tampones: 7,00, 4,01, 10,01 pH y 6,86, 4,00, 9,18 pH. Para cambiar el juego de la solución tampón, apague la unidad, luego pulse y mantenga pulsado **STAND** mientras enciende la unidad de nuevo. Si la unidad está calibrada y en el modo pH, muestra “7,00” si el primer juego está activo y “6,86”, si el segundo está activo.

Calibración de pH

El pH100 utiliza calibración de 2 puntos. El primer punto debe ser el tampón 6,86/7,00 y el segundo debe ser 4,00/4,01 ó 9,18/10,01. Estas soluciones tampón se pueden comprar al representante de YSI.

1. Encienda la unidad. Conecte el electrodo de pH en el conector BNC y la sonda ATC/Temp en el conector ATC/Temp en la unidad; aparece “ATC”. Pulse **MODE** hasta que aparezca “pH”. Autolock (autobloqueo) puede estar encendido o apagado según lo desee.
2. **AUTOLOCK ENCENDIDO:** Coloque las sondas pH y ATC/Temp en la primera solución tampón (7,00 ó 6,98). Deje que las lecturas de temperatura se estabilicen, luego pulse “STAND” para calibrar. Si **AUTOLOCK** (autobloqueo) está apagado, el primer punto se ha calibrado. Si **AUTOLOCK** (autobloqueo) está encendido, “WAIT” parpadea hasta que la unidad detecta una lectura estable. Cuando la unidad calibra el primer punto, “STAND” no parpadea, pero “SLOPE” sí.

   NOTA: Si no está conectada la sonda de temperatura, ajuste la lectura de temperatura al nivel de la primera solución tampón utilizando la tecla Δ o ∇ (0,0 a 60° C) **ANTES** de pulsar “STAND”.
3. Enjuague las sondas pH y ATC/Temp con agua destilada, luego colóquelas en la segunda solución tampón (4,01/4,00 ó 10,01/9,18). Deje que las lecturas de temperatura se estabilicen, luego pulse “SLOPE” para calibrar. Si **AUTOLOCK** (autobloqueo) está apagado, el segundo punto se ha calibrado. Si **AUTOLOCK** (autobloqueo) está encendido, “WAIT” parpadea hasta que la unidad detecta una lectura estable. Cuando la unidad calibra el segundo punto, tanto “STAND” como “SLOPE” no parpadean.

   NOTA: Si no está conectada la sonda de temperatura, ajuste la lectura de temperatura al nivel de la primera solución tampón utilizando la tecla Δ o ∇ (0,0 a 60° C) **ANTES** de pulsar “SLOPE”.
4. La unidad calcula y compensa la desviación de inclinación del electrodo de pH correspondiente a los valores de las dos soluciones tampón de calibración. La unidad ahora cuenta con dos puntos calibrados y está lista para realizar mediciones. Después de la calibración, pulse y mantenga pulsado **MEA. /EFF.** por 5 segundos para ver la nueva eficiencia del electrodo.

Uso del simulador de electrodo del modelo pH160

El simulador de electrodo del modelo pH160 se puede utilizar para confirmar la calibración apropiada del medidor. Para utilizar el simulador:

1. Instale la pila de 9 voltios proporcionada.
2. Conecte el pH160 al pH100. Encienda ambas unidades. El pH160 tiene un interruptor pequeño a la derecha de los botones de pH.
3. En el modo de medición de pH, pulse uno de los botones de simulador de solución tampón de pH en el pH160. El valor correspondiente de pH debe aparecer en ambas pantallas.

Nota: La calibración con el simulador de pH sólo se hace en el medidor y NO en el medidor y la sonda. Para obtener la mejor precisión, calibre el medidor de pH y la sonda juntos utilizando las soluciones tampón.

Mediciones de pH

Para tomar mediciones de pH, “STAND” y “SLOPE” no deben parpadear, lo que indica que la unidad está calibrada en dos puntos y está lista para realizar mediciones. Si “STAND” y “SLOPE” parpadean, realice la calibración de pH antes de tomar las mediciones.

1. Pulse **MODE** (modo) para entrar en el modo pH con AUTOLOCK (autobloqueo) encendido o apagado, como lo desee. Para las muestras naturalmente inestables, la unidad no entrará en AUTOLOCK (autobloqueo). En este caso debe apagar AUTOLOCK (autobloqueo).
2. Enjuague el electrodo de pH y/o sonda ATC/Temp con agua destilada y sumérjala en la muestra que será medida. Saque las burbujas de aire atrapadas alrededor de la sonda sacudiendo o agitando la sonda. Deje que el pH y/o la temperatura se estabilicen. Si la sonda ATC/Temp no está conectada, aparece “MAN”, lo que indica que se utiliza la compensación manual de temperatura. Fije la unidad para que indique la temperatura de la muestra pulsando las teclas Δ y ∇ (-10,0 a 120° C). Si la sonda ATC/Temp está conectada, aparece “ATC” junto a la temperatura de la muestra.
3. Si AUTOLOCK (autobloqueo) está apagado, el valor de pH de la muestra aparece en la pantalla. Si las lecturas de pH y temperatura son estables, tome la lectura. Si AUTOLOCK (autobloqueo) está encendido, pulse **MEA./EFF.** “WAIT” parpadea hasta que la unidad detecta una lectura estable de pH.

Mediciones de temperatura

El modelo pH100 puede medir temperatura de manera independiente con la sonda ATC/Temp, sin utilizar el electrodo de pH. Ponga la sonda ATC/Temp en el medio a ser medido. Aparecerá la medición de temperatura.

Mediciones de mV

1. Conecte el electrodo opcional de combinación mV en la unidad. Pulse **MODE** (modo) para entrar en el modo mV con AUTOLOCK (autobloqueo) encendido o apagado, como lo desee. Para las muestras naturalmente inestables, la unidad no entrará en AUTOLOCK (autobloqueo). En este caso utilice el modo mV con AUTOLOCK (autobloqueo) apagado.
2. Enjuague el electrodo con agua destilada y sumérjalo en la muestra a ser medida. Si AUTOLOCK (autobloqueo) está apagado, el valor de mV de la muestra aparece en la pantalla. Si AUTOLOCK (autobloqueo) está encendido, pulse **MEA./EFF.** “WAIT” parpadea hasta que la unidad detecta una lectura estable de mV.

LOCALIZACIÓN Y RESOLUCIÓN DE PROBLEMAS

PANTALLA PRINCIPAL	CAUSAS POSIBLES	ACCIÓN CORRECTIVA
Er 1	• El desfase del electrodo de pH es mayor/inferior a +/-1,5 pH. • Se pulsó **STAND** antes de que el electrodo y la sonda ATC/Temp lleguen cerca del valor de la solución tampón de ±1,5 pH. • El electrodo de pH tiene fallos	• Reemplace la solución tampón y/o el electrodo de pH. Pulse la tecla **ESC**. • Deje transcurrir suficiente tiempo para que el electrodo y la sonda ATC/Temp se estabilicen. • Envíelo al servicio técnico.
Er 2	• La inclinación del electrodo de pH está a más de 30% de la inclinación ideal. • Se pulsó **SLOPE** antes de que el electrodo y la sonda ATC/Temp lleguen cerca del 30% del valor de la solución tampón. • La solución tampón 4,00, 4,01, 9,18 ó 10,01 no es correcta.	• Verifique el uso de la solución tampón correcta y que la inclinación del electrodo no sea superior al 30% de la inclinación teórica. • Deje transcurrir suficiente tiempo para que el electrodo y la sonda ATC/Temp se estabilicen. • Reemplace la solución tampón y/o el electrodo de pH. Pulse la tecla **ESC**. • Envíelo al servicio técnico.
Er 3	• La temperatura está fuera de la escala de 0,0 a 60,0° C.	• Haga que la temperatura de la solución tampón esté dentro de la escala. • Envíelo al servicio técnico.
OvEr/ Undr	• El pH medido está fuera de la escala de 16,00/-2,00 pH. • El mV medido está fuera de la escala de 1250/-2000 mV. • La temperatura medida está fuera de la escala de -10/120° C.	• Haga que la unidad fuera de escala entre en la escala de medición correcta. • Si las unidades se encuentran dentro de la escala correcta, devuelva el producto para obtener servicio técnico.

ESPECIFICACIONES

Pantalla	Escala	Precisión	Resolución
pH	-2,00 a 16,00 pH	±0,1%, ±2 lsd	0,01 pH
mV	-1999 a 1250 mV	±0,1%, ±1 lsd	1 mV
Temperatura en °C	-10,0 a 120° C	±0,5° C	0,1° C

Compensación de pH temperatura	AUTO/MANual –10,0 a 120,0 °C
Reconocimiento de pH de solución tampón	(4,01, 7,00 y 10,01) o (4,00, 6,86 y 9,18)
Escala de temperatura de calibración de pH de la solución tampón	0 a 60° C
Reconocimiento de desfase del electrodo de pH	±90 mV a pH 7,0 ó 6,86
Reconocimiento de inclinación del electrodo de pH	±30% a pH 4,00, 4,01, 9,18 ó 10,01
Energía	Una pila de 9 voltios
Respaldo de la calibración	Sí
Respuesta audible	Sí, en todas las teclas
Característica Autolock (autobloqueo)	Sí
Escala de temperatura de funcionamiento	0 a 50° C
Escala de humedad relativa de funcionamiento	Hasta 95%
Sonda ATC	Termistor, 10kΩ / 25° C
Dimensiones (anc x prof x alt)	86 mm x 241 mm x 72 mm (3 pulg. x 9,5 pulg. x 2,8 pulg.)
Peso (con la pila)	430 gramos (1 libra)

LISTA DE PIEZAS DE RECAMBIO RECOMENDADAS

PIEZA Nº	DESCRIPCIÓN
100-1	Cable Y hidrófugo de 1 metro con combinación de electrodos pH/unión de referencia y ATC.
100-4	Cable Y hidrófugo de 4 metros con combinación de electrodos pH/unión de referencia y ATC.
110-1	Electrodo de pH con cable de 1 metro.
115-1	Electrodo de mV con cable de 1 metro.
130-1	Electrodo de ATC (temperatura) con cable de 1 metro.
160	Electrodo simulador de pH.
180	Estuche portátil de pH, de lados rígidos
405	Estuche portátil para medidor, no rígido

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Revisión A • Marzo de 2003

GARANTIE

Für das Instrument YSI pH100 wird für den Zeitraum von einem (1) Jahr ab dem Datum des Kaufs durch den Endbenutzer eine Garantie bezüglich Material- und Fabrikationsfehlern gewährt. Für YSI pH100-Sonden und -Kabel wird für den Zeitraum von sechs (6) Monaten ab dem Datum des Kaufs durch den Endbenutzer eine Garantie bezüglich Material- und Fabrikationsfehlern gewährt. Innerhalb der Garantiefrist wird YSI jedes Produkt, für das diese Garantie gilt, nach eigenem Ermessen entweder kostenlos reparieren oder ersetzen.

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Diese Garantie gilt nicht für irgendwelche Beschädigungen oder Ausfälle eines YSI-Produkts, die durch Folgendes verursacht werden: (i) Versäumnis, das Produkt in Übereinstimmung mit den schriftlichen Instruktionen von YSI zu installieren, in Betrieb zu nehmen oder zu benutzen; (ii) Missbrauch oder Zweckentfremdung des Produkts; (iii) Versäumnis, das Produkt in Übereinstimmung mit den schriftlichen Instruktionen von YSI oder einem branchenüblichen Verfahren in Stand zu halten; (iv) unsachgemäße Reparaturen am Produkt; (v) eine von Ihnen vorgenommene Verwendung defekter oder ungeeigneter Komponenten oder Teile bei der Wartung oder Reparatur des Produkts; oder (vi) die Abänderung des Produkts in irgendeiner Weise, die nicht ausdrücklich von YSI genehmigt ist.

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INHALTSVERZEICHNIS

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ALLGEMEINE EINLEITUNG

Das MODELL pH100 ist ein Präzisionsinstrument, das pH, mV und die Temperatur misst. Ein eingebauter Mikroprozessor speichert, berechnet und kompensiert alle Parameter im Zusammenhang mit der pH-Bestimmung, einschließlich der Temperaturcharakteristika der Elektrode, Neigungsabweichungen der Elektrode und Pufferlösungen.

Dieses Gerät besitzt ein spritzwasserfestes Gehäuse gemäß der Schutzklasse IP65. Die mechanischen Berührungstasten mit fühlbarem und hörbarem Feedback sind äußerst zuverlässig. Das Instrument wird von einer 9 Volt-Batterie gespeist. Es ist keine erneute Kalibrierung notwendig, wenn die Stromversorgung wiederhergestellt wird.

Auf der Vorderseite des Instruments befindet sich ein großes LCD-Anzeigefeld, das gleichzeitig die pH- oder mV-Werte sowie die Temperatur mit Bedienerhinweisen/Eingabeaufforderungen und die Betriebsart anzeigt. Das Gerät führt den Benutzer durch die Kalibrierungs- und Messverfahren.

Mit einer AUTOLOCK-Funktion für pH- und mV-Messwerte kann das Gerät automatisch den Umschlagspunkt wahrnehmen und die Anzeige „festschreiben“, um den Wert des Umschlagspunkts einer Messung anzuzeigen. Das pH100-Gerät kann auch ohne AUTOLOCK-Betriebsmodus benutzt werden. AUTOLOCK und Bedienerhinweise/Eingabeaufforderungen tragen dazu bei, die meisten Fehler bei der Bestimmung von pH- und mV-Werten zu eliminieren. Das Ergebnis sind präzise, wiederholbare und fehlerfreie Messungen.

Das Modell pH100 ist mit pH-, mV-, ORP- und ATC-Sonden (Automatische Temperaturkompensation) erhältlich. Zu den weiteren Merkmalen gehören Elektrodenoffset-Erkennung, Elektrodenneigungs-Erkennung, Elektrodeneffizienz-Anzeige, eingebaute Pufferkoeffizienten, automatische oder manuelle Temperaturkompensation, eine lange Batterielebensdauer und eine hohe 50/60 Hz WS-Störgeräuschunterdückung. Das Instrument ist vielseitig, benutzerfreundlich und für Anwendungen in der Feldforschung, Industrie und im Labor geeignet.

INSPEKTION VOR DEM EINSATZ

Packen Sie das Gerät und sein Zubehör sorgfältig aus und untersuchen Sie alle Teile auf eventuelle Transportschäden. Vergleichen Sie die erhaltenen Teile mit den Gegenständen, die auf dem Packzettel aufgeführt sind. Benachrichtigen Sie YSI unverzüglich über irgendwelche Schäden oder fehlende Teile. Bewahren Sie das Verpackungsmaterial auf, bis der einwandfreie Betrieb des Geräts bestätigt ist.

SPRITZWASSERSCHUTZ

Obwohl das pH100-Messinstrument in einem spritzwassergeschützten Gehäuse untergebracht ist, DARF ES NICHT unter Wasser eingesetzt werden. Das spritzwassergeschützte Gehäuse verhindert permanente Schäden am Gerät, falls es versehentlich in nichtätzende Lösungen fällt. Im Falle eines Eintauchens in eine Flüssigkeit müssen sofort die folgenden Schritte ausgeführt werden:

1. Spülen Sie das Gerät sorgfältig mit destilliertem Wasser ab. Nach dem Abspülen und Trocknen sollten Sie die Anschlussstücke inspizieren und säubern, um alle verunreinigenden Substanzen zu entfernen, die die Sondenanschlüsse angreifen könnten.

2. Warten Sie, bis das Gerät und die Sonde völlig trocken sind, bevor Sie das Gerät wieder in Betrieb nehmen.

3. Falls das Gerät nach den Schritten 1 und 2 nicht korrekt funktionieren sollte, rufen Sie YSI wegen einer möglichen Reparatur oder eines Ersatzes an (siehe Garantie).

EINSETZEN DER BATTERIE

Eine anfängliche Anzeige von „BAT” auf dem LCD bedeutet, dass das Gerät noch ca. 1 Stunde innerhalb der Spezifizierungen mit der Batterie betrieben werden kann. Wechseln Sie die Batterie aus, wenn „BAT” auf dem LCD-Anzeigefeld erscheint. (Siehe Abbildung 1)

Zum Austausch der Batterie entfernen Sie die beiden Schrauben für die Batterieabdeckung, die Batterieabdeckung und den O-Ring. Wechseln Sie die 9 Volt-Batterie aus. Setzen Sie die Batterieabdeckung und den O-Ring wieder ein (achten Sie auf die korrekte Ausrichtung des O-Rings für eine gute Abdichtung) und ziehen Sie die beiden Schrauben für die Batterieabdeckung fest, damit das Gerät spritzwassergeschützt bleibt.

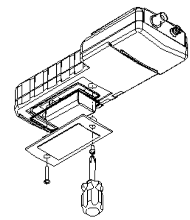

Abbildung 1.
Einsetzen der Batterie

HAUPTFUNKTIONEN DES MODELLS pH100

1. **⏻:** Schaltet das Gerät EIN oder AUS. Die pH-Kalibrierungswerte werden nicht gelöscht, wenn das Gerät ausgeschaltet wird. Das Gerät schaltet sich im selben Status wie beim Ausschalten ein. Wenn das Gerät nicht benutzt wird, schalten Sie es aus, um die Batterie zu schonen. Entfernen Sie die Batterien im Falle einer längeren Lagerung.
2. **MODE:** Wählt den Anzeigemodus. Drücken Sie auf **MODE**, um nacheinander pH-AUTOLOCK, mV-AUTOLOCK, pH und mV anzuzeigen. Die Änderung des Anzeigemodus wirkt sich nicht auf die Kalibrierungswerte aus.
3. **STAND-** und **SLOPE-**Tasten: Werden zur Zwei-Punkte-pH-Kalibrierung des Geräts verwendet. Drücken Sie auf die **STAND-Taste**, während Sie den Strom anschalten, um die Puffersätze zu ändern.
4. ∆ und ∇ Tasten: Drücken Sie auf diese Tasten, um die Temperaturwerte manuell (MAN-Modus) einzugeben. Diese Tasten funktionieren im ATC-Betriebsmodus nicht.
5. **MEA./EFF.:** Drücken Sie diese Taste, um den AUTOLOCK-Status aufzuheben, wenn das Gerät im pH-AUTOLOCK- oder mV-AUTOLOCK-Modus betrieben wird. Drücken Sie die Taste 5 Sekunden lang, um die Elektrodeneffizienz anzuzeigen.
6. **ESC:** Drücken Sie auf diese Taste, wenn eine Fehlermeldung angezeigt wird; es werden alle Kalibrierungswerte im internen Speicher gelöscht. Die Taste reagiert nur, wenn sie mindestens 2 Sekunden lang gedrückt wird. Somit wird eine unbeabsichtigte Löschung während des normalen Gebrauchs verhindert. Die Taste reagiert nur dann, wenn eine Fehlermeldung gezeigt wird.

   Wenn die **ESC**-Taste gedrückt wird, leuchten alle LCD-Elemente auf. Nach ungefähr 2 Sekunden wird der pH-AUTOLOCK-Modus aufgerufen. „AUTOLOCK“ wird angezeigt und „STAND“ beginnt zu blinken; dies weist darauf hin, dass eine Kalibrierung erforderlich ist. Drücken Sie nur dann auf die **ESC**-Taste, wenn Fehler auftreten, die eine Neukalibrierung des Geräts erforderlich machen.

DAS LCD-ANZEIGEFELD

1. **WAIT:** Wird angezeigt, während das Gerät auf einen stabilen Messwert oder die Wahrnehmung des Umschlagspunkts wartet.
2. **BAT:** Anzeige für niedrigen Batteriestand.

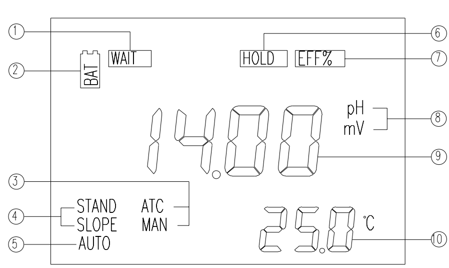

Abbildung 2. LCD-Anzeigefeld

3. **ATC/MAN:** „ATC“ wird angezeigt, falls eine ATC-Sonde angeschlossen ist. Andernfalls wird „MAN“ angezeigt.
4. **STAND/SLOPE:** „STAND“ oder „SLOPE“ bleiben konstant, falls der Parameter kalibriert wurde. Die Anzeige blinkt, falls keiner der Parameter kalibriert wurde.
5. **AUTO:** Anzeige des Autolock-Modus.
6. **HOLD:** Zeigt an, dass ein Messwert während des Autolock-Modus festgeschrieben ist.
7. **EFF%:** Wird angezeigt, wenn der Benutzer die Elektrodeneffizienz abliest. Es wird empfohlen, die Elektrode auszuwechseln, wenn die Effizienz unter 75% fällt.
8. **pH/mV:** Einheits- und Modusanzeigen.
9. Hauptanzeige für pH-, mV- und Sondeneffizienz-Werte.
10. **°C:** Temperaturanzeige.

BEDIENUNGSVERFAHREN

Wahl der Puffertabelle

Dieses Gerät hat zwei Puffersätze: 7.00, 4.01, 10.01 pH und 6.86, 4.00, 9.18 pH. Schalten Sie das Gerät ab und halten dann die **STAND**-Taste niedergedrückt, während Sie das Gerät wieder anschalten, um den Puffersatz zu ändern. Falls das Gerät nicht kalibriert ist und sich im pH-Modus befindet, wird „7.00“ angezeigt, falls der erste Satz aktiv ist, und „6.86“, falls der zweite Satz aktiv ist.

pH-Kalibrierung

Das Modell pH100 verwendet eine Zweipunkt-Kalibrierung. Der erste Punkt muss ein 6.86/7.00-Puffer und der zweite Punkt entweder ein 4.00/4.01- oder ein 9.18/10.01-Puffer sein. Diese Puffer können bei einem YSI-Vertreter gekauft werden.

1. Schalten Sie das Gerät ein. Schließen Sie die pH-Elektrode an den BNC-Anschluss und die ATC/Temp-Sonde an den ATC/Temp-Anschluss des Geräts an; „ATC“ wird angezeigt. Drücken Sie auf **MODE**, bis „pH“ angezeigt wird. Autolock kann je nach Wunsch ein- oder ausgeschaltet sein.
2. **AUTOLOCK ON:** Tauchen Sie die pH- und ATC/Temp-Sonden in die erste Pufferlösung (entweder 7.00 oder 6.98). Warten Sie, bis sich die Temperaturwerte stabilisiert haben, und drücken Sie dann zur Kalibrierung auf „STAND“. Falls **AUTOLOCK** abgeschaltet ist, wurde der erste Punkt kalibriert. Falls **AUTOLOCK** angeschaltet ist, blinkt „WAIT“, bis das Gerät einen stabilen Messwert erkennt. Sobald das Gerät den ersten Punkt kalibriert hat, wird „STAND“ konstant angezeigt und „SLOPE“ blinkt auf.

   HINWEIS: Falls keine Temperatursonde angeschlossen ist, müssen Sie mit den **Δ-** oder **∇-** Tasten (0,0 bis 60 ºC) den Temperaturmesswert an den des ersten Puffers angleichen, **BEVOR** Sie auf „STAND” drücken.

3. Spülen Sie die pH- und ATC/Temp-Sonden in destilliertem Wasser ab, und geben Sie sie dann in die zweite Pufferlösung (entweder 4.01/4.00 oder 10.01/9.18). Warten Sie, bis sich die Temperaturwerte stabilisiert haben, und drücken Sie dann zur Kalibrierung auf „STAND“. Falls **AUTOLOCK** ausgeschaltet ist, wurde der zweite Punkt kalibriert. Falls **AUTOLOCK** angeschaltet ist, blinkt „WAIT“, bis das Gerät einen stabilen Messwert wahrnimmt. Sobald das Gerät den zweiten Punkt kalibriert, werden sowohl „STAND“ als auch „SLOPE“ konstant angezeigt.

   HINWEIS: Falls keine Temperatursonde angeschlossen ist, müssen Sie mit den **Δ-** oder **∇**-Tasten (0,0 bis 60 ºC) den Temperaturmesswert an den des ersten Puffers angleichen, **BEVOR** Sie auf „SLOPE” drücken.

4. Entsprechend den Werten der beiden Kalibrierungspuffer berechnet das Gerät die pH-Elektrodenneigungs-Abweichung und nimmt einen Ausgleich vor. Das Gerät ist jetzt mit zwei Punkten kalibriert und einsatzbereit für Messungen. Nach der Kalibrierung drücken Sie die Taste **MEA./EFF.** ungefähr 5 Sekunden lang, um die neue Elektrodeneffizienz anzuzeigen.

Verwendung des Elektrodensimulators Modell pH160

Der Elektrodensimulator Modell pH160 kann zur Bestätigung der ordnungsgemäßen Kalibrierung des Instruments verwendet werden. So benutzen Sie den Simulator:

1. Legen Sie die mitgelieferte 9 V-Batterie in das Batteriefach.
2. Bringen Sie den pH160 am pH100 an. Schalten Sie beide Geräte ein. Der pH160 hat einen kleinen Schalter rechts neben den pH-Tasten.
3. In der Betriebsart für die pH-Messung drücken Sie auf eine der pH-Puffersimulatortasten am pH160. Der entsprechende pH-Wert sollte auf beiden Bildschirmen erscheinen.

Hinweis: Die Kalibrierung mit dem pH-Simulator kalibriert nur das Messgerät – NICHT das Messgerät und die Sonde. Für die größte Genauigkeit sollten Sie das pH-Messgerät und die Sonde gemeinsam mit Pufferlösungen kalibrieren.

pH-Messungen

„STAND“ und „SLOPE“ müssen konstant angezeigt werden, um pH-Messungen vorzunehmen. Dies zeigt an, dass das Gerät an zwei Punkten kalibriert und einsatzbereit für Messungen ist. Falls „STAND“ und „SLOPE“ blinken, müssen Sie vor Messungen eine pH-Kalibrierung durchführen.

1. Drücken Sie auf **MODE**, um den pH-Modus aufzurufen, wobei AUTOLOCK je nach Wunsch ein- oder ausgeschaltet sein kann. Für Proben, die inhärent instabil sind, kann derAUTOLOCK-Modus nicht aufgerufen werden. In diesem Fall sollten Sie AUTOLOCK ausschalten.
2. Spülen Sie die pH-Elektrode und/oder ATC/Temp-Sonde mit destilliertem Wasser ab und tauchen Sie sie in die zu messende Probe ein. Schütteln Sie die Sonde oder schwenken Sie sie, um Luftblasen an der Sonde zu entfernen. Warten Sie, bis sich der pH-Wert und/oder die Temperatur stabilisiert haben. Falls keine ATC/Temp-Sonde angeschlossen ist, erscheint „MAN“ für die manuelle Temperaturkompensation. Stellen Sie das Gerät mit den Tasten **Δ** und **∇** (-10,0 bis 120 °C) ein, um die Temperatur der Probe anzuzeigen. Falls eine ATC/Temp-Sonde angeschlossen ist, wird „ATC“ zusammen mit der Temperatur der Probe angezeigt.
3. Falls AUTOLOCK ausgeschaltet ist, wird der pH-Wert der Probe auf dem Bildschirm angezeigt. Falls sowohl der pH- als auch der Temperaturwert stabil sind, lesen Sie die Messwerte ab. Falls AUTOLOCK eingeschaltet ist, drücken Sie auf **MEA./EFF.** „WAIT“ blinkt auf, bis das Gerät einen stabilen pH-Messwert bestimmt.

Temperaturmessungen

Das Modell pH100 kann die Temperatur mit der ATC/Temp-Sonde unabhängig ohne die pH-Elektrode messen. Tauchen Sie die ATC/Temp Sonde in das zu messende Element. Die gemessene Temperatur wird angezeigt.

mV-Messungen

1. Schließen Sie die wahlweise einsetzbare mV-Kombinationselektrode an das Gerät an. Drücken Sie auf **MODE**, um den mV-Modus aufzurufen, wobei AUTOLOCK je nach Wunsch ein- oder ausgeschaltet sein kann. Für Proben, die inhärent instabil sind, kann der

AUTOLOCK-Modus nicht aufgerufen werden. Benutzen Sie in diesem Fall den mV-Modus mit ausgeschaltetem AUTOLOCK.

2. Spülen Sie die Elektrode mit destilliertem Wasser ab und tauchen Sie sie in die zu messende Probe. Falls AUTOLOCK ausgeschaltet ist, wird der mV-Wert der Probe auf dem Bildschirm angezeigt. Falls AUTOLOCK eingeschaltet ist, drücken Sie auf **MEA./EFF.** „WAIT“ blinkt auf, bis das Gerät einen stabilen mV-Messwert bestimmt.

AUFFINDEN UND BESEITIGEN VON STÖRUNGEN

HAUPT-ANZEIGE	MÖGLICHE URSACHE	ABHILFSMASSNAHME
Er 1	• pH-Elektrodenausgleich ist größer/kleiner als +/-1,5 pH. • **STAND** wurde gedrückt, bevor sich die Elektrode und die ATC/Temp-Sonde auf einen Bereich von ±1,5 pH des Pufferwerts einpendelten. • Die pH-Elektrode ist fehlerhaft.	• Wechseln Sie den Puffer und/oder die pH-Elektrode aus. Drücken Sie auf **ESC**. • Geben Sie der Elektrode und der ATC/Temp-Sonde genügend Zeit, um sich zu stabilisieren. • Schicken Sie das Gerät zur Inspektion zurück.
Er 2	• Die pH-Elektrodenneigung weicht mehr als 30% von der Idealneigung ab. • **SLOPE** wurde gedrückt, bevor sich die Elektrode und die ATC/Temp-Sonde auf einen Bereich innerhalb von 30% des Pufferwerts einpendelten. • Puffer 4.00, 4.01, 9.18 oder 10.01 sind nicht richtig.	• Überprüfen Sie, dass der richtige Puffer benutzt wird und dass die Elektrodenneigung nicht mehr als 30% von der theoretischen Neigung abweicht. • Geben Sie der Elektrode und der ATC/Temp-Sonde genügend Zeit, um sich zu stabilisieren. • Wechseln Sie den Puffer und/oder die pH-Elektrode aus. Drücken Sie auf **ESC**. • Schicken Sie das Gerät zur Inspektion zurück.
Er 3	• Die Temperatur liegt außerhalb des Bereichs von 0,0 bis 60,0 °C.	• Bringen Sie die Puffertemperatur in den angegebenen Bereich. • Schicken Sie das Gerät zur Inspektion zurück.
OvEr/Undr	• Der gemessene pH-Wert liegt außerhalb des Bereichs von 16,00/-2,00 pH. • Der gemessene mV-Wert liegt außerhalb des Bereichs von 1250/-2000 mV. • Die gemessene Temperatur liegt außerhalb des Bereichs von –10/120 °C.	• Bringen Sie die außerhalb des Bereichs befindliche Maßeinheit in den korrekten Messbereich zurück. • Falls die Maßeinheiten sich innerhalb des ordnungsgemäßen Bereichs befinden, schicken Sie das Produkt zur Inspektion zurück.

TECHNISCHE DATEN

Anzeige	Bereich	Genauigkeit	Auflösung
pH	-2,00 bis 16,00 pH	±0,1%, ±2 lsd	0,01 pH
mV	-1999 bis 1250 mV	±0,1%, ±1 lsd	1 mV
Temperatur °C	-10,0 bis 120 °C	±0,5 °C	0,1 °C

pH-Temperaturkompensation	AUTO/MANuell -10,0 bis 120,0 °C
pH-Pufferekennung	(4.01, 7.00 & 10.01) oder (4.00, 6.86 & 9.18)
Temperaturbereich der pH-Pufferkalibrierung	0 bis 60 °C
pH-Elektrodenoffset-Erkennung	±90 mV bei pH 7.00 oder 6.86
pH-Elektrodenneigungs-Erkennung	±30% bei pH 4.00, 4.01, 9.18 oder 10.01
Stromquelle	Eine 9 Volt-Batterie
Sicherung der Kalibrierungsdaten	Ja
Audio-Feedback	Ja, auf allen Tasten
Autolock-Funktion	Ja
Betriebstemperaturbereich	0 bis 50 °C
Relative Luftfeuchtigkeit Betriebsbereich	bis zu 95%
ATC-Sonde	Thermistor, 10 kΩ / 25 °C
Abmessungen (B x T x H)	86 mm x 241 mm x 72 mm (3 in x 9.5 in x 2.8 in)
Gewicht (mit Batterie)	430 Gramm (1 lb)

LISTE EMPFOHLENER ERSATZTEILE

Artikelnummer	BESCHREIBUNG
100-1	1 Meter langes wasserdichtes Y-Kabel mit kombinierter pH-/Referenzverbindung & ATC-Elektroden.
100-4	4 Meter langes wasserdichtes Y-Kabel mit kombinierter pH-/Referenzverbindung & ATC-Elektrode.
110-1	pH-Elektrode mit 1 Meter langem Kabel.
115-1	mV-Elektrode mit 1 Meter langem Kabel.
130-1	ATC (Temperatur)-Elektrode mit 1 Meter langem Kabel.
160	pH-Simulatorelektrode
180	pH-Tragekoffer, Hartschale
405	Instrument-Tragetasche, weich

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Revision A • März 2003

GARANZIA

Il misuratore YSI pH100 è coperto da garanzia per un anno dai difetti di manodopera e di materiali a partire dalla data di acquisto dell'utente finale. Le sonde e i cavi di YSI pH100 sono coperti da garanzia per sei mesi dai difetti di manodopera e di materiali a partire dalla data di acquisto dell'utente finale. Durante il periodo di validità della garanzia, Entro il periodo della garanzia, YSI si assume la responsabilità di riparare o sostituire, a sua discrezione, gratuitamente, qualsiasi prodotto che YSI ritenga coperto da garanzia.

Per esercitare il diritto alla garanzia, scrivere o contattare il rappresentante di zona YSI, oppure il Servizio Assistenza Clienti a Yellow Springs, in Ohio. Inviare il prodotto e la prova d'acquisto, con trasporto a proprio carico, al Centro Assistenza autorizzato scelto da YSI. Una volta effettuata la riparazione o la sostituzione il prodotto verrà rinviato, sempre con trasporto a proprie spese. I prodotti riparati o sostituti sono coperti da garanzia per il rimanente periodo di validità della garanzia originale, o per almeno 90 giorni dalla data di riparazione o sostituzione.

Limitazione della garanzia

Questa garanzia non si applica ai prodotti YSI il cui danno o cattivo funzionamento è dovuto a: (i) installazione, messa in funzione o utilizzo del prodotto non conformi alle istruzioni scritte di YSI; (ii) abuso o uso improprio del prodotto; (iii) mancato rispetto delle istruzioni scritte di YSI o delle procedure standard dell'industria; (iv) eventuali riparazioni improprie del prodotto; (v) utilizzo da parte dell'utente di parti o componenti impropri o difettosi in fase di manutenzione o riparazione del prodotto; o (vi) eventuali modifiche del prodotto in modalità non espressamente autorizzate da YSI.

QUESTA GARANZIA SOSTITUISCE TUTTE LE ALTRE, ESPLICITE O IMPLICITE, COMPRESE QUELLE DI COMMERCIABILITÀ O IDONEITÀ AD UNO SCOPO PARTICOLARE. LA RESPONSABILITÀ DI YSI SECONDO QUESTA GARANZIA SI LIMITA ESCLUSIVAMENTE ALLA RIPARAZIONE O ALLA SOSTITUZIONE DEL PRODOTTO CHE COSTITUIRÀ L'UNICA ED ESCLUSIVA FORMA DI RIMBORSO PER EVENTUALI DIFETTI COPERTI DA QUESTA GARANZIA. IN NESSUN CASO YSI SARÀ RESPONSABILE DI EVENTUALI DANNI SPECIALI, INDIRETTI, INCIDENTALI O CONSEQUENZIALI DERIVANTI DA EVENTUALI DIFETTI DEL PRODOTTO COPERTO DA QUESTA GARANZIA.

REFERENTE

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INTRODUZIONE GENERALE

Il modello pH100 è uno strumento di precisione che misura pH, mV e la temperatura. Un microprocessore incorporato memorizza, calcola e compensa tutti i parametri relativi alle determinazioni del pH comprese le caratteristiche della temperatura dell'elettrodo pH, le deviazioni di pendenza dell'elettrodo e le soluzioni buffer.

Questa unità ha un alloggiamento IP65 a tenuta stagna. I tasti a sfioramento meccanico sono estremamente affidabili grazie alla conferma di azionamento tattile e acustica. Questo misuratore utilizza una batteria da 9V. Quando viene ripristinata l'alimentazione non è richiesta alcuna ricalibrazione.

La parte anteriore del misuratore presenta un ampio display LCD che visualizza simultaneamente pH o mV e la temperatura insieme ai prompt per l'utente e agli indicatori di modalità. L'unità avvisa l'utente attraverso procedure di calibrazione e di misurazione.

Una funzione AUTOLOCK per le misurazioni pH e mV consente all'unità di rilevare automaticamente il punto finale e di "bloccare" il display per indicare il valore del punto finale di una misurazione. È possibile utilizzare pH100 anche in modalità non-AUTOLOCK. La funzione AUTOLOCK e i prompt per l'utente aiutano a eliminare la maggior parte degli errori di determinazione dei valori pH e mV, effettuando misurazioni precise, riproducibili e senza errori.

Il modello pH100 è disponibile con le sonde pH, mV, ORP e ATC (CAT: Compensazione automatica della temperatura). Le altre funzioni includono il riconoscimento offset dell'elettrodo, quello della pendenza dello stesso, il display di rendimento dell'elettrodo, i coefficienti del buffer incorporati, la compensazione automatica o manuale della temperatura, una lunga durata utile della batteria e un filtraggio CA 50/60 Hz. Questo misuratore è universale, di facile utilizzo, per applicazioni su campo, industriali e di laboratorio.

ISPEZIONE INIZIALE

Disimballare accuratamente l'unità e gli accessori e valutare la presenza di eventuali danni da trasporto. Controllare se i pezzi ricevuti corrispondono ai materiali elencati nella distinta di spedizione. Informare immediatamente YSI di eventuali parti danneggiate o mancanti. Conservare tutti i materiali di imballaggio fino al corretto funzionamento.

TENUTA STAGNA

Sebbene il misuratore pH100 sia montato in un alloggiamento a tenuta stagna, NON utilizzarlo sott'acqua. L'alloggiamento a tenuta stagna impedisce danni permanenti all'unità nel caso cada accidentalmente in soluzioni non corrosive. Seguire immediatamente queste procedure se l'unità viene immersa in qualsiasi tipo di soluzione:

1. Risciacquare accuratamente l'unità con acqua distillata. Dopo il risciacquo e l'asciugatura, ispezionare e pulire i connettori per rimuovere tutte le eventuali sostanze contaminanti che potrebbero danneggiare i collegamenti della sonda.
2. Attendere che l'unità e la sonda siano completamente asciutte prima di riprendere il funzionamento.
3. Se l'unità non funziona correttamente dopo le fasi 1 e 2, rivolgersi a YSI per eventuali riparazioni o per la sostituzione (vedere Garanzia).

INSTALLAZIONE DELLA BATTERIA

Un messaggio iniziale di “BAT” sul display indica un tempo residuo di funzionamento a batteria pari a circa un'ora, entro le specifiche. Sostituire la batteria quando sul display appare “BAT”. (Vedere Figura 1.)

Per la sostituzione, rimuovere i due coprivite della batteria, il dispositivo di copertura della batteria e l'o-ring. Sostituire la batteria da 9V. Rimettere il dispositivo di copertura della batteria e l'o-ring (allineare l'o-ring correttamente per garantire un'adeguata chiusura) e stringere i due coprivite della batteria per conservare l'ermeticità.

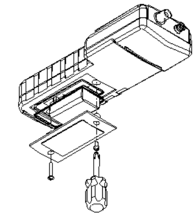

Figura 1
Installazione della batteria

FUNZIONI CHIAVE DEL MODELLO pH100

1. **⏻:** Accende e spegne l'unità. I valori di calibrazione del pH non si cancellano quando l'unità viene spenta. Una volta riattivata, l'unità presenta lo stesso stato di quando è stata spenta. Quando l'unità non è in uso, spegnerla per prolungare la durata utile della batteria. Per un immagazzinaggio a lungo termine, rimuovere le batterie.
2. **MODALITÀ:** seleziona la modalità display. Premere **MODE** per visualizzare in successione pH-AUTOLOCK , mV-AUTOLOCK , pH, e mV. I valori di calibrazione non vengono influenzati dal cambiamento di modalità del display.
3. **Tasti STAND** e **SLOPE:** utilizzati per una calibrazione pH a doppio punto dell'unità. Mantenere premuto **STAND** durante l'accensione per modificare le impostazioni del buffer.
4. **Tasti ∆** e **∇:** premere per inserire i valori della temperatura in modalità (MAN) manuale. Questi tasti sono inattivi in modalità ATC.
5. **MEA./EFF.:** Premere per disabilitare lo stato AUTOLOCK quando si opera in modalità pH-AUTOLOCK o mV-AUTOLOCK. Mantenere premuto per 5 secondi per visualizzare il rendimento dell'elettrodo.
6. **ESC:** premere per azzerare l'unità quando appare un segnale di errore; questo azzera tutti i valori di calibrazione conservati nella memoria interna. Per prevenire azzeramenti accidentali durante il normale utilizzo, il tasto non risponde a meno che non venga premuto per 2 secondi. Il tasto risponde solo quando viene visualizzato un messaggio di errore.

   Quando viene premuto **ESC**, tutti gli elementi LCD si illuminano. Dopo circa 2 secondi, l'unità entra in modalità pH-AUTOLOCK. Si visualizza “AUTOLOCK” e “STAND” comincia a lampeggiare indicando la necessità della calibrazione. Premere **ESC** esclusivamente quando si verificano errori che richiedono la ricalibrazione dell'unità.

IL DISPLAY LCD

1. **WAIT:** si visualizza quando l'unità è in attesa di una lettura stabile o di un rilevamento del punto finale.
2. **BAT:** indicatore di batteria scarica.
3. **ATC/MAN:** si visualizza “ATC” se una sonda ATC è collegata.. Altrimenti si visualizza "MAN".
4. **STAND/SLOPE:** “STAND” o “SLOPE” rimane stabile se il parametro è stato calibrato. Se uno dei due non è stato calibrato, questo lampeggia.
5. **AUTO:** indicatore della modalità Autolock .

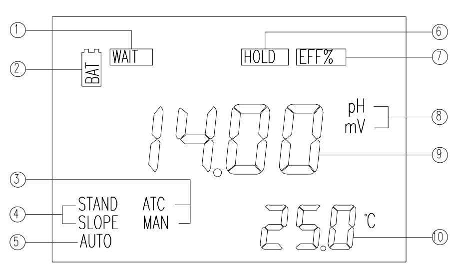

Figura 2. Display LCD

6. **HOLD:** indica che una lettura è congelata durante la modalità Autolock.
7. **EFF%:** si visualizza quando l'utente visualizza il rendimento dell'elettrodo. Si raccomanda di sostituire l'elettrodo quando il rendimento è inferiore al 75%.
8. **pH/mV:** unità e indicatori di modalità.
9. Il display principale per i valori pH, mV e di rendimento della sonda.
10. **°C:** display della temperatura.

PROCEDURE DI FUNZIONAMENTO

Selezione della tabella buffer

Questa unità ha due impostazioni buffer: 7.00,4.01,10.01pH e 6.86,4.00,9.18pH. Per modificare l'impostazione del buffer, spegnere l'unità, quindi tenere premuto **STAND** durante la riaccensione dell'unità. Se l'unità non è calibrata e in modalità pH, si visualizza "7,00" se la prima impostazione è attiva e "6,86" se è la seconda quella attiva.

Calibrazione pH

Il pH100 utilizza una calibrazione del 2-punto. Il primo punto deve essere un buffer 6,86/7,00 e il secondo uno di 4,00/4,01 o 9,18/10,01. È possibile acquistare questi buffer presso il rappresentante di zona YSI.

1. Accendere l'unità. Collegare l'elettrodo pH al connettore BNC e la sonda ATC/Temp al connettore ATC/Temp dell'unità; si visualizza "ATC". Premere **MODE** fino a quando non si visualizza "pH". Autolock potrebbe essere acceso o spento, come si desidera.

2. **AUTOLOCK ON:** posizionare le sonde pH e ATC/temp nella soluzione del primo buffer (7,00 o 6,98). Consentire la stabilizzazione delle letture della temperatura, quindi premere "STAND" per calibrare. Se **AUTOLOCK** è off, il primo punto è stato calibrato. Se **AUTOLOCK** è on, "WAIT" lampeggia fino a quando l'unità non rileva una lettura stabile. Dopo che l'unità ha calibrato il primo punto, "STAND" si visualizza stabilmente e "SLOPE" lampeggia.

   NOTA: se non è collegata alcuna sonda della temperatura, regolare la lettura della temperatura in base a quella del primo buffer utilizzando i tasti **Δ** o **∇** (0,0 a 60ºC) **PRIMA** di premere "STAND".

3. Risciacquare le sonde pH e ATC/temp in acqua distillata, quindi immergerle nella soluzione del secondo buffer (4,01/4,00 o 10,01/9,18). Consentire la stabilizzazione delle letture della temperatura, quindi premere "SLOPE" per calibrare. Se **AUTOLOCK** è off, il secondo punto è stato calibrato. Se **AUTOLOCK** è on, "WAIT" lampeggia fino a quando l'unità non rileva una lettura stabile. Una volta che l'unità calibra il secondo punto, "STAND" e "SLOPE" si visualizzano stabilmente.

   NOTA: se la sonda della temperatura non è collegata, regolare la lettura della temperatura in base a quella del primo buffer utilizzando i tasti **Δ** o **∇** (0,0 a 60ºC) **PRIMA** di premere "SLOPE".

4. L'unità calcola e compensa per la deviazione della pendenza dell'elettrodo pH corrispondente ai valori dei due buffer della calibrazione. L'unità è adesso calibrata a doppio punto e pronta per le misurazioni. Dopo la calibrazione, tenere premuto **MEA. /EFF.** per 5 secondi per visualizzare il nuovo rendimento dell'elettrodo.

Utilizzo del simulatore dell'elettrodo modello pH160

È possibile utilizzare il Simulatore dell'elettrodo pH160 per confermare la giusta calibrazione del misuratore. Per utilizzare il simulatore:

1. Installare la batteria da 9V in dotazione.
2. Fissare pH160 a pH100. Accendere entrambe le unità. Il pH160 presenta un piccolo interruttore sulla destra dei pulsanti pH.
3. In modalità misurazione pH, premere uno dei pulsanti del simulatore buffer pH sul pH160. Il valore pH corrispondente appare su entrambi gli schermi.

Nota: la calibrazione con il simulatore pH calibra esclusivamente il misuratore - NON il misuratore e la sonda. Per una maggiore precisione, calibrare il misuratore pH e la sonda insieme utilizzando le soluzioni buffer.

Misurazioni pH

Per effettuare misurazioni di pH, "STAND" e "SLOPE" devono essere visualizzati in maniera stabile, indicando che l'unità è calibrata a doppio punto e pronta per le misurazioni. Se "STAND" e "SLOPE" lampeggiano, eseguire una calibrazione pH prima di eseguire le misurazioni.

1. Premere **MODE** per inserire la modalità pH con AUTOLOCK on o off come desiderato. Per campioni intrinsecamente instabili, l'unità non passerà in AUTOLOCK. Disattivare AUTOLOCK in questo caso.
2. Risciacquare l'elettrodo pH e/o la sonda ATC/temp con acqua distillata e immergere nel campione da misurare. Rimuovere eventuali bolle d'aria intrappolate intorno alla sonda agitando o muovendo la sonda. Consentire la stabilizzazione del pH e/o della temperatura. Se non è collegata alcuna sonda ATC/temp, si visualizza "MAN", ad indicare la compensazione della temperatura manuale. Impostare l'unità per visualizzare la temperatura del campione premendo i tasti **Δ** e **∇** (-10,0 a 120°C). Se è collegata una sonda ATC/temp, si visualizza "ATC", insieme alla temperatura del campione.
3. Se AUTOLOCK è off, il valore pH del campione si visualizza sullo schermo. Se entrambe le letture del pH e della temperatura sono stabili, effettuare una lettura. Se AUTOLOCK è on, premere **MEA./EFF.** "WAIT" lampeggia fino a quando l'unità determina una lettura pH stabile.

Misurazioni della temperatura

Il modello pH100 può misurare la temperatura indipendentemente con la sonda ATC/Temp senza utilizzare l'elettrodo pH. Posizionare la sonda ATC/Temp nel fluido da misurare. Si visualizza la temperatura misurata.

Misurazioni mV

1. Collegare l'elettrodo mV di combinazione opzionale all'unità. Premere **MODE** per inserire la modalità mV con AUTOLOCK on o off come desiderato. Per campioni intrinsecamente instabili, l'unità non passerà in AUTOLOCK. Utilizzare la modalità mV con AUTOLOCK off in questo caso.
2. Risciacquare l'elettrodo con acqua distillata e immergerlo nel campione da misurare. Se AUTOLOCK è off, il valore mV del campione viene visualizzato sullo schermo. Se AUTOLOCK è on, premere **MEA./EFF.** "WAIT" lampeggia fino a quando l'unità determina una lettura mV stabile.

INDIVIDUAZIONE E RISOLUZIONE DEI PROBLEMI

DISPLAY PRINCIPALE	POSSIBILE CAUSA	AZIONE CORRETTIVA
Er 1	• L'offset dell'elettrodo pH è maggiore/inferiore rispetto a +/- 1,5 pH • **STAND** era stato premuto prima dell'elettrodo e la sonda ATC/Temp regolata all'interno dello ±1,5 pH del valore del buffer. • l'elettrodo pH è difettoso	• Sostituire il buffer e/o l'elettrodo del pH. Premere **ESC.** • Consentire un tempo sufficiente di stabilizzazione per l'elettrodo e la sonda ATC/Temp. • Restituire all'assistenza.
Er 2	• La pendenza dell'elettrodo pH devia oltre il 30% della pendenza ideale. • **SLOPE** era stato premuto prima dell'elettrodo e la sonda ATC/Temp regolata all'interno del 30% del valore del buffer. • Buffer 4,00, 4,01, 9,18 o 10,01 non è corretto.	• Controllare che venga utilizzato il buffer corretto e che la pendenza dell'elettrodo non devii oltre il 30% dalla pendenza teorica. • Consentire un tempo sufficiente di stabilizzazione per l'elettrodo e la sonda ATC/Temp. • Sostituire il buffer e/o l'elettrodo del pH. Premere **ESC.** • Restituire all'assistenza.
Er 3	• La temperatura è fuori dall'intervallo 0,0 - 60,0 °C.	• Portare la temperatura del buffer nell'intervallo. • Restituire all'assistenza.
OvEr/Undr	• Il pH misurato è fuori dall'intervallo 16,00/-2,00 pH. • L'mV misurato è fuori dall'intervallo 1250/-2000 mV. • La temperatura misurata è fuori dall'intervallo 10/120 °C.	• Portare l'unità fuori dall'intervallo in quello di misurazione corretto. • Se le unità sono nell'intervallo giusto, restituire il prodotto all'assistenza.

SPECIFICHE

Display	Intervallo	Precisione	Risoluzione
pH	-2,00 – 16,00 pH	±0,1%, ±2 lsd	0,01 pH
mV	-1999 – 1250 mV	±0,1%, ±1 lsd	1 mV
Temperatura °C	-10,0 - 120 °C	±0,5 °C	0,1 °C

Compensazione Temp pH	AUTO/MANuale –10,0 – 120,0 °C
Riconoscimento buffer pH	(4,01, 7,00 e 10,01) o (4,00, 6,86 e 9,18)
Temp. calibrazione buffer pH Intervallo	0 - 60 °C
Riconoscimento offset elettrodo pH	±90mV a pH 7,00 o 6,86
Riconoscimento pendenza elettrodo pH	±30% a pH 4,00, 4,01, 9,18 o 10,01
Potenza	Una batteria da 9V
Back up di calibrazione	Sì
Feedback audio	Sì, su tutti i tasti a sfioramento
Funzione Autolock	Sì
Intervallo temp. di funzionamento	0 - 50 °C
Intervallo di umidità relativa al funzionamento	fino al 95%
Sonda ATC	Termistore, 10kΩ / 25 °C
Dimensioni (L x P x A)	86 mm x 241 mm x 72 mm (3 in x 9,5 in x 2,8 in)
Peso (batterie incluse)	430 grammi (1 lb)

ELENCO DEI PEZZI DI RICAMBIO RACCOMANDATI

N. PEZZO	DESCRIZIONE
100-1	cavo Y da 1 metro resistente all'acqua con combo pH/giunto freddo ed elettrodi ATC.
100-4	cavo Y da 4 metri resistente all'acqua con combo pH/giunto freddo ed elettrodo ATC.
110-1	elettrodo pH con cavo da 1 metro.
115-1	elettrodo mV con cavo da 1 metro.
130-1	elettrodo ATC (temperatura) con cavo da 1 metro.
160	elettrodo simulatore pH.
180	contenitore per il trasporto pH, rigido.
405	Contenitore per il trasporto del misuratore, morbido.

N. di pezzo 605367 • N. disegno A605367
Revisione A • marzo 2003

QUALITY ASSURANCE PROJECT PLAN

Amendment 1 For

FURNACE & OLDHAM POND WATERSHED RESTORATION PLAN

May 5, 2010

Revision No: 4
RFA # 10085

Massachusetts Department of Environmental Protection 604(b) Water Quality Management Planning Grant Program: Furnace & Oldham Pond Watershed Restoration Plan (BRP 09-03/ARRA 604)

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1.3. Distribution List

A complete project distribution list is provided in Section 3, Distribution List of the draft QAPP.

1.4. Project / Task Organization

Project / Task Organization is provided in Section 4, Project Organization and Responsibilities of the draft QAPP.

1.5. Problem Definition/Background

The Town of Pembroke, Massachusetts has a number of ponds within its boundaries. Two of these ponds, Oldham Pond and Furnace Pond have significant water quality problems with Oldham Pond listed as Category 4c for exotic species on the Massachusetts 303(d) list of impaired waters and Furnace Pond listed as Category 5 for organic enrichment and low dissolved oxygen. Oldham Pond is approximately 220-acres in size, approximately eight feet deep, and directly feeds Furnace Pond. Furnace Pond is approximately 96-acres in size and approximately twelve feet deep. Historic water quality data for both ponds indicates significantly high total phosphorus levels and turbidity likely lending to the excessive nuisance aquatic weeds and algal blooms. Located in a relatively developed watershed, the shoreline of these ponds is dotted with full-time residences and several commercial businesses.

Previous studies include a Diagnostic Feasibility Study completed in 1993 for both Furnace and Oldham Ponds. This study was completed under MGL Chapter 628, the Massachusetts Clean Lake Program that existed at that time. Extensive water quality data in this survey indicates that Oldham and Furnace have high levels of nutrient enrichment and invasive aquatic vegetation. Both ponds were also found to have stormwater impacts, although at the time the study's recommendations said little about how to specifically deal with stormwater contamination. The study did recommend leaching catch basins for the Furnace Pond drainage area. A subsequent study of Oldham Pond was completed under the Department of Environmental Management's (DEM now DCR) Lakes Program in the year 2000 (Comprehensive Environmental, Inc., 2000) while Furnace was completed under the same program in 2001 (Comprehensive Environmental, Inc., 2001). These studies included additional sampling data and updated recommendations based on the advancement of stormwater technologies at the time.

As a result of these studies, beginning in 2001, the Town received and successfully completed several MassDEP/EPA s.319 Nonpoint Source Pollution grant projects. Projects concentrated on the lower reaches of the watershed by retrofitting 27 catch basins with leaching basins and using a vacuum street sweeper adjacent to the ponds. More recently, the Town worked with the North and South Rivers Water Association (NSRWA), the Pembroke Watershed Association (PWA) and CEI to engineer and construct several Low Impact Development (LID) retrofit projects at the Oldham Pond boat ramp and Town Hall. Since 2006, the PWA has collected significant water quality data from both ponds and in 2008 began data collection under an approved Quality Assurance Project Plan.

As the studies approach the 10 year mark, the Town and the PWA would like to prepare an update that will evaluate watershed improvements completed to date, allow for the incorporation of more recent development and water quality testing and provide more specific BMP recommendations with quantifiable results to help guide future restoration efforts. Stakeholders include the Town of Pembroke, watershed residents, citizens utilizing the public beach for recreational purposes and swimming lessons and the dedicated members of the PWA. Additionally, Furnace Pond (fed by Oldham Pond) is a back-up drinking water supply for the City of Brockton. Stakeholders aim to gain over the next 10-years improved water quality to Oldham and Furnace Pond, specifically reduced phosphorus and sediment inputs therefore reducing algal blooms and nuisance aquatic weeds and decreasing fish kill events currently resulting from low DO.

The South Coastal Watershed Action Plan identifies Furnace Pond as a waterbody in critical condition with the pond having lost much of its depth to excessive eutrophication and filling in with soft sediments. It indicates a great need for restoration (along with Oldham) and is being limited recreationally by lack of depth. Low DO has stressed conditions for fish and other species using the pond. The Action Plan indicates that 1) dredging should be high on the list of remediation actions to remove existing phosphorus that is recycling in the pond and 2) it calls for immediate corrective actions to stop inputs of untreated stormwater. The Town, PWA and CEI recently completed a Dredging Feasibility Study for Furnace Pond and are currently completing a hydrologic analysis related to potential dredging impact to groundwater. With this effort already underway, the proposed project will address the second issue outlined in the Action Plan which will prioritize restoration efforts in a long-term plan for both Oldham and Furnace Pond.

1.6. Project / Task Description

The primary purpose of the proposed project is to develop a long-term watershed restoration plan for both Oldham and Furnace Pond by utilizing a quantitative approach. This approach will prioritize future watershed protection activities to obtain the most cost effective pollutant removal, while estimating the anticipated improvements. The study will focus on where the pollutants, in this case phosphorus, are coming from and how much of it needs to be removed under existing and buildout conditions to reduce in-lake phosphorous levels to meet recreational goals. Ultimately, the Town of Pembroke can use the plan to implement the most cost-effective BMPs to meet water quality goals and to obtain future funds under the s319 grant program for implementation.

A task-by-task approach is as follows:

Objective / Task #1: Amended Quality Assurance Project Plan (QAPP)

The Pembroke Watershed Association currently collects water quality data within the Oldham and Furnace Pond watersheds under an approved December 31, 2007 Quality Assurance Project Plan (QAPP). This QAPP will be amended to incorporate the proposed water quality modeling to be performed under this project as described under Task 4 and any changes to the existing monitoring program discussed under Task 2. Currently approved QAPP is attached.

Objective / Task #2: Implement Monitoring Program

The Pembroke Watershed Association has been collecting water quality data from Oldham and Furnace Ponds between 2008 and the present at four locations within Oldham Pond and three locations within Furnace Pond under the above referenced approved QAPP. The new study will modify the sampling locations such that five locations within Oldham Pond and two within Furnace Pond will be sampled. Monthly samples are collected between June and September and analyzed for pH, temperature, dissolved oxygen (DO), conductivity, salinity, total phosphorus, alkalinity, chloride and turbidity. Additionally, Secchi disk readings are taken at all locations during all sampling rounds and nitrite nitrogen, nitrate nitrogen, TKN, and ammonia nitrate are analyzed once per year.

Currently, grab samples are taken at a depth of 48 inches. The YSI /pH instrument measurements are conducted at a depth of 48 inches and 84 inches to obtain a profile of the pond and determine if the pond stratifies. Sampling in Oldham and Furnace Ponds will involve collecting temperature and dissolved oxygen data at two-foot intervals at each deep hole location. If stratification is found to occur, two phosphorus samples will be collected, one from the epilimnion layer (surface) and one from the hypolimnion layer (bottom). All test parameters listed above are evaluated and compared to state standards and when applicable US EPA nutrient criteria. The information collected will be used as base line data against which to assess future changes.

Objective / Task #3: Field Reconnaissance
A windshield survey of the watershed will be performed to review changes in the watershed that have occurred since the 2000 and 2001 studies and to identify specific pollution sources that may require more attention in the proposed modeling and possible sites for BMP locations.

Objective / Task #4: Pollutant Modeling & Buildout Analysis
Phosphorus loadings were previously estimated in the 2000 and 2001 pollution source investigation studies using a simplistic loading model based on impervious surfaces. The purpose was to identify the subwatersheds with the greatest loadings to help target BMPs. While it did allow for comparisons of subwatersheds, it was not calibrated to existing water quality data within the watershed. These loadings will be updated based on more recent land use data and land use based loading coefficients for phosphorus.

The subwatersheds for each pond were delineated under the 2000 and 2001 studies based on topography and locations of inlets to the ponds. The use of subwatersheds allows the pollutant loadings to be broken up based on key subwatershed features, which allows for easier prioritization of needed actions by focusing on those areas that require the most attention.

In conjunction with the field sampling measures at Furnace and Oldham Ponds, a land use based model and a lake response model utilizing subwatershed characteristics and the Simple Method to model pollutant loadings. Modeling will be performed for both existing conditions and buildout conditions, while also roughly estimating how much of the load might be corrected through specific measures. Existing land uses within the watershed will be obtained through MassGIS files and local GIS information as available and input into the model to estimate phosphorus loads from the watershed. The model will account for loadings associated with stormwater runoff from each type of land use as well as septic systems within proximity of the ponds. Other inputs such as flow from active cranberry bogs, phosphorus from internal recycling and phosphorus from baseflow will also be estimated for use in the model. The modeling effort will be supported by a windshield survey of the watershed to review changes in the Furnace and Oldham Pond watersheds that have occurred since the 2000 and 2001 studies and to identify specific pollution sources that may require more attention in the proposed modeling and possible sites for BMP locations.

A buildout scenario will be prepared by overlaying existing land use with existing zoning and accounting for development restrictions such as protected lands and wetlands. The anticipated lands uses at buildout will be input into the model to determine loadings under buildout conditions. The buildout scenario will be used to develop load reduction measures necessary to meet water quality goals.

Objective / Task #5: Identify Load Reduction Measures

Realistic, achievable water quality goals that promote the recreational and wildlife use of the ponds will be set for phosphorus within the ponds. The required load reduction to meet these goals under existing and buildout conditions will be calculated using the lake response model established under Task 4.

Based on the needed reductions and available watershed information, specific BMPs will be identified to reduce phosphorus loadings to the desired levels. Load reduction measures to be reviewed may include:

a. Site-specific improvements such as runoff controls for specific areas identified during the watershed review
b. Septic system improvements or changes to ordinances – increased pumping, replacement of failing systems, etc.
c. Use of Low Impact Development (LID) to retrofit existing development
d. Use of LID for new projects (how to encourage/incentivize/regulate LID)
e. Street sweeping and maintenance of catch basins and other stormwater controls
f. Public education improvements and focus
g. In-lake measures where applicable
h. Other measures
    i. Invasive species controls
    ii. Erosion controls
    iii. Regular monitoring program to evaluate trends – flows and water quality

Objective / Task #6: Watershed Restoration Plan

A draft and final watershed restoration plan will be prepared outlining the findings from the above tasks and including recommendations for proposed BMPs to meet the defined water quality goals. Costs and phosphorus removal will be defined for each recommended BMP and presented as cost per pound of phosphorus removed. Recommendations will be prioritized and a 10-year implementation schedule will be performed. Recommendations will be presented in a user friendly format, clearly identifying the steps needed to implement the recommendations with milestones, along with the objectives, responsibility, cost and potential funding sources for each recommended BMP.

Criteria that will be used to prioritize areas for future site BMPs or watershed restoration will include the extent of water quality impacts from each tributary, type of pollutant being remediated, will the BMP adequately promote stormwater awareness, area required to construct a BMP that sufficiently treats stormwater, property ownership, cost to implement or construct BMP, maintenance responsibilities and associated costs. Criteria will then be weighted for each area based on associated benefits. Areas with the highest ranking will be the highest priority locations.

Objective / Task #7: Prepare Engineering Designs
Engineering designs will be prepared for the top 3-5 structural improvements identified for future submittal for s.319 grant funding. Engineering drawings to a 30% level and estimated construction costs will be prepared.

Objective / Task #8: Reporting
Monthly project status reports will be prepared and submitted to MassDEP per the new ARRA reporting requirements. Additionally, quarterly invoices will be submitted as well as a final project report per grant guidelines and required copies. **Table 1.6-1** outlines the project schedule.

Table 1.6-1. Project Milestone Schedule

Task Description	Month														
	Jan 2010	Feb 2010	Mar 2010	Apr 2010	May 2010	Jun 2010	Jul 2010	Aug 2010	Sep 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	Mar 2011
Task 1: QAPP	x	x	x												
Task 2: Monitoring Program				x	x	x	x	x							
Task 3: Field Reconnaissance					x	x									
Task 4: Pollutant Modeling							x	x	x						
Task 5: Load Reduction Measures									x	x					
Task 6: Watershed Restoration Plan										x	x	x	x		
Task 7: Prepare Engineering Designs													x	x	
Task 8: Reporting	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

1.7. Data Quality Objectives for Measurement Data

The primary purpose of this project is to develop a long-term watershed restoration plan for both Oldham and Furnace Pond by utilizing a quantitative approach. This approach will prioritize future watershed protection activities to obtain the most cost effective pollutant removal, while estimating the anticipated improvements. The study will focus on where the pollutants are coming from and how much need to be removed under both existing and buildout conditions to reduce in-lake phosphorus levels to meet recreational goals.

Criteria that will be used to prioritize areas for future site BMPs or watershed restoration will include the extent of water quality impacts addressed, type of pollutant being remediated, public visibility and awareness, area required to construct a BMP that sufficiently treats stormwater, property ownership issues, cost to implement or construct BMP, and maintenance frequency and costs. Criteria will then be weighted for each area based on associated benefits. Areas with the highest ranking will be the highest priority locations. Each BMP location will be prioritized based on the previously mentioned criteria ranked as follows:

Table 1.6-2. Criteria and Prioritization

Point Value	Water Quality Impact Addressed	Type of Pollutant Addressed	Public Visibility and Awareness	Area Required	Property Ownership Issues	Cost of Design and Construction	Maintenance Concerns
3	Large Improvement Expected	Phosphorus	High Visibility (downtown, high profile)	Minimal Area Required (<0.25 acres)	Owned by Town, Undeveloped	Highly Cost Effective	Low (>5 year frequency / low cost)
2	Moderate Improvement Expected	Nitrogen / Dissolved Oxygen	Medium Visibility (e.g. secondary road)	Medium Area Required (0.25 - 1 acre)	Owned by Other, Undeveloped	Moderately Cost Effective	Medium (2- 5 year frequency / moderate cost)
1	Minimal Improvement Expected	Turbidity and Other Pollutants	Low Visibility (e.g. woods, underground BMP)	Large Area Required (>1 acre)	Developed Land	Minimally Cost Effective	High (<1 - 2 year frequency / high cost)

Values and criteria may change from the above-mentioned parameters, and any changes made will be detailed in the final report.

- Water Quality Impact Addressed: BMPs that are expected to provide a larger water quality improvement as outlined in the Massachusetts Stormwater Handbook will rank highest whereas those providing a smaller improvement will rank lower.
- Type of Pollutant Addressed: pollutants of primary concern and those referenced on the 303(d) List of Impaired Waters rank highest. More than one selection is possible.
- Public Visibility and Awareness: BMPs constructed in highly visible areas and those that offer public education opportunities (e.g. raingardens, gravel wetland), rank highest whereas those in a less public place or located underground (e.g. swirl separators) rank lower.
- Area Required: BMPs that require a smaller area rank highest whereas those requiring a larger area rank lower.
- Available Property / Ownership Issues: property that is either already town-owned or easily acquired will rank highest whereas areas that have no room for development will rank lower.
- Cost of Construction: BMPs which are cheapest to design and construct will rank highest, whereas more expensive BMPs will rank lower.

- Maintenance Concerns: BMPs which require less frequent maintenance, or maintenance is not expected to be costly will rank highest, whereas those requiring more frequent or expensive maintenance will rank lower.

Data will be used to assess the most appropriate sites for structural BMP construction in terms of the beneficial impact on surface water quality. MA DEP will use the data to assess the performance of projects it funds through their respective grant programs. The data will also be available to other interested parties, such as the Pembroke Watershed Association, and for regional reporting purposes. Model calibration, validation, sensitivity and uncertainty are described in Sections 4.1 and 4.2 of the QAPP.

Field data quality objectives are consistent with measures described under a previously approved QAPP and are provided under Section 7, Data Quality Objectives of the QAPP. Both Data Completeness tables were updated to reflect 5 proposed sites in Oldham Pond and 2 proposed sites at Furnace Pond.

1.8. Training Requirements / Certification

Field training methods for sampling by the PWA are provided under Section 8, Training Requirements of the QAPP. Modeling will be done by Comprehensive Environmental. Staff familiar with both landuse and lake response models will perform modeling, including calculations, coefficient approximations, and accuracy checks. Although no special training is required to perform modeling, experienced personnel with knowledge of the underlying principles of the model will oversee development and application of the spreadsheet model used in this study.

1.9. Documentation and Records

Detailed documentation and records are provided in Section 9, Documentation and Records of the QAPP. Documentation of this project will be kept on file by the MA DEP, the Town of Pembroke, Pembroke Watershed Association, and Comprehensive Environmental Inc. (CEI). The Modeling Coordinator will be responsible for assembling and maintaining project documents and records. Modeling data will be stored in a Microsoft Excel spreadsheet. Summary data will be tabulated into various tables and graphs and presented in the draft and final reports. Maps generated from MassGIS, aerial, and other data sources will be stored in an electronic format. Hard copies will be included in the final report. Other aspects of the modeling effort will be documented in a narrative and stored in Microsoft Word format.

Monthly and quarterly reports will document work from the most recent reporting round. The final report will document procedures and findings for the entire project. All reports will be submitted to the Town of Pembroke, Pembroke Watershed Association, EPA and MA DEP for approval. The central storage location for all final project deliverables is the Comprehensive Environmental office in Marlborough, MA. Files will be maintained at this location for a minimum period of 5 years. Electronic files will be stored on servers at Comprehensive Environmental. Servers are secure and backed up several times per week. Electronic data will be stored for a minimum of five years.

Upon approval by MA DEP and EPA, the approved QAPP will be distributed to those specified on the Distribution List as outlined in Section 1.3. Distribution will be done via email, with hardcopies available to CEI staff and the Pembroke Watershed Association. Any updates will be sent via email.

2.1. Sampling Process Design

The sampling process is described in Section 10, Sampling Process of the QAPP. The proposed sampling program was altered slightly from the original design for Oldham and Furnace Ponds. Sampling will consist of 5 samples in Oldham Pond and 2 in Furnace Pond as shown in Map Two and Map Three in the QAPP. Locations are described as follows:

Table 2.1-1. Sample Locations

Waterbody	Name	Description	Latitude	Longitude
Oldham Pond	Tributary A		42^0 04.217 N	70^0 50.640 W
	Tributary B		42^0 04.172 N	70^0 50.669 W
	Country Lane	Upstream of culvert	42^0 04.496 N	70^0 50.724 W
	O-08	Southeast Pembroke Side	42^0 03.645 N	70^0 49.910 W
	Outlet		42^0 03.550 N	70^0 49.976 W
Furnace Pond	F-08	South	42^0 03.233 N	70^0 49.315 W
	Outlet		42^0 03.186 N	70^0 49.182 W

Sampling locations were adjusted from the previously approved program to try and gain a better understanding of what is going in and coming out of each pond. By sampling both major tributaries and outfalls of each pond, a lake response model can be developed to replicate phosphorus impacts and potential solutions.

This modified sampling program will also involve collecting samples from the deep hole locations in each pond. To determine whether or not the pond stratifies, DO and temperature readings will be performed at two-foot intervals throughout the water column. Should stratification be observed, phosphorus samples will be collected, one each from the epilimnion and hypolimnion layers.

2.2. Sampling Method Requirements

Sampling method requirements are outlined in Section 11, Sampling Method Requirements of the QAPP. No additional project-specific details are required as this project will build upon a previously approved QAPP.

2.3. Sample Handling and Custody Requirements

Sample handling and custody procedures are described in Section 12, Sample Handling and Custody Requirements. No additional project-specific details are required as part of the ARRA project.

2.4. Analytical Methods Requirements

Field and Laboratory analytical method requirements are outlined in Section 13, Analytical Methods Requirements.

2.5. Quality Control Requirements

Quality control procedures are outlined in Section 14, Quality Control Procedures of the QAPP. No additional project-specific details are required as part of the ARRA project.

2.6. Equipment Testing, Inspection, and Maintenance Requirements

Equipment testing, inspection and maintenance is outlined in Section 15, Instrument/Equipment Inspection and Testing of the QAPP. No additional project-specific details are required as part of the ARRA project.

2.7. Instrument Calibration and Frequency Requirements

Instrument calibration is provided in Section 16, Instrument Calibration Frequency of the QAPP. No additional project-specific details are required as part of the ARRA project.

2.8 Inspection / Acceptance Requirements of Supplies and Consumables

Inspection and acceptance requirements for supplies and consumables are detailed under Section 17, Inspection & Acceptance Requirements for Supplies in the QAPP. No additional project-specific details are required as part of the ARRA project.

2.9. Data Acquisition Requirements

Field data acquisition requirements are provided under Section 18, Data Acquisition Requirements of the QAPP for previous data sources. Maps will be prepared using MassGIS data layers to identify the general land features in the region, including subwatershed, lake, and land use type areas. Data such as groundwater information and topography will be obtained from the United States Geological Survey (USGS) and the United States Department of Agriculture (USDA). Current and historic aerial photographs will be obtained from the USGS and/or similar Town sources. Soils information will be obtained from the National Resources Conservation Services (NRCS). Rainfall information will be obtained from the NOAA National Weather Service website. Phosphorus export coefficients will be obtained from Uttormark et al. (1974) and Reckhow et al. (1980). As available, the most up-to-date data will be used (with the exception of historic aerial photographs), with an effort made to choose images with the highest resolution possible.

Precision, bias, representativeness, and completeness within each model will be discussed in the final report. Calculations made, such as areas and land use sizes, will have little error as there is a large amount of information and data available on these types of variables. Data such as soils information is general in nature to a large area such as a watershed, and not necessarily specific to the underlying area such as that found at a specific structural BMP location. These types of data will have moderate error. Other assumptions, such as the use of coefficients, will have a larger degree of error, as concrete numbers are not available. Assumptions will be made using the best available information.

The above-referenced sources provide state or federal databases with accurate information suitable for this study. Data collected during this project will be used to prioritize future water quality improvements and used for comparison with future water quality monitoring efforts.

Additional field reconnaissance efforts will be performed by CEI staff familiar with the area and experienced in conducting a watershed assessment. Watershed data such as land use types and specific pollution sources that will require additional attention during modeling analysis will be compared to existing MassGIS data and incorporated into the report. Staff will also review changes in the watershed that have occurred since the completion of previous studies in 2001 that may be impacting the water quality of the ponds. Potential structural BMP locations will also be mapped and incorporated into final reports and maps.

2.10. Data Management

The field data management is described in Section 19, Data Management of the QAPP. Modeling calculations will be subject to an internal quality control process by the Modeling Coordinator and QA/QC Officer at Comprehensive Environmental, Inc. The data will be critically reviewed for reasonableness, correspondence with data quality objectives, appropriate qualification, censoring of suspect data, and that data has been entered correctly. Models used are as follows:

1. Land use based model
2. Lake response model
3. Simple Method

Modeling and calculations will be performed with the aid of a Microsoft Excel spreadsheet. Final results and summaries may be maintained and displayed in a Microsoft Excel spreadsheet. Final maps may be displayed in part by using ArcGIS maps if appropriate. The remainder of data will be described in a narrative format.

Electronic files with modeling, calculations, field reconnaissance results, sampling data, etc. will be maintained with Comprehensive Environmental, Inc. Electronic files associated with the final report including sampling results will be stored with CEI for distribution as appropriate. Electronic files are stored on secure servers which are backed up several times each week. Hard copies of reports will be distributed to the Town of Pembroke, Pembroke Watershed Association, MA DEP, and EPA as part of applicable reports.

3.1. Assessment and Response Actions

Field assessment and response actions are detailed under Section 20, Assessment and Response Actions in the QAPP. The Modeling Coordinator and QA/QC Officer will be responsible for review, oversight and follow-up on data quality and corrective actions throughout the project. Data assessments will be performed during the project as part of the monthly reporting efforts as required by the MA DEP 604(b) program. Assessments to be performed during the project will include:

- ✓ Evaluation of field reconnaissance observed issues
- ✓ Existing and current data variations
- ✓ Modeling assumption issues

- ✓ Model comparison difficulties
- ✓ Engineering design problem

The results of assessments will be documented and reported in the monthly and quarterly status reports. The final report will contain a summary of assessments, as well as actions taken to address issues. Reports will be provided to the Town of Pembroke, Pembroke Watershed Association, MA DEP, and EPA for review. CEI will incorporate revisions to the final report, based on review comments provided by these agencies.

3.2. Reports

Comprehensive Environmental Inc. (CEI) will produce project reports with input from the Pembroke Watershed Association as required. Copies of reports will be distributed to the Town of Pembroke, PWA, MA DEP and EPA for review and comment prior to finalization and approval. Monthly and quarterly reports will document recent activities performed on the project. The draft and final report will document the entire project. Table 3.2-1 lists the reports that will be produced as a result of this project.

Table 3.2-1. Reports to Management

Report Type	Report Frequency	Parties Receiving Report
Monthly Progress Reports	Monthly for the duration of the project.	-Town of Pembroke -Pembroke Watershed Association -MA DEP -EPA
Quarterly Progress Reports	Quarterly for the duration of the project, due on December 21st, March 20th, June 20th, and September 20th.	-Town of Pembroke -Pembroke Watershed Association -MA DEP -EPA
Draft Project Report	At the conclusion of modeling and design.	-Town of Pembroke -Pembroke Watershed Association -MA DEP -EPA
Final Project Report	Upon receipt of comments on Draft Project Report	-Town of Pembroke -Pembroke Watershed Association -MA DEP -EPA

Brief monthly and quarterly reports will document activities performed within the previous reporting period. Reports will be submitted via email on a standard form. Reports will contain a summary and percentage of work completed by task during the reporting period, planned activities for the next quarter, a description of difficulties encountered and steps taken to address those difficulties, and an explanation of significant discrepancies between progress achieved and the level of progress that should have occurred based on the scope of services and timeline.

Final results will be incorporated into the final project report required by the MA DEP 604(b) Grant Program at the completion of the project. Comprehensive Environmental Inc. will be responsible for preparing the draft final project report, distributing the report, responding to comments, and finalizing the report. This report will contain the following:

- ✓ Executive Summary
- ✓ Project Introduction and Background
- ✓ Data Assessment
- ✓ Pollutant Modeling
- ✓ QA/QC Issues
- ✓ Recommendations and Conclusions
- ✓ Structural Engineering Designs (30%)
- ✓ References and Further Reading
- ✓ Figures, Tables and Appendices

The executive summary will provide a summary of the entire report, condensed into a maximum of several pages, with a focus on the recommendations and conclusions.

A detailed description of the project will be provided, including a description of previous reports completed for the ponds under previous QAPPs. Project goals, objectives, methodology, assumptions, reasoning, etc. will be outlined.

Applicable data obtained from past projects will be detailed. Field reconnaissance efforts and data from current sampling rounds will be summarized. Data such as watershed maps and sizes, land use data, anticipated flow rates, etc. will be summarized. Data sources will be provided, as well as the reasoning and methods used to acquire the data.

A detailed explanation of the pollutant modeling used will be provided. The report will document the modeling purpose, description, scope, approach and application. Model data sources, components, quality, validation performance, and variables used to obtain final results. Parameter assumptions, values, excluded data and sources will be documented in detail. Model calibration performance conditions will be analyzed, as well as future predictions for the buildout scenario. A summary of modeling results will be provided.

Quality assurance and quality control issues encountered during the project pertaining to sampling or modeling will be summarized in narrative form. Methods taken to address issues encountered will be addressed.

An evaluation of load reduction measures will be provided, as well as final recommendations and conclusions to reduce phosphorus levels in the ponds and improve water quality. The final plan will outline proposed BMPs, estimated costs, and expected pollutant removal levels.

Preliminary 30% designs and estimated construction costs will be prepared for the top five structural BMP improvements. Detail will be sufficient for s.319 grant funding.

References will be provided, as well as additional recommended reading sources. Supporting figures, tables and appendices will be provided.

4.1. Data Review, Verification, and Validation Requirements

Field data review is described in Section 22, Data Review, Validation and Verification Requirements of the QAPP. Phosphorus loadings will be estimated using a land use based model (The Simple Method) in combination with a lake response model (Reckhow Phosphorus Lake Model) to predict in-lake phosphorus concentrations based on the projected loadings. Phosphorus loads into the pond will be estimated using literature based loading coefficients for various land uses and pollutant sources. This information is based on stormwater sampling data collected from runoff from various types of land use and results in the total mass of phosphorus entering the pond from each type of land use. There is not enough water quality data to compare the model predicted loadings to the actual loadings to the pond, as an extensive amount of water quality and flow data would be needed to accurately calculate the loads associated with flows into the pond. However, lake-response models can be used to estimate the relationship between phosphorus loads and lake concentrations, such that the actual lake concentration can be used to predict the load to the pond or the load to the pond can be used to estimate a concentration. It is this relationship that will be used to calibrate the data. The modeled loadings from land use values will be compared to the expected loadings calculated based on the actual in-pond concentrations. Model input factors will then be adjusted until the predicted in-lake phosphorus concentrations are within 10% of the observed concentrations documented via the field monitoring program.

The modeling will be performed according to the following procedural steps:

Step 1: Land Use Model
Step 2: Lake Response Model
Step 3: Model Calibration
Step 4: Buildout Analysis
Step 5: Phosphorus Removal Solutions

Step 1: Land Use Model

Phosphorus loadings to the Lake will be determined based on the Simple Method. The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as follows:

$$\mathbf{L = 0.226 * R * C * A}$$

Where: L = Annual load (lbs)
0.226 = Unit conversion factor
C = Pollutant concentration (mg/l)
A = Area (acres)
R = Annual runoff (inches) $\mathbf{= P * P_j * (0.05 + 0.9 * I / 100)}$
P = Annual rainfall (in)
P_j = % of rainfall events producing runoff (assumed to be 90%)
I = Impervious cover percent (%)

Existing information sources available through local, state and federal sources will be used to estimate parameters for use in the model. Watershed (A) and lake area will be determined from topographic maps downloaded from USGS and MassGIS, and inserted into a computer aided drafting (CAD) based program or similar to determine actual areas. Precipitation for the area will be estimated from the NOAA National Weather Service website for the area.

Pollutant concentrations (C) will be obtained from the Simple Method for each type of land use (e.g., commercial, forest, high density residential, etc.) in the watershed. Areas for each land use will be calculated through GIS computer software.

Phosphorus loadings from septic systems and atmospheric deposition (direct precipitation) will be estimated from literature based coefficients for these sources. Phosphorus from atmospheric deposition is determined from lake area and an assumed phosphorus concentration of 0.2 kg/ha-yr in precipitation from Wetzel, 1975 and Reckhow and Chapra, 1983. Potential loadings from internal recycling will also be estimated using available inflow and outflow and Lake sampling data and considering the methods used in the 1993 Diagnostic Feasibility study.

By using the Simple Method and literature based coefficients, a total runoff and associated total phosphorus load to the Lake will be determined.

Step 2: Lake Response Model

The Reckhow Phosphorus Lake Model will be used to predict the in-lake concentration based on the loadings estimated in Step 1. The Reckhow steady-state lake model is expressed as:

$$\mathbf{P = L / (11.6 + 1.2 * qs)}$$

Where: L = annual areal phosphorus loading (g/m2-yr) **= W / As**

W = total phosphorus mass loading (includes stormwater, internal recycling, septic systems as determined through Step 1) (g/yr)

As = lake area (acres)

qs = areal water loading (m/yr), **qs = Q / As**

Q = inflow water volume to lake (m3/yr)

The total inflow water volume to the Lake (Q) will be calculated as:

$$\mathbf{Q = P * A_T – Evapotranspiration}$$

Where: P = total precipitation (ft)

A_T = total watershed area (sf)

Evapotranspiration = estimated at 40% of the total precipitation volume (Hanson, R.L.)

Step 3: Model Calibration

The difference between the modeled phosphorus load determined in Step 2 based on land use loading values and the expected loadings based on actual in-pond concentrations will be compared and a difference between observed and predicted noted. Calibration will then be performed by altering the input variables (e.g., land use loading concentrations) by the percent difference to match observed and predicted in-pond phosphorus concentrations close to one another using the limited data available. A 10% alteration of variables is considered reasonable to match observed and predicted values and/or a 10% difference in predicted versus observed in-pond concentrations without adjustment of variables. If greater than 10% alteration is needed, the reason for the greater alteration will be explored and explained. Model input reasoning will be explained in the final report, as well as any changes made to the variables. Calibration will continue until observed values vs. predicted values are within 10% of each other.

As the modeling approach presented in this QAPP is relying upon a simplistic model intended for planning purposes, the importance is to establish a relationship between loadings and in-pond concentrations on which to base decisions. This is a reliable method for comparing various areas (e.g., subwatersheds) and land uses to one another, as well as various sources to one another and also for determining the percent reduction necessary to achieve a water quality goal, regardless of whether the mass load is 100% accurate. Thus, the level of uncertainty in the exact loading value has little impact on how it is ultimately used; however, uncertainty will be evaluated as a function of the level of adjustment needed to calibrate the model. This simplified approach uses average data values, which will first be reviewed and examined to identify any outliers.

Documentation of model uncertainty will be outlined in a narrative form in the draft and final report. Data will be reviewed by the Modeling Coordinator and QA/QC Officer as well as the MA DEP 604(b) Project Officer and QA Officer to determine if they meet the QAPP objectives and verify accuracy.

Step 4: Buildout Analysis
A buildout scenario will be prepared by overlaying existing land use with existing zoning and accounting for development restrictions such as protected lands and wetlands. The anticipated lands uses at buildout will be input into the model to determine loadings under buildout conditions. The buildout scenario will be used to develop load reduction measures necessary to meet water quality goals.

Step 5: Phosphorus Removal Solutions
Upon calibrating the model, the reductions necessary to meet water quality goals will be determined by adjusting the loadings downward until the desired in-lake concentration is achieved. CEI will tailor recommendations to meet these reductions, using literature based removal efficiencies, such as provided in the Massachusetts Stormwater Handbook.

4.2. Validation and Verification Methods

Field data review is described in Section 23, Validation and Verification Methods of the QAPP. The Modeling Coordinator and QA/QC Officer will examine the data for logical consistency, as presented in Table 4.2-1. The Modeling Coordinator is familiar with running these types of scenarios and is experienced with computer simulation models. If inconsistencies are found, an attempt will be made to determine whether the data is in error. Apparent problems will be noted in the final reports as appropriate.

Table 4.2-1 Validation and Verification Procedures

Responsible Party	When	Activity	Possible Corrective Measures and Notification
Modeling Coordinator / QA/QC Officer	When model compilation has been completed.	Compare test results with targets or expected values. Spot-check calculations.	Re-run calculations. Flag problems that are not correctable.

Responsible Party	When	Activity	Possible Corrective Measures and Notification
	When model calibration has been performed.	Check for outliers.	Discuss outliers or errors in the final narrative.

4.3. Reconciliation with Data Quality Objectives

Data quality objectives are described in Section 24, Reconciliation with Data Quality Objectives (DQO's). No additional project-specific details are required as part of the ARRA project.

4.4. Literature Cited

The following studies were previously cited:

Baystate Environmental Consultants, Inc. (January 1993). Diagnostic/Feasibility Study for the Management of the Pembroke Ponds, Oldham, Furnace, Little Sandy Bottom and Stetson, Pembroke, Massachusetts.

Comprehensive Environmental, Inc. (November 2000). Oldham Pond Pollution Source Investigation and BMP Identification.

Comprehensive Environmental, Inc. (December, 2001). Furnace Pond Pollution Source Investigation and BMP Identification.