Town of Orleans
Ponds and Lakes Monitoring Program

A Partnership with
Coastal Systems Program
School for Marine Science and Technology
University of Massachusetts Dartmouth

Quality Assurance Project Plan
2018-2020

Prepared by:

Town of Orleans
Marine and Fresh Water Quality Committee

And

Coastal Systems Program
School for Marine Science and Technology
University of Massachusetts Dartmouth

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Approval Page
Town of Orleans, Marine and Fresh Water Quality Committee and
Coastal Systems Program, SMAST/UMassD and
MassDEP QAPP Review

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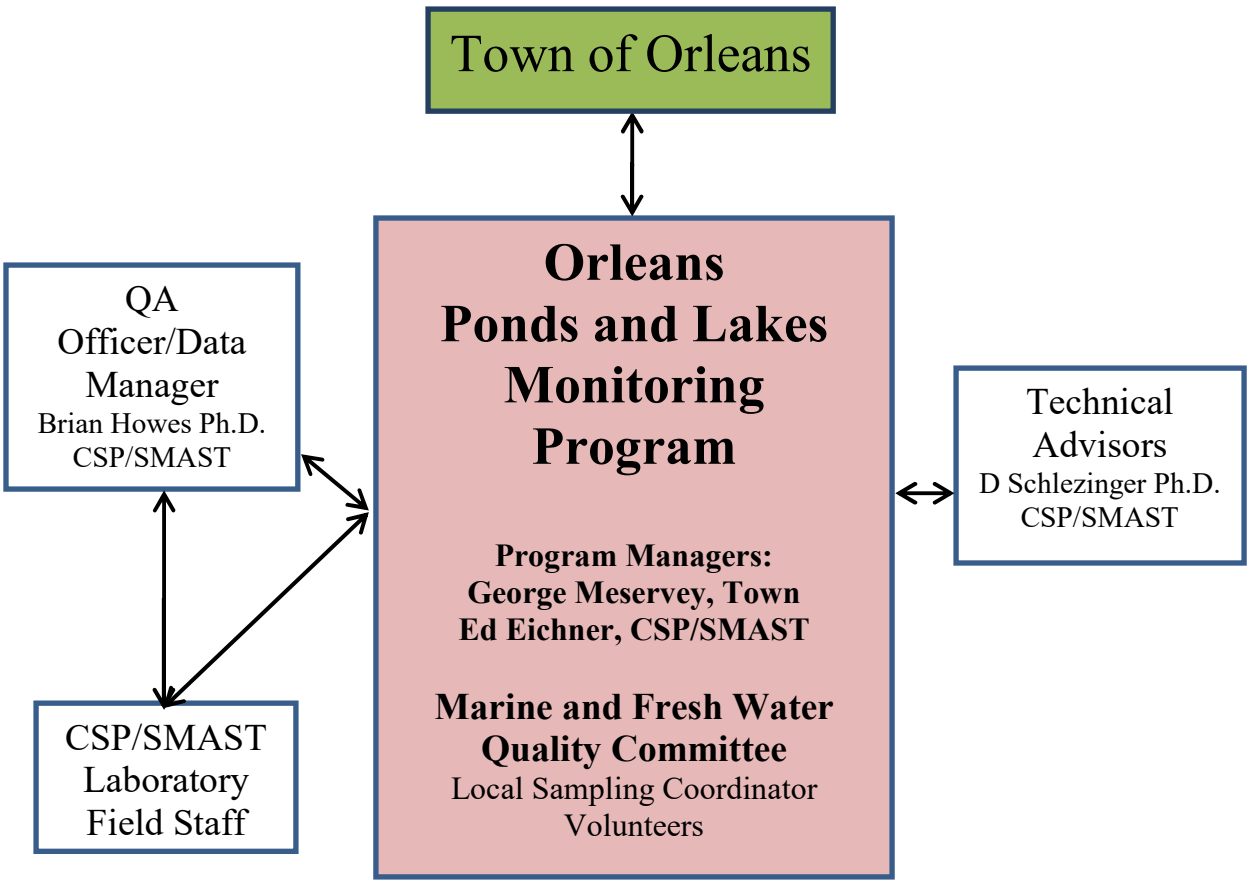
2. Program Organizational Chart



2.1 Project Partners and Responsibilities

Title	Responsibilities
Project Manager 1	Manage finances, coordinate with Marine and Fresh Water Quality Committee, and file necessary updates with funding source. Project Manager1: George Meservey
Project Manager 2	Develop project scope, coordinate sampling and training of volunteers, sampling locations, field data collection, laboratory reporting, review data and sampling accuracy, analysis integrity, data review Project Manager2: Eduard Eichner
Technical Advisors	Assist with development of program objectives, data quality objectives, and methods, facilitate implementation of action plans when possible, use data and case studies to inform state water policies where appropriate. Assist with data analysis. David Schlezinger, Brian Howes and P.M. 2, Eduard Eichner
Field Staff/Volunteers	Volunteers will be trained with sampling procedures and will conduct sampling of multiple ponds. Remaining ponds will be divided among town and CSP/SMAST field staff. Town and CSP/SMAST field staff will coordinate to ensure that sampling procedures are the same. Local Sampling Coordinator and CSP/SMAST staff will coordinate and be responsible for delivery of samples to the laboratory according to QAPP procedures.
Laboratory	Coastal Systems Analytical Facility Laboratory, School of Marine Science and Technology (SMAST) provides analysis of water samples specifically for nutrients and nutrient-related constituents at the low concentrations typically found in surface waters. Lab will provide appropriate sample containers and coolers for sample collection and transport. Handle and analyze samples using standard methods and performs all quality control checks as required by their QAPP. Provide results of analysis in a timely fashion. Work with Project Managers, and others as appropriate, to resolve any issue that may arise during the sampling season. Brian Howes, Director; Sara Sampieri, Analytical Facility Manager
Data Manager	Data from the Lab and field data are collated and reviewed to ensure QA standards are met by Data Manager/ProjectManager-2. Data is maintained by Data Manager/ProjectManager-2 and shared with Project Manager-1. Project Manager-1 will post project results and reports on the town's public access website. Data Manager-1: Brian Howes; Data Manager-2: Eduard Eichner

3. Introduction

The Town of Orleans has 60 fresh ponds and lakes of which 25 are greater than one acre and four are greater than 10 acres.[1] Citizen water quality monitoring of 18 of these ponds has been completed regularly since 2000.[2] This effort has been coordinated through the Marine and Fresh Water Quality Committee (nee Task Force) with assistance of a number of advisors, including staff from Coastal Systems Program, School for Marine Science and Technology, University of Massachusetts Dartmouth (CSP/SMAST). These efforts have generally followed sampling procedures established through the regional Cape Cod Pond and Lake Stewardship (PALS) program. The PALS program established procedures and minimum assay results for a long-term monitoring program with annual county-wide snapshots in late summer. This strategy targeted what was generally thought to be the worst water quality conditions with the idea that PALS snapshot results could be used to prioritize water quality management activities and additional sampling and analysis by volunteers and/or CSP/SMAST scientific staff. The PALS program provided laboratory analysis of water samples collected according to PALS procedures. PALS samples have been assayed at the CSP/SMAST Analytical Facility at no cost to the Cape Cod towns or volunteer monitors since its inception in 2001. Available Orleans pond data was reviewed in 2007 and one of the resulting recommendations was to add an early spring (April) snapshot using the same PALS procedures for comparison with late summer.[3] Similar expansions of water column sampling into other months and using other laboratories for assays have been completed creating some Town concerns about comparability of resulting data. All available citizen water column monitoring results were recently reviewed and results indicated that some of these comparability concerns were valid.[4]

As the Town of Orleans begins to move into development of water quality management strategies for prioritized ponds, the Town through the Marine and Fresh Water Quality Committee would like to ensure that pond sampling procedures continue to be consistent and that the Town documents the procedures to ensure that all pond samples collected in the Town follow acceptable protocols. The Committee would also like to have an approved QAPP for any potential grant funding or regulatory discussions. Consistency is important to ensure that future monitoring results can be compared to past monitoring results to assess change and, as the town begins the process of developing and implementing pond management plans, monitoring is aligned with management goals and Town management priorities.

4. Project Partners

The project partners share many of the same goals and philosophies including adequate information to develop water quality management strategies and ensure the protection of the

[1] Eichner, E.M., T.C. Cambareri, G. Belfit, D. McCaffery, S. Michaud, and B. Smith. 2003. Cape Cod Pond and Lake Atlas. Cape Cod Commission. Barnstable, MA. Baker Pond, Cedar Pond Crystal Lake and Pilgrim Lake (Ponds greater than 10 acres are publicly owned and "Great Ponds" under Massachusetts Law, MGL, Chapter 91); Cedar Pond is listed in current state lists based on past characterization, even though more recent alterations have made it saline.

[2] Eichner, E and B. Howes. 2017. Town of Orleans Freshwater Ponds, Water Quality Monitoring Database: Development and Review. Coastal Systems Program, School for Marine Science and Technology, University of Massachusetts Dartmouth. New Bedford, MA. 216 pp.

[3] Eichner, E. 2007. Review and Interpretation of Orleans Freshwater Ponds Volunteer Monitoring Data. Cape Cod Commission. Barnstable, MA. 80 pp.

[4] Eichner, E and B. Howes. 2017. Town of Orleans Freshwater Ponds, Water Quality Monitoring Database.

ponds and their associated ecosystems. The Town through the Marine and Fresh Water Quality Committee is committed to ensuring that pond ecosystems are managed appropriately through an integrated partnership with volunteers, pond and lake associations, homeowner associations, and other volunteer monitoring partners. The key to appropriate management is reliable data and regular feedback. CSP/SMAST is assisting the town and associations meet their water and habitat quality goals by making available state-of-the-art tools and approaches and sharing expertise and guidance in order to provide the necessary level of scientific support for effective management of these ecological resources.

4.1 Town of Orleans

The Town of Orleans was incorporated as a municipality in 1797 and currently has approximately 5,900 year-round residents.[5] The Town has a total land area of 14.1 square miles and over 60 ponds with a combined surface area of 220 acres.[6] The Town has conducted regular water quality monitoring of both its freshwater ponds and coastal estuaries since 2000 coordinated through the Town Marine and Fresh Water Quality Committee (née Task Force). The monitoring partnership between the Town and CSP/SMAST resulted in data used for the five estuary ecosystem assessments completed through the Massachusetts Estuaries Project and the resulting nitrogen TMDLs developed by the Massachusetts Department of Environmental Protection (MassDEP). The Town has recently committed to organizing and reviewing all available pond[7] and estuary[8] water quality results as part of town-wide water quality management and the recent county-wide 208 update.

The recent compilation and review of available 2000-2016 Orleans pond water quality monitoring data showed that samples have been collected at various times of year, often with different approaches and use of a variety of laboratories for analysis of collected samples.[9] The Town is preparing this QAPP to ensure that going-forward all approaches are comparable and all existing and future data is acceptable for development and assessment of management strategies. Establishing a consistent monitoring program based on past monitoring, that includes a regular review and reassessment, will provide the Town of Orleans with a consistent and reliable basis for management of pond and lake water quality.

Data reliability is crucial as the Town moves forward with development and implementation of management strategies. The Town includes four Great Ponds (Bakers Pond, Cedar Pond, Crystal Lake, and Pilgrim Lake) and 15 others that have been monitored on a regular basis. Public discussion of prioritization of freshwater pond management activities included reviewing a number of factors (*e.g.*, available water quality data[10], watershed land use, accessibility). As a result of those discussions, Uncle Harvey's Pond was selected as the first freshwater pond for the development of a management plan. Uncle Harvey's Pond was prioritized due to regular blue-green algal blooms and its categorization in the most recent MassDEP Integrated List as an

[5] 2010 US Census count = 5,890

[6] Eichner, E.M., T.C. Cambareri, G. Belfit, D. McCaffery, S. Michaud, and B. Smith. 2003. Cape Cod Pond and Lake Atlas.

[7] Eichner, E and B. Howes. 2017. Town of Orleans Freshwater Ponds, Water Quality Monitoring Database.

[8] Estuary water quality monitoring database will be available during the first quarter of 2018.

[9] Eichner, E and B. Howes. 2017. Town of Orleans Freshwater Ponds, Water Quality Monitoring Database.

[10] *Ibid*

impaired water.[11] The final Uncle Harvey's Pond Management Plan[12] was reviewed and approved by the Town, through the Marine and Fresh Water Quality Committee, and discussions are underway to plan the implementation of Plan recommendations. Concurrently, the Town has prioritized Pilgrim Lake and Crystal Lake for targeted data gap measurements needed to support subsequent development of management/restoration plans in upcoming years.

4.2 Coastal Systems Program, School for Marine Science and Technology, University of Massachusetts Dartmouth

The Coastal Systems Program at the School for Marine Science and Technology, University of Massachusetts Dartmouth (CSP/SMAST) provides a full range of lake and pond assessment, monitoring, and management skills with extensive experience in developing assessments of point and non-point source impacts, watersheds, water quality, and ecosystems, as well as associated development of diversified options and strategies to attain environmental management goals. CSP/SMAST maintains staff scientists and support personnel that are supplemented on a project basis by specialists throughout the U.S.

CSP/SMAST was established to provide research-quality information to address the growing ecological degradation of coastal ecosystems and, through expanded demand, has begun to apply many of the same tools to freshwater systems. Staff fills the niche between basic and applied research by providing high quality scientific support for management of surface waters (bays, harbors, wetlands, ponds/lakes, and watersheds). CSP/SMAST scientists evaluate nutrient-related water quality issues, providing information fundamental to developing data driven management plans for the protection of surface waters. These efforts have generally integrated investigation of nutrient inputs with transformations and losses during transport from their sources to understand their ultimate fate and impact on the ecological health of fresh and saltwater ecosystems. Communities throughout Southeastern Massachusetts currently use data generated by CSP/SMAST and its analytical facility and associated restoration alternatives and recommendations prepared by CSP/SMAST staff for management and to support policy decisions regarding restoration, remediation, and protection of fresh and saltwater systems.

CSP/SMAST is a leader in freshwater pond monitoring and assessment. CSP/SMAST has partnered with towns, cities, regional government, advocacy groups, trade associations, pond associations and state agencies throughout southeastern Massachusetts. CSP/SMAST is a partner with the Cape Cod Commission and the towns of Barnstable County to provide laboratory services for 17 years of the regional Cape Cod Pond and Lake Stewards (PALS) Snapshots. These Snapshots are citizen-based water quality sampling of ponds throughout Cape Cod during the late summer and have regularly included 150 or more ponds. This data has been invaluable in creating a region-wide pond monitoring culture that has expanded throughout southeastern Massachusetts and has empowered groups of citizen stewards. This, in turn, has led to more intensive pond-specific assessments and development of management strategies and, more recently, multiple pond restoration projects.

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[11] Massachusetts Department of Environmental Protection. June 2017. Massachusetts Year 2016 Integrated List of Waters, Draft Listing. CN 470.0. Worcester, MA. 357 pp.

[12] Eichner, E., B. Howes, and D. Schlezinger. 2018. Uncle Harvey's Pond Management Plan. Final. Town of Orleans, Massachusetts. Coastal Systems Program, School for Marine Science and Technology, University of Massachusetts Dartmouth. New Bedford, MA. 106 pp.

CSP/SMAST staff has also completed pond assessments of more than 30 ponds and lakes in the past 10 years. Recent assessments have included:

a) intensive, citizen-based, pond water quality sampling programs,
b) sediment core collection and incubation to nutrient regeneration rates
c) watershed delineations, land use assessments and estimates of nutrient loads
d) monitoring and characterization of cranberry bogs and interactions with ponds,
e) aquatic bird, freshwater mussel, and plant surveys,
f) monitoring of incoming and outflowing streamflow and associated nutrient loads, and
g) stormwater monitoring, including individual storm monitoring, discharge point watersheds

CSP/SMAST has the ability and experience to produce effective pond and lake assessments and management strategies through working with town and regional boards, various non-profit organizations, and private sector environmental consulting firms while coordinating activities with state agencies. Recent projects have included a water quality assessment and subsequent management plan for Scargo Lake in Dennis and Sassaquin Pond in New Bedford, a water quality assessment of the Mills Pond complex in Brewster, and a water quality assessment and TMDL strategies for White Island Pond in Plymouth/Wareham. Past pond and lake project partners have included the Towns of Barnstable, Brewster, Orleans, Eastham, Harwich, Plymouth, and Westport, the City of New Bedford, the Cape Cod Cranberry Growers Association, MassDEP, the Lake Wequaquet Protective Association, and the Indian Ponds Association.

CSP/SMAST provides a logistical, educational and data synthesis center for water quality monitoring. CSP/SMAST is fully equipped for the field and analytical requirements of water quality research including: automated nutrient analyzers (LACHAT), field (SeaTech and YSI) fluorometers, & gas (ECD, TCD, FID) chromatographs, mass spectrometers (Finnegan), CTD's (Seabird), a range of ADCPs for autonomous flow profiling, water and sediment sampling gear, field automated samplers (ISCO), Marsh-McBurney electromagnetic flow meters, field moorings for oxygen, temperature, salinity, depth (Endeco/YSI), and a fleet of small coastal vessels. Specific to nutrient related research are the automated nutrient analyzers, Turner AU10 laboratory fluorometer, Radiometer SB10 potentiometric oxygen titrator, automated alkalinity titrator, Buchler chloridometer, Eh, pH and specific conductivity electrodes and meters, scanning spectrophotometers (Spectronic 2000 & Spectronic 801), CO2 Infrared analyzers, Perkin Elmer PE2400 automated CHN analyzer, plus the full suite of analytical balances, drying ovens, autoclaves, walk-in freezers & refrigerators, radiochemistry laboratory, glove boxes, benthic grab samplers and Niskin and pump samplers. CSP/SMAST currently runs over 35,000 chemical assays of water samples each year for federal, state, and numerous municipal and research groups, including: US Environmental Protection Agency, US Army Corps of Engineers, US Department of Energy, US Department of Defense, MassDEP, Rhode Island Department of Environmental Management, and South Florida Water Management District.

5. Sampled Ponds

Listed below are the ponds that are regularly sampled by volunteers coordinated through the Orleans Marine and Fresh Water Quality Committee. During each year, these ponds will be targeted for a spring (April) sampling and a late summer (August/September) using the sampling protocols and analytical techniques specified in this QAPP. The Town of Orleans is currently in the midst of efforts to develop management plans for many of these ponds and it is anticipated that additional sampling associated with implementation of management techniques may occur through either contracted or Town staff and using the same techniques as specified in this QAPP. This additional sampling would cause duplication of volunteer efforts. If this occurs, volunteer sampling will not occur at these ponds.

PALS #	POND	Atlas Area	Depth	Years of WQ Data	Watershed Delineation	Regulatory					
		ac	m			Great Pond	Integrated List Status	Herring Run	Cyano closings	ACEC	Natural Heritage Habitats
OR-167	Baker	29.3	17.73	17	Pleasant Bay MEP	Y	4a - TMDL completed - Hg in Fish Tissue				Priority
OR-136	Boland	7.3	5.51	16	Nauset Marsh MEP	N	not listed				
OR-122	Cedar	15	3.65	16	Rock Harbor MEP/Cedar Pond Management Plan	Y (brackish)	5 - TMDL required - impaired - Chlorophyll-a, DO, DO saturation	historic		Inner Cape Cod Bay	
OR-129	Critchetts			15		N	not listed				
OR-153	Crystal	38.2	13.63	17	Pleasant Bay MEP	Y	5 - TMDL required - impaired - DO			Pleasant Bay	Priority
OR-262	Deep	4.7	5.51	16	Pleasant Bay MEP	N	not listed				Priority
OR-174	Gould	5.5	3.88	16		N	not listed			Pleasant Bay	Priority
OR-113	Icehouse	5.7	6.07	16		N	not listed				
OR-147	Kettle		1.59	12		N	not listed				Priority
OR-256	Meadow Bog	2.6	1.52	16		N	not listed			Pleasant Bay	Priority
OR-176	Pilgrim	44.7	8.93	17	Pleasant Bay MEP	Y	3 - no uses assessed	Y		Pleasant Bay	
OR-123	Reubens	1	0.95	15		N	not listed				
OR-249	Sarahs	5.6	5.30	16	Pleasant Bay MEP	N	not listed			Pleasant Bay	Priority
OR-253	Shoal	8.6	1.71	16	Pleasant Bay MEP	N	not listed				Priority
OR-247	Twinings	9.1	3.56	16	Pleasant Bay MEP	N	not listed				Priority
OR-142	Uncle Harvey	7	5.85	16	Pleasant Bay MEP	N	5 - TMDL required - impaired - harmful algal blooms		Y		
OR-228	Uncle Israels	2.1	0.63	16		N	not listed				Priority
OR-264	Uncle Seths	5.4	3.05	16	Pleasant Bay MEP	N	not listed			Pleasant Bay	
OR-203	Wash	1.3	2.56	9		N	not listed				Priority

NOTE: Cedar Pond has a Town and MEPA-approved Adaptive Management Plan in place that includes regular monitoring. As such, during the timeframe of this QAPP, volunteers will not be sampling Cedar Pond.

6. Program Description and Goals

Among the responsibilities of the Orleans Marine and Fresh Water Quality Committee are monitoring of freshwater ponds, recruiting monitoring volunteers, and identifying impaired waters and recommending steps for restoration.[13] Since water quality monitoring is one of the key responsibilities, the Committee has accessed the guidance, expertise, and support available from CSP/SMAST through the PALS program and has leveraged all the years of past monitoring to jump-start its identification of impaired waters and development of plans for freshwater pond restoration. In order to ensure that future monitoring is completed in such a way that it can be compared to past monitoring and is accepted in all regulatory settings, the Committee is developing this QAPP. The goal of this QAPP is to formally describe the procedures used in Orleans Ponds citizen water column sampling, including sampling procedures, sample handling, assay detection limits, and review and organization of sampling data. If future sampling follows the described procedures, it will be consistent with past monitoring and provide a reliable basis for assessing the success of restoration activities, support adaptive management planning and provide guidance for future water quality management in the Town.

6.1 Water Quality Monitoring Protocols for the Ponds

Orleans Marine and Fresh Water Quality Committee recruits volunteers, trains them to follow sampling procedures, notifies them when samples should be collected, and works to provide feedback to the volunteers on the sampling results. Committee members and Town staff will work to maintain these sampling relationships in the future, but the total count and personnel/volunteers assigned to particular ponds may change depending on funding and personnel/volunteer availability. At a minimum, ponds will be sampled twice a year: 1) once during April to establish the yearly pond water quality conditions heading into the summer and 2) once between August 15 to September 15 to target what is generally the worst water quality conditions during a year and to be consistent with past Cape Cod PALS Snapshot sampling (collected since 2001). Samples will be collected between 7 AM and 3 PM to maximize phytoplankton activity. Individual sampling dates within each sampling window are based on sampler availability.

The sampling protocol requires locating the deepest location on the pond, collecting dissolved oxygen and temperature profiles (at 0.5 to 1 m depth intervals) at that location, measuring Secchi transparency, and collecting water quality samples at standardized depths. Dissolved oxygen and temperature profile readings are recorded using an YSI-55 or YSI-550A meter calibrated prior to each sampling event. Membranes or cartridges on the meter probe are changed according to the meter operations manual. Sampling locations on each pond are determined based on GPS coordinates and water depths from prior surveys (sampling locations for each pond are shown in Appendix E).

The project sampling protocol requires that between 2 and 4 nutrient samples are collected at each pond, depending on water depth. A minimum of two samples are collected at each pond. If the pond is very shallow, two 0.5 m samples are collected. In moderately shallow ponds, at least two water samples are collected, one at 0.5 m and another 1 m off the bottom. If the pond is

[13] Marine and Fresh Water Quality Committee charge adopted at 2017 Annual Town Meeting. Full charge is available in Appendix F and on the town's website at: https://www.town.orleans.ma.us/marine-and-fresh-water-quality-committee/pages/revised-committee-charge (accessed 1/17/18).

approximately 9 m deep, a third sample is collected at 3 m and if the pond is greater than 11 m, a fourth sample is collected at 9 m. This sampling protocol has been used for citizen-based, volunteer pond water quality PALS snapshots for 17 years on Cape Cod[14] and the consistency of this approach provides a potential valuable comparison between the ponds in the present study and other southeastern Massachusetts ponds that are in the same ecoregion.

All water column samples for water quality analysis are collected with Van Dorn Horizontal Beta Bottles 2.2 liter samplers (or equivalent) and sub-samples are transferred to dark HDPE acid-washed 1 liter bottles and transported in coolers with ice packs (4°C) to the Coastal Systems Analytical Facility at the School for Marine Science and Technology (SMAST), University of Massachusetts Dartmouth in New Bedford. Duplicate quality assurance (QA) samples will be collected and analyzed for 10% of samples collected during the April and regional PALS sampling periods. All samples are delivered to the Analytical Facility within 24 hours of collection. Laboratory procedures are described in the SMAST Coastal Systems Analytical Facility Laboratory Quality Assurance Plan (2003). Laboratory and field data collected, along with analyte detection limits and accuracy measurements, are shown in Table 2.

6.2 Volunteer Monitoring

The Orleans ponds sampled through coordination with the Orleans Marine and Fresh Water Quality Committee are sampled by trained volunteers. Volunteers generally are Committee members, representatives of various pond and/or homeowner associations, and interested and willing residents. The Committee will ensure that all volunteers have been trained in necessary sampling procedures; most volunteers have years of experience with the sampling procedures. A volunteer training/refresher session will be held each year prior to the April sampling. Committee members and/or Town staff may accompany select volunteers to ensure consistency with sampling protocols.

6.3 Education, Outreach and Management

One of the primary goals of Orleans Marine and Fresh Water Quality Committee is to engage and educate the community. The Committee holds regular public meetings on Town pond management activities and will strive to ensure that any reports or presentations are posted on the Committee's portion of the Town website.[15] The Committee reaches out to local watershed/pond associations as well as smaller homeowner associations and citizens near ponds where associations have not been established. The Town will continue posting Committee meetings and any reports produced from Committee activities on the Town website, as well as working to ensure regular outreach to associated watershed and pond associations.

[14] Eichner, E.M., T.C. Cambareri, G. Belfit, D. McCaffery, S. Michaud, and B. Smith. 2003. Cape Cod Pond and Lake Atlas. Cape Cod Commission. Barnstable, MA

[15] https://www.town.orleans.ma.us/marine-and-fresh-water-quality-task-force

6.4 Schedules

Time Schedule of Orleans Ponds Sampling

TASK	DESCRIPTION	TIMELINE
1	QAPP	As soon as possible
2	Training/Refresher Session for Volunteers	March/Early April
3	Sampling and Lab Analysis	Sampling: a) April b) August 15 through September 15 Lab Analysis Report: October 1 through Jan 30

7. Water Quality Test Parameters

All the water samples are analyzed by Coastal Systems Analytical Facility at SMAST/UMass Dartmouth campus in New Bedford, MA for parameters listed below:

1) Total Phosphorus
2) Total Nitrogen
3) pH
4) Chlorophyll-a
5) Phaeophytin
6) Alkalinity

CSP/SMAST Analytical Facility is accepted[16] for the parameters listed in this QAPP via the SMAST Coastal Systems Analytical Facility Quality Assurance Plan (2003), which included both fresh and salt water nutrient analysis. Water samples are collected and held for delivery to the Facility as outlined in Section 8, and transported to the laboratory on the same day they are collected. The analysis is done according to MassDEP and/or US EPA criteria (See Table 1). The initial analysis results are submitted to Program Manager-2 and QA Officer for review, completeness, identification of potential outliers, and comparison with previous results. If any issues are identified these are flagged in the final results, but generally no repeat sampling will occur. Final analysis results are submitted annually to the Town in spreadsheet with brief comparison to averages and ranges developed in the review completed for the Pond Database report.[17] Results are reviewed more extensively, including trend analysis, every three years or as management activities are developed and reviewed for individual ponds. All data and reviews will be available through the Orleans Marine and Fresh Water Quality Committee's portion of the Town website.[18]

[16] The facility has run blind samples from DEP, and has been reviewed by USGS for inorganic N species and gone through laboratory intercalibration on the estuarine inorganic N assays for the Town of Chatham; the laboratory was accepted for the Merrimack River TMDL assays, Department of Defense Ashumet Pond Assays and for the regulatory Massachusetts Estuaries Project (fresh and salt water nutrients), Alkalinity for CC PALS. Data has been published in over 50 peer reviewed journal articles and 100+ technical reports for various agencies, including MassDEP, etc.

[17] Eichner, E and B. Howes. 2017. Town of Orleans Freshwater Ponds, Water Quality Monitoring Database: Development and Review. Coastal Systems Program, School for Marine Science and Technology, University of Massachusetts Dartmouth. New Bedford, MA. 216 pp. https://www.town.orleans.ma.us/sites/orleansma/files/uploads/orleanspondsreport_wqmonitoringdatabase2017_final.pdf

[18] https://www.town.orleans.ma.us/marine-and-fresh-water-quality-task-force

8. Data Quality - Quality Assurance

The Orleans Ponds and Lakes Monitoring Program will employ and satisfy the quality control measures and data quality objectives outlined in this section. The data collected by this project are used in making decisions regarding management activities as described in the Program Description and Goals section. This section outlines measures to ensure samples are collected and analyzed properly, thereby meeting quality standards.

8.1 Data Representativeness

Data Representativeness will be met by the following requirements:

8.1.1. All sampling sites will be over the deepest point in each pond (Appendix E). These sites are selected to be representative of "average" early spring or late summer conditions for the water body. These sampling points will be used each annual spring and late summer samplings.

8.1.2. Ponds to be sampled will be determined prior to each sampling season. The Town of Orleans is currently in the midst of efforts to develop management plans for many of the ponds that have been historically sampled (see Table in Section 5). It is anticipated that additional sampling associated with implementation of management techniques may occur through either contracted or Town staff for selected pond using the same techniques as specified in this QAPP. These additional samplings would cause duplication of volunteer efforts. If this occurs, volunteer sampling will not occur at these ponds.

8.1.3. Any abnormal or episodic conditions that may affect the representativeness of sample data are noted and maintained as metadata.

8.1.4. Field blanks will be prepared every sampling day using distilled water and sampling equipment prior to the sampling runs. Blanks will be prepared during each sampling season by the Local Sampling Coordinator and subject to all sample transfer and analysis procedures, including reporting, to ensure sampling and lab procedures are not adding bias to results. The Local Sampling Coordinator will strive to utilize the same blank preparation techniques over the course of many years. The field blank bottle will be labelled with date of collection, sampling program name, and "field blank." A separate Orleans Ponds Sampling Sheet/chain-of-custody form will be prepared for each field blank.

8.2 Duplicate Sampling

8.2.1. Duplicate field samples are required for approximately 10% of samples for each sampling period or a minimum of one for each sampling day. For example, 40 locations per year would require 4 duplicate samples during a year, but a sampling day with only 8 samples would also require one duplicate. A unique identifier will be assigned to the duplicate and noted in the Orleans Ponds Sampling Sheet/chain of custody form (Appendix D). Locations for duplicate samples will be selected and coordinated between Program Managers.

8.2.2. Duplicate samples are collected at the same location and depth as the primary sample. Duplicate samples are collected by using the same sampling procedures twice sequentially by the same sampler and filling of two 1L sample bottles. The duplicate sample bottle will have the same labeling as the primary sample with the addition of "DUP".

8.2.3. Duplicate field readings of dissolved oxygen and temperature profiles and Secchi measurements will also be collected at the selected duplicate sample site/pond. These readings will be noted on the same Orleans Ponds Sampling Sheet/chain of custody form as the duplicate water quality sample is noted.

8.2.4. Upon receipt of duplicate results, the QA Officer will review to ensure samples are within an acceptable range, normally ±20%. If data is outside of acceptable range, the QA Officer will seek to verify all procedures for the questionable results, including field, sample transfer, and laboratory tasks and comparison to other results from the same sampling, to try to determine potential causes. If the results cannot be reconciled, the questionable results will not be included in the database that will be submitted to the Town and the exclusion will be noted in the metadata associated with the database.

8.3 Comparability of Project Data

The comparison of project data to previously collected data will be enhanced by the using the same sampling and analysis protocols.

8.3.1. Documenting sampling sites, times and dates and sample transport and transfer on Orleans Ponds Sampling Sheet/chain of custody form (Appendix D), this also functions as a sample chain-of-custody form. No samples are accepted at the CSP/SMAST Laboratory without an appropriate chain-of-custody form.

8.3.2. Comparability of data can be produced by following these established protocols. This will ensure that all new samples are collected following the same procedures and approaches and are assayed by the same methods as in the prior surveys.

8.3.3. Results can be compared to historical data from the same stations collected during the same season.

8.3.4. Detailed and complete sample records, including the Orleans Ponds Sampling Sheet/chain-of-custody forms (Appendix D), will be maintained within the Coastal Systems Program Analytical Facility.

8.3.5. Final CSP/SMAST Laboratory analysis results and field collected data will be submitted annually to the Town in spreadsheet with brief technical memo comparing results to historic averages and ranges developed in the review completed for the Pond Database report.[19] The spreadsheet will include all metadata for each pond sampling and percentile rank for results compared to historic data. Results will be reviewed more extensively, including trend analysis, every three years or as management activities are developed and reviewed for individual ponds. All data and reviews will be available in digital formats through the Orleans Marine and Fresh Water Quality Committee's portion of the Town website.[20]

The Tables below summarize the accuracy/precision, the minimum detection limits, the approximate potential range, the analysis test methods and holding times used by the Coastal Systems Program (CSP/SMAST) Analytical Facility. The Facility address is:

Coastal Systems Analytical Facility
Attn: Sara Sampieri, Lab Manager (ssampieri@umassd.edu)
School for Marine Science and Technology
University of Massachusetts Dartmouth
706 South Rodney French Blvd.
New Bedford, Massachusetts 02744-1221
508-910-6325

[19] Eichner, E and B. Howes. 2017. Town of Orleans Freshwater Ponds, Water Quality Monitoring Database.
[20] https://www.town.orleans.ma.us/marine-and-fresh-water-quality-task-force

Table 1. Ponds and Lakes Monitoring Program, field parameters measured & data objectives					
Parameter	**Method/ Range Units**	**Sensitivity**	**Precision**	**Accuracy**	**Calibration**
Temperature	YSI Dissolved Oxygen Meter/ -5 to 45°C	0.1°C	0.1°C	0.3°C	Calibrated against certified thermometer prior to field use (in lab) over temperature range
Dissolved Oxygen (ppm)	YSI Dissolved Oxygen Meter/ 0 to 20 mg/L	0.01 ppm	0.1 ppm	0.3 ppm	Calibrated in lab before field use by Winkler titration over DO range
Water Clarity	Secchi Disk disappearance / meters	1 cm	10 cm	NA	NA: line is measuring tape

Table 2. CSP/SMAST Analyte Details for Orleans Ponds and Lakes Monitoring Program					
Analyte	**units**	**Reporting Limit**	**Accuracy/Precision**	**Analysis Method/Type**	**Max Holding Time**
Alkalinity	mg/l as CaCO3	0.5	80-120% Std. Value	Acid Titration [1]	24 hrs
Chlorophyll *a*/ Phaeophytin *a*	µg/l	0.1	80-120% Std. Value	Acetone extraction [2]	24 hrs
Nitrogen, Total	µM	0.2	80-120% Std. Value	Persulfate digestion [3]	Frozen 60 days[6]
pH	stnd units	NA	±0.2 of QC standard	Electrode [4]	24 hrs
Phosphorus, Total	µM	0.1	80-120% Std. Value	Persulfate digestion [5]	Preserved 28 days

Notes:

a) Accuracy is determined by the analysis of spiked samples and comparison to known standards, except as noted in the table. QC sample recoveries may also be used to assess accuracy when spiked sample analysis is not possible. The general data quality observation for all analyte blanks are no exceedances of the Reporting Limit. All procedures, methods, and lab SOPs are documented in the SMAST Coastal Systems Analytical Facility Laboratory Quality Assurance Plan (2003).

b) For accuracy determination, comparison of spike samples and known standards is preferred.

c) Overall precision is measured using the Relative Percent Difference, RPD (or std. deviation for n > 2) of field duplicate samples. Lab precision is based on an estimate of the RPD between duplicate aliquots of the same lab sample.

Methods details:

1) Standard Methods 19th Edition, Method 2320-B
2) Parsons, T.R., Y. Maita and C. Lalli. 1989. *Manual of Chemical and Biological Methods for seawater analysis*. Pergamon Press, 173 pp. Analysis using Turner Designs - AU-10.
3) Standard Methods 19th Edition, Method 4500-Norg-D D'Elia, C.F., P.A. Steudler and N. Corwin. 1977. Determination of total nitrogen in aqueous samples using persulfate digestion. *Limnol. Oceanogr.* 22:760-764.
4) Standard Methods 19th Edition, Method 4500-H+B
5) Standard Methods 19th Edition, Method 4500-P-B.5, persulfate digestion and assay as orthophosphate.
6) Avanzino, R. J., and V. C. Kennedy (1993), Long-term frozen storage of stream water samples for dissolved orthophosphate, nitrate plus nitrite, and ammonia analysis, *Water Resour. Res.*, 29(10), 3357–3362, doi:10.1029/93WR01684

9. Sampling Procedures

The sampling process begins the day before field sample collection, by ensuring all required instruments and supplies are gathered. The date of each sampling will be determined in discussions with the Local Sampling Coordinator and in consideration of weather and the availability of volunteer samplers. Checklist of required supplies includes the number of sample bottles and chain of custody/data sheets required for the next day. Sample bottles, including bottles for QA/QC duplicates, ice packs, coolers, and meters are reviewed. Bottles must be acid-leached, 1L, dark Nalgene bottles. Bottles will be acid-cleaned (10% HCl), distilled water-rinsed and dried no more than one week prior to sampling.

In the field, the sampling location is determined by review of available bathymetric map, GPS coordinates, and measurement of water depth from acoustic depth sounder or Secchi disk. Available maps with sampling location and GPS coordinates for each pond are compiled in Appendix E. The location and time of sampling is recorded on the Orleans Ponds Sampling Sheet/chain of custody form (Appendix D).

A Secchi clarity reading is then collected by lowering the Secchi disk over the shaded side of the boat, recording the depth at which the Secchi disc just disappears based on visual inspection, lowering the disc further and then raising the disc and recording the depth at which it just reappears. The Secchi depth is the average of the two readings. All readings are recorded on the Orleans Ponds Sampling Sheet/chain of custody form. Total depth is determined by acoustic depth sounder or when necessary gently lowering the Secchi disk to the bottom of the pond and recording the depth.

After the Secchi readings are recorded, the DO meter is used to record dissolved oxygen (in mg/L) and temperature (in °C) at 0.5 m, 1 m, 2 m, and other 1 m increments to within a minimum of 1.0 m of the bottom. Selected shallow ponds will have DO and temperature readings collected at 0.5 m increments (and to within a minimum of 0.5 m of the bottom). Selected increments for each pond are indicated on the pond sampling maps in Appendix E. Readings should be recorded on the Orleans Ponds Sampling Sheet/chain of custody form. Care is taken to record these readings on the opposite side of the boat from the Secchi readings in order to minimize any potential anomalies caused by sediment disturbance during the total depth recording.

Water samples are then collected at depths based on the total depth. At each pond, one sample each is collected at depths of 0.5 m and 1 m off the bottom. If the pond is ~9 m deep, one additional sample is collected at a 3 m depth, so a total of three samples are collected at the pond at depths of 0.5 m, 3 m, and 1 m off the bottom. If the pond is greater than 11 m deep, one additional sample is collected at 9 m, so a total of four samples are collected at the pond at depths of 0.5 m, 3 m, 9 m, and 1 m off the bottom. Depending on the water depth, between 2 and 4 samples are collected from each pond; in very shallow ponds (< 1.5 m deep), two samples are collected at 0.5 m depth. Samples are collected with a 2.2 L Van Dorn Sampler designed to collect discrete samples at each specified depth. Visual inspection of deep water sample is conducted to ensure that no obvious sediment is included; if sediment is found, the sample is discarded, the Van Dorn Sampler rinsed with distilled water, and another sample is collected. Filling of the water bottles is done in such a way that the fill tube from the device does not touch the water bottle during the water transfer. Bottles receive a rinse with the sample water and then

are filled to the neck of the bottle. After filling, the bottles are transferred to a cooler and stored with ice packs sufficient to allow the water samples to attain 4°C. At the end of the sampling day, coolers and enclosed samples are returned to the CSP Analytical Facility through transfer coordination among the Local Sampling Coordinator, Project Managers, and CSP staff. All individuals that have the samples in their possession will be noted on the Orleans Ponds Sampling Sheet/chain of custody form for each pond.

At the laboratory, water samples are divided into appropriate aliquots for the laboratory analytes. Total Phosphorus aliquots are preserved with sulfuric acid (H_2SO_4) and stored at 4°C, while total nitrogen aliquots are frozen (-22°C). Pigment aliquots are filtered within 24 hours of sampling and filters stored in the dark in laboratory freezers at -22°C.

10. Training of Volunteers

Prior to the start of spring sampling period (April), Orleans Marine and Fresh Water Quality Committee members will conduct a training session for all involved sampling personnel and volunteers. This session will include stressing consistency of sampling techniques and will review sampling protocols, equipment use, sampling handling procedures, sampling safety, and provide suggested pre-sampling checklists and written field protocols. Committee members will coordinate with individual volunteers following the April sampling to get feedback and work to correct any identified issues. Attendance and techniques taught will be tracked by the Committee Chair to ensure that sampling is consistent. If volunteers are recruited between the April and August/September samplings, members will ensure that they receive an individualized training session comparable to the April session.

11. Safety Considerations

Most Orleans pond volunteers are experienced water quality samplers and have extensive experience launching and utilizing small boats and sampling equipment, as well as boating safety procedures, such as mandatory use of lifejackets. Sampling is typically conducted with two people. A separate volunteer sampling member will be contacted on departure and return of the field team with set deadlines for return. Every effort is made to ensure safe access to each pond.

12. Documentation and Records

The Orleans Ponds and Lakes Sampling program generates records and documents related to field data collection, data processing, and planning. The primary water sampling test results are compiled in Excel spreadsheets, which are submitted to the Town and are maintained at CSP/SMAST. Sampling results will be incorporated into the master Town database annually and will be assessed every three years for trend analysis, comparability and usefulness or when management activities for specific ponds are being considered. Data and reviews will be available through the Orleans Marine and Fresh Water Quality Committee's portion of the Town website.[21] CSP/SMAST will also maintain documentation and records related to the sampling aspects of this program, while the Town will maintain records of all community outreach and coordination. Data and reports are maintained by the Town of Orleans, with backup within the CSP at SMAST.

[21] https://www.town.orleans.ma.us/marine-and-fresh-water-quality-task-force

Appendix A – Orleans Ponds and Lakes Monitoring Program: Water Sampling Procedures

1.0 Purpose

This procedure outlines the field methodology for the collection of surface water samples for the Orleans Pond and Lakes Monitoring Program by the Town of Orleans (Town) and the Coastal Systems Program, School for Marine Science and Technology, UMass Dartmouth (CSP/SMAST).

2.0 Definitions

Surface water: Includes water bodies with exposure to the atmosphere, including, but not limited to, lakes, ponds, reservoirs, streams, rivers, springs, seeps, and wetlands.
YSI: Yellow Springs Instrument to collect field water quality parameters (DO, Temperature).

3.0 Sampling Locations

Pond sampling locations will be determined and evaluated prior to the start of sampling. Final sampling locations of each pond's deep basin will be identified by GPS coordinates.

4.0 Procedure

4.1 Field Equipment & Supplies

- map of sampling locations
- Orleans Ponds Sampling Sheet/chain of custody forms, clipboard and #2 pencils
- Van Dorn Sampler (to collect discrete water samples at depth)
- Secchi disk on meter tape
- Dissolved Oxygen (DO) probe and meter (YSI-55 or YSI-550A); calibrated prior to use according to meter instruction manual
- GPS
- Acoustic depth sounder (if available)
- sample bottles with labels
- waterproof permanent marker for bottle labels
- cooler with ice packs
- safety items; cell phone, first aid kit and life vest (for boat)

4.2 Sampling Method

Arrive at sample site and record applicable observations in Orleans Ponds Sampling Sheet/chain of custody form. Label the sample bottle with appropriate site name, date and time of sample collection and sampling team.
Collect field data, including Secchi/clarity, temperature/dissolved oxygen profiles and total water depth and record on Orleans Ponds Sampling Sheet/chain of custody form. Collect 2 to 4 water samples based on the depth of the pond. Record pond name, depth, and date on each sample bottle and record corresponding information on the Orleans Ponds Sampling Sheet/chain of custody form along with time of day.

4.3 Field Duplicate Collection

Field duplicates will be taken based on 10% of samples taken per year or a minimum of once each sampling day. For example, 40 locations per year would require 4 duplicate samples in a year, but a sampling day with only 8 samples would also require one duplicate. The Project Managers will randomly determine duplicate location sites and notify samplers. The Orleans Ponds Sampling Sheet/chain of custody form will note the collection of duplicate sample(s).

Appendix B – Orleans Ponds Water Sampling Procedures*: Field Checklist*

Needed prior to sampling date:

- Ensure adequate bottle supply for all anticipated samples, including field duplicates
- Ensure all sampling equipment is working properly.
- Gather all ancillary field materials, including GPS, Orleans Ponds Sampling Sheet/chain of custody forms, Van Dorn Sampler, cooler, ice packs, labeling pen, etc.
- Review Sampling Guidance Sheets (shown below) and bring laminated versions (distributed by Local Sampling Coordinator).

For sampling day:

- Orleans Ponds Sampling Sheet/chain of custody forms for each pond
- Map(s) or queued digital map images of access points
- Phone numbers of access contacts for private access points
- Sufficient sample bottles for each pond plus field duplicates
- Cooler and ice packs
- Sampling equipment, including DO/Temperature meter (calibrated prior to use according to meter instruction manual), Van Dorn sampler, and Secchi disc

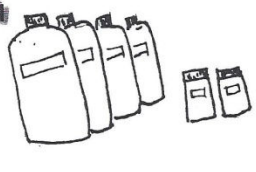
Return of samples to lab:

- Ensure samples remain cold until returned.
- Samples should be returned to lab within 10 hours of collection to maintain holding times.
- Orleans Ponds Sampling Sheet/chain of custody forms for each pond should be signed by samplers, transfer personnel/couriers, and all CSP/SMAST staff that control/transport the samples and data sheets, including time and location. Sample couriers will be coordinated between the Chair of Marine and Fresh Water Quality Committee/Local Sampling Coordinator and CSP/SMAST staff for each sampling day.
- Copies of sampler Orleans Ponds Sampling Sheet/chain of custody forms should be retained by the samplers and delivered to the Chair of the Marine and Fresh Water Quality Committee/Local Sampling Coordinator. The Chair will store the forms.
- CSP/SMAST staff will ensure Orleans Ponds Sampling Sheet/chain of custody forms are collected and stored for later review and input of field data into spreadsheets.

NIGHT BEFORE SAMPLING: Check all equipment

Freeze

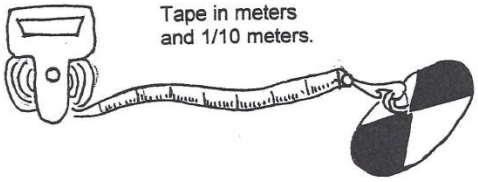
Label



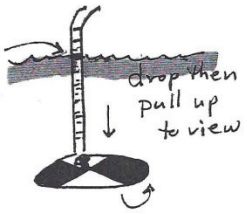
Load Filter

DAY OF SAMPLING:
Collect sampling kit, cooler with ice packs, DO meter, sampling device, and bottles.
Turn on DO meter.

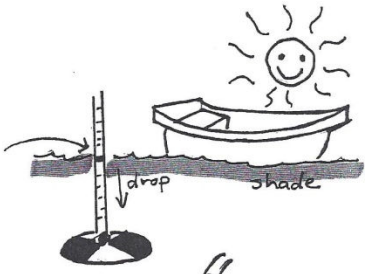
MEASURE DEPTH WITH SECCHI DISK:



1. Secchi Depth, read tape where it **"disappears"** (without sun glasses on)

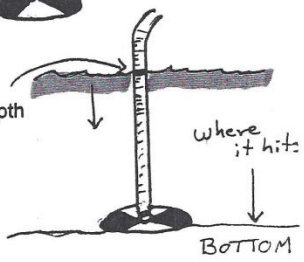


2. Secchi Depth, read tape where is **"reappears"**

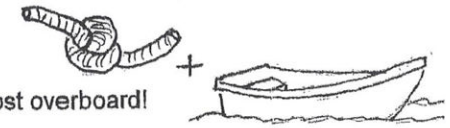


3. Record average of 1 and 2

4. Actual Depth of Water



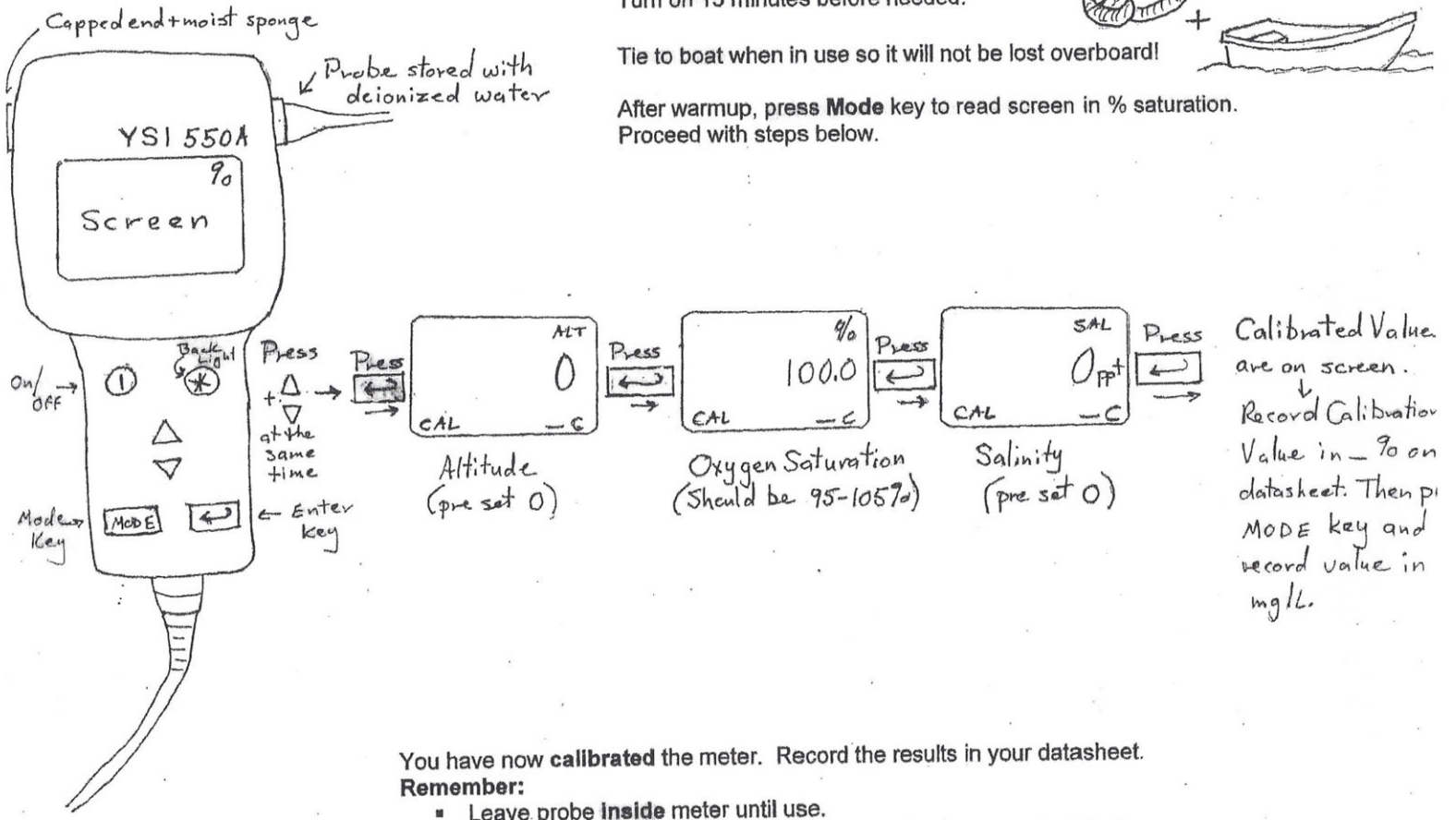
How to Calibrate YSI 550A Dissolved Oxygen Meter



Turn on 15 minutes before needed.

Tie to boat when in use so it will not be lost overboard!

After warmup, press **Mode** key to read screen in % saturation.
Proceed with steps below.



You have now **calibrated** the meter. Record the results in your datasheet.

Remember:

- Leave probe **inside** meter until use.
- Leave meter **on** until all measurements for the day are completed.
- After use, rinse the probe with **distilled water** before inserting back into its chamber.
- Rinse the cable with tap water at home.

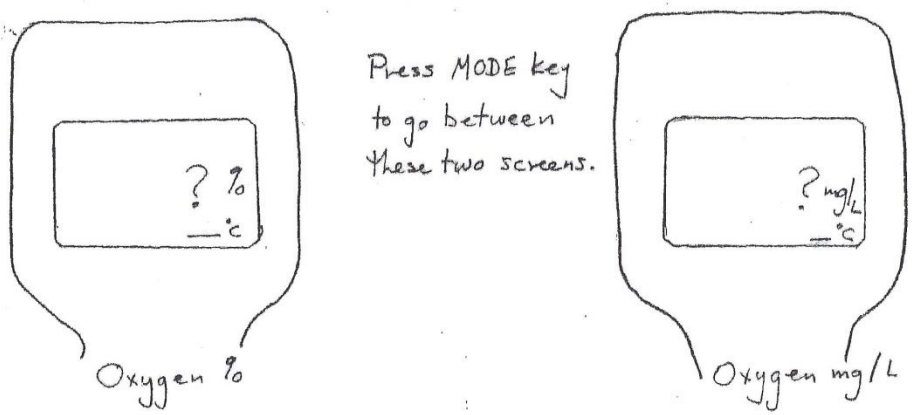
Operating Dissolved Oxygen Meter

Remove the probe from storage chamber and lower to proper depth:

- At mid-point of depth for shallow locations.
- Surface measurement at ½ meter below surface.
- Bottom measurement at ½ meter above bottom.

Jiggle probe up and down 1-2 inches. Wait about 30 seconds until reading is steady.

Record time, depth, temperature and % oxygen saturation (in 0.1 units) on the datasheet for each depth.



Press Mode key to change to mg/L and record your reading (in 0.1 units) on the datasheet. Press Mode key again to return to %.

- ✓ Rinse probe with deionized water and store inside meter.
- ✓ Turn off meter when sampling is complete for the day.
- ✓ Take care in packing equipment that meter is not accidentally turned on.

Appendix C – Orleans Ponds Water Sampling Procedures*: Field Instructions*

1. Record all applicable information on the Orleans Ponds Sampling Sheet/chain of custody form, including sampling volunteers, date, weather conditions, pond observations, and sampling depths.
2. Collect Secchi readings and total station depth; record readings on provided Orleans Ponds Sampling Sheet/chain of custody form.
3. Collect dissolved oxygen and temperature profile readings at 0.5 m, 1 m, 2 m, and subsequent one meter increments to within 1.0 of the bottom; record readings on Orleans Ponds Sampling Sheet/chain of custody form. Selected ponds will have readings made at 0.5 m increments and the deepest reading for these ponds will be within 0.5 m of the bottom; these ponds are noted in the QAPP Appendix E bathymetric maps and will be confirmed with each sampler by the Local Sampling Coordinator prior to sampling. Bathymetric maps also show each individual pond sampling location.
4. Enter pond name, date and sample depth on labels of sample bottles.
5. Collect water samples at depths specific to the total station depth with Van Dorn Sampler. A minimum of two samples per pond with samples at 0.5 m and 1 m off the bottom. If the pond is 1.5 m or less in depth, collect two samples at 0.5 m depth. In ponds of ~9 m, collect one additional sample at 3 m depth (0.5 m, 3 m, 1 m above bottom). In ponds with a total station depth greater than 11 m, collect one additional sample at 9 m depth (0.5 m, 3 m, 9 m, 1 m above bottom). Record sampled depths on Orleans Ponds Sampling Sheet/chain of custody form.
6. Samples should be transferred to 1L dark, acid-washed, Nalgene bottles. Care should be taken to avoid contact with the interior portion of the bottle or with the water stream between the sampling device and the sample bottles.
7. Sample bottles should be stored in the cooler with ice packs, as they are collected.
8. If a duplicate sample is required at the pond (as noted by the Project Managers prior to sampling day), duplicate sample should be indicated on the bottle ("DUP") and recorded on appropriate sampling sheet. Duplicate dissolved oxygen and temperature profiles and Secchi readings will also be collected.
9. If a field blank is prepared by the Local Sampling Coordinator and provided to samplers, it will remain in the sample cooler and be returned to the Analytical Facility with the other samples.
10. Samples should be returned to the CSP/SMAST Analytical Facility within 10 hours of sampling to ensure holding times are met. Sample couriers will be coordinated between the Chair of Marine and Fresh Water Quality Committee/Local Sampling Coordinator and CSP/SMAST staff. Each courier/individual in possession of samples will sign and note the time of sample transfer on the Orleans Ponds Sampling Sheet/chain of custody form accompanying the samples.

Appendix D – Orleans Ponds Sampling Sheet/chain of custody form

SMAST
University of Massachusetts Dartmouth

POND AND LAKE SAMPLING DATA SHEET
Town of Orleans Pond and Lake Monitoring Program

ORLEANS, MASSACHUSETTS INCORPORATED MAR. 3, 1797

LAKE/POND NAME: _____

Sample Collector: _____ Date: _____ Time: _____ (AM or PM)

Observations (write in or circle as appropriate):

Water Color: _____ (blue, brown, green, blue/green, red/orange, white, etc)

Weather (circle): 1. Cloudless, 2. Pt. Cloudy, 3 Overcast, 4. Rain, 5. Fog/Haze, 6. Drizzle, 7. Intermit. Rain

Wind (circle): 1. Calm, 2. Light Breeze, 3. Steady Wind, 4. Strong Wind

Plants on Pond (check conditions):	Over 50%	25% to 50%	10% to 25%	up to 10%	less than 1% or None
Waterlilies coverage of pond surface:					
Floating Algae on pond surface:					
Emergent Grasses/Sedges of surface:					
Other plant #1_____:					
Other plant #2_____:					

Other Notes:

TOTAL DEPTH: _____ meter

SECCHI READING: Disappearing: _____ meter Reappearing: _____ meter

DISSOLVED OXYGEN/TEMPERATURE PROFILE

Meter Manufacturer: _____ Model# _____

Record DO/Temp profile in one-meter increments except for the first surface reading which is taken at 0.5 m (*for example:* 0.5 m, 1 m, 2 m, 3 m, etc). For selected shallow ponds, record readings at 0.5 meter increments (*for example*: 0.5 m, 1 m, 1.5 m, 2 m, etc.). Profile increments are detailed in the Pond QAPP; clarify the increments with the sampling coordinator prior to sampling.

Depth (m)	Temp (°C)	Dissolved Oxygen (mg/l)	Depth (m)	Temp (°C)	Dissolved Oxygen (mg/l)	Depth (m)	Temp (°C)	Dissolved Oxygen (mg/l)

COMPLETE BOTH SIDES OF DATA SHEET

LAKE/POND NAME: _____

Sample Collector: _____ Date: _____

WATER QUALITY SAMPLING

LIST POND NAME, SAMPLE DEPTH, AND DATE ON BOTTLE LABEL

⇒ POND GREATER THAN 9 METERS DEEP ⇐	
Sampling Depth	Bottle Label (Pond Name, Sample Depth, & Date)
a. just below the surface (0.5 m)	
b. 3 m down	
c. 9 m down	
d. 1 m above the bottom	

⇒ In ponds ~9 m deep, collect three samples ⇐
(just below the surface, 3 m down, and 1 m above the bottom).

⇒ POND LESS THAN 9 METERS DEEP ⇐	
Sampling Depth	Bottle Label (Pond Name, Sample Depth, & Date)
a. just below the surface (0.5 m)	
b. 1 m above the bottom	

⇒ In ponds approximately 1 m deep, please collect two samples just below the surface (0.5 m) ⇐
If a duplicate sample is included, please note depth and "DUP" in the spaces above.

TIME SAMPLING COMPLETED: _____ (AM or PM)

All water samples must be kept cold, in a cooler with ice packs. Collected samples should be delivered to the Orleans local sampling coordinator and the coordinator will arrange for transfer to the Coastal System Program/SMAST lab.
Contacts: Local Coordinator, Carolyn Kennedy 516-680-0413; Cape Coordinator, Ed Eichner 508-737-5991; Coastal System Program/SMAST lab, Sara Sampieri Horvet 508-910-6314.

SAMPLE SIGNOFFS	Signature	Received Date/Time	Delivered Date/Time
Pond Monitor			
Sampling Coordinator			
Sample Courier			
Sample Courier			
Sample Courier			
SMAST			

COMPLETE BOTH SIDES OF DATA SHEET

Appendix E: Orleans Ponds and Lakes Monitoring Program: Sampling Locations and Bathymetric Maps

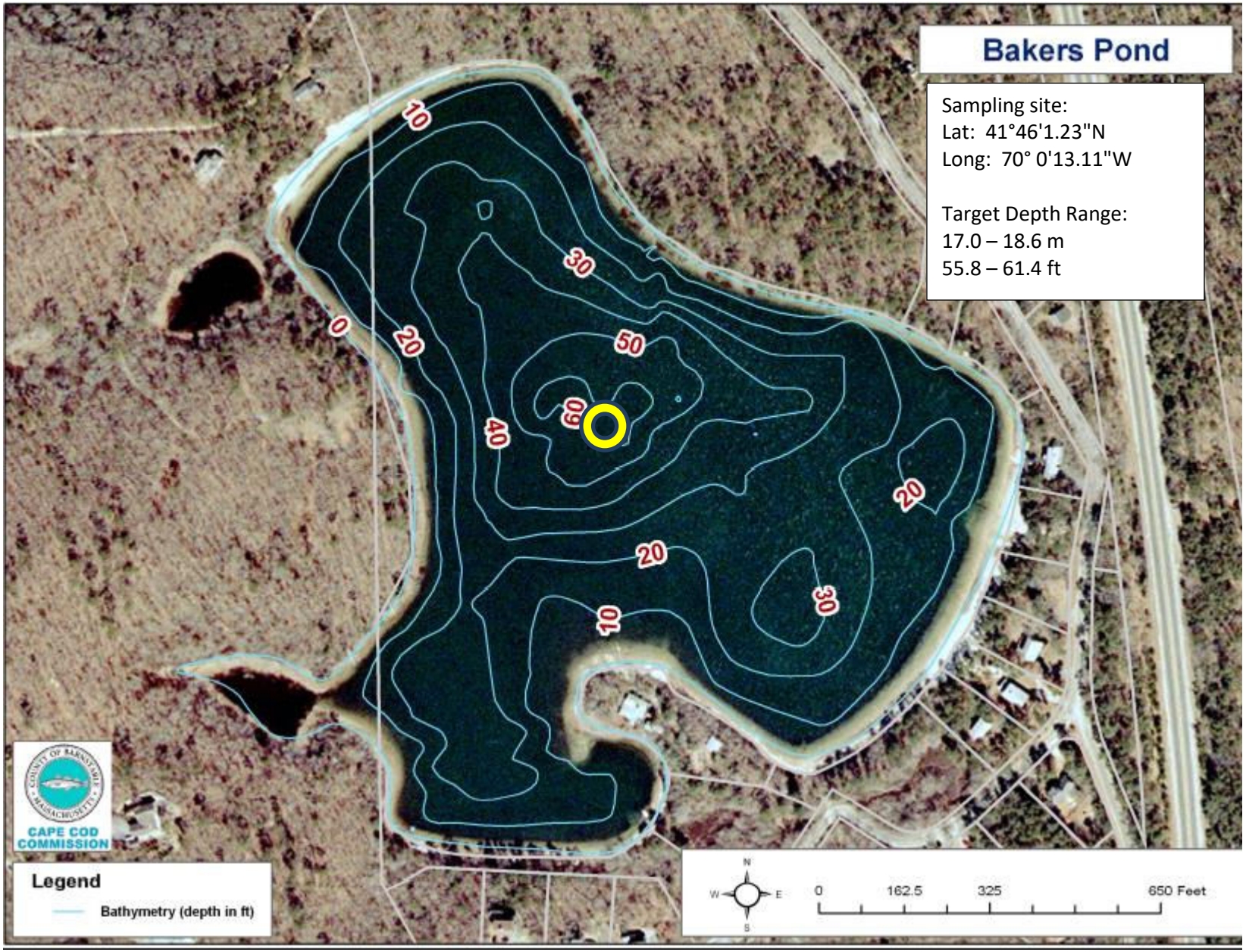
Most of the bathymetric base maps below are from Appendix A of Eichner, E. 2007. Review and Interpretation of Orleans Freshwater Ponds Volunteer Monitoring Data. Cape Cod Commission. Barnstable, MA. 80 pp. GPS coordinates based on Google Earth 4/14/17 aerial photos (accessed 1/18/18). Target depth range for deep location sampling site based on 2000-2016 monitoring and review of available bathymetric maps. Unless seasonal ranges are specified, depths should be toward the upper end of the range in April and toward the lower end of the range in August/September due to normal groundwater level fluctuations.

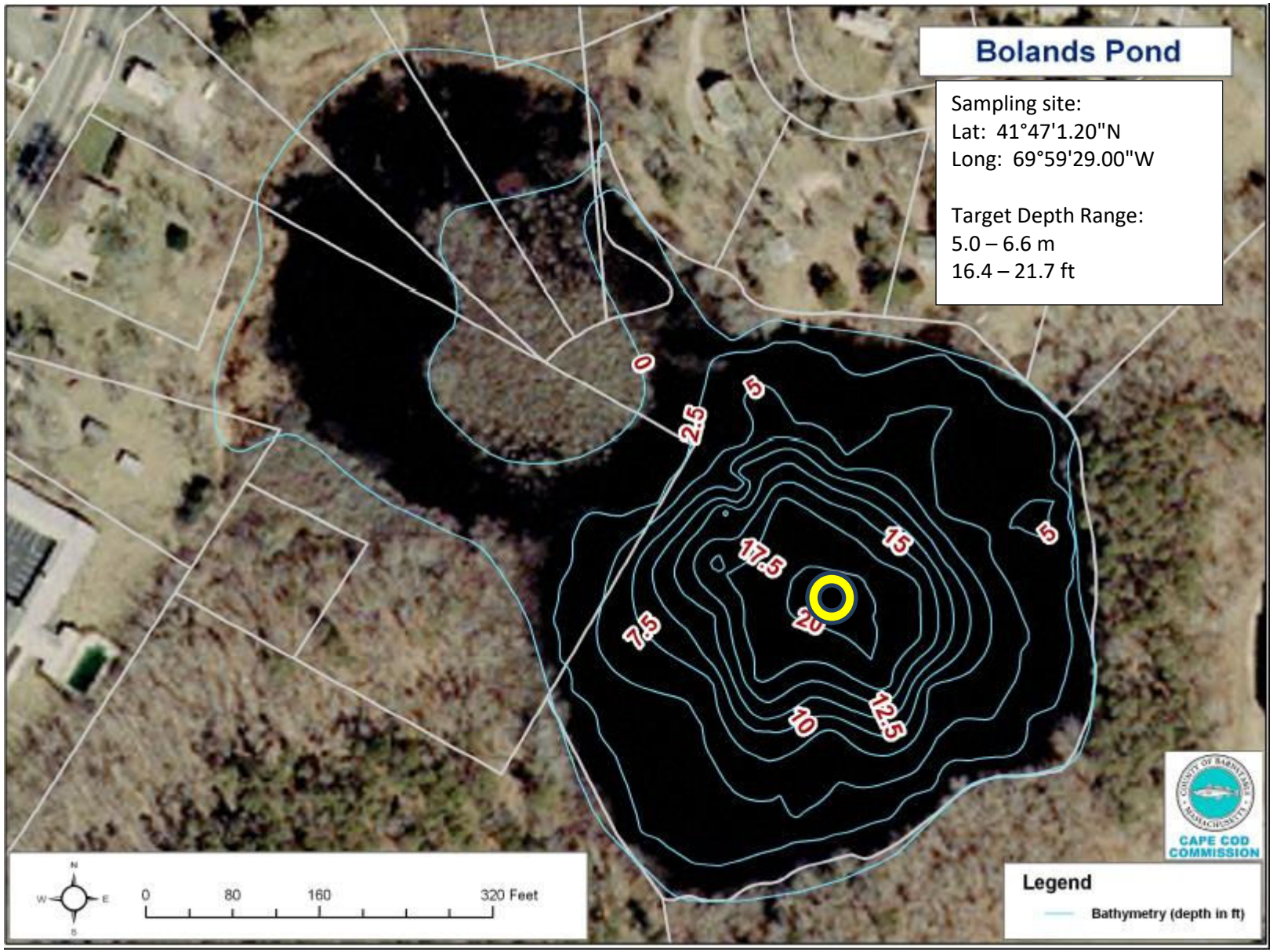
All depth readings except Uncle Harvey's Pond and Pilgrim Lake were collected by town volunteers using GPS and depth sounding equipment during 2005 and 2006. Data interpretation and preparation of bathymetric contours and maps by Scott Michaud, Ben Smith, and Xiaotong Wu, Cape Cod Commission. Bathymetric contours for selected ponds extend beyond the shoreline. This is likely due to groundwater fluctuations and differences in base maps.

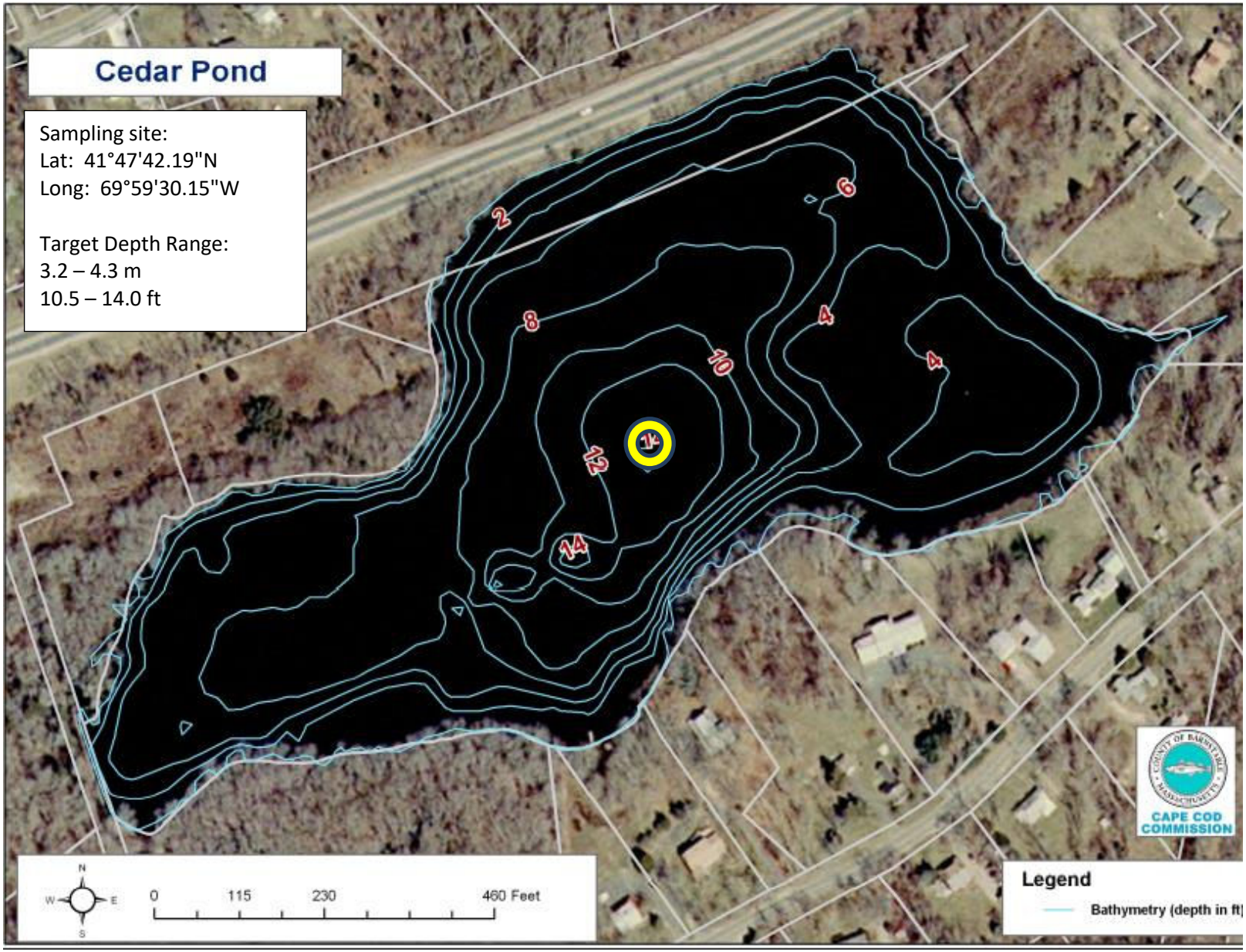
Uncle Harvey's Pond and Pilgrim Lake bathymetry were collected by CSP/SMAST staff on June 15, 2017 using a small boat equipped with a differential GPS coupled to a survey-grade fathometer that collected thousands of individual readings. Horizontal datum was 1983 State Plane coordinates and vertical datum was NAD83. Bathymetry readings were collected as part of data gap surveys completed in support of Uncle Harvey's Pond Management Plan and Diagnostic Assessment (Eichner, Howes, and Schlezinger, 2017) and Pilgrim Lake Management Plan and Diagnostic Assessment (in development), respectively.

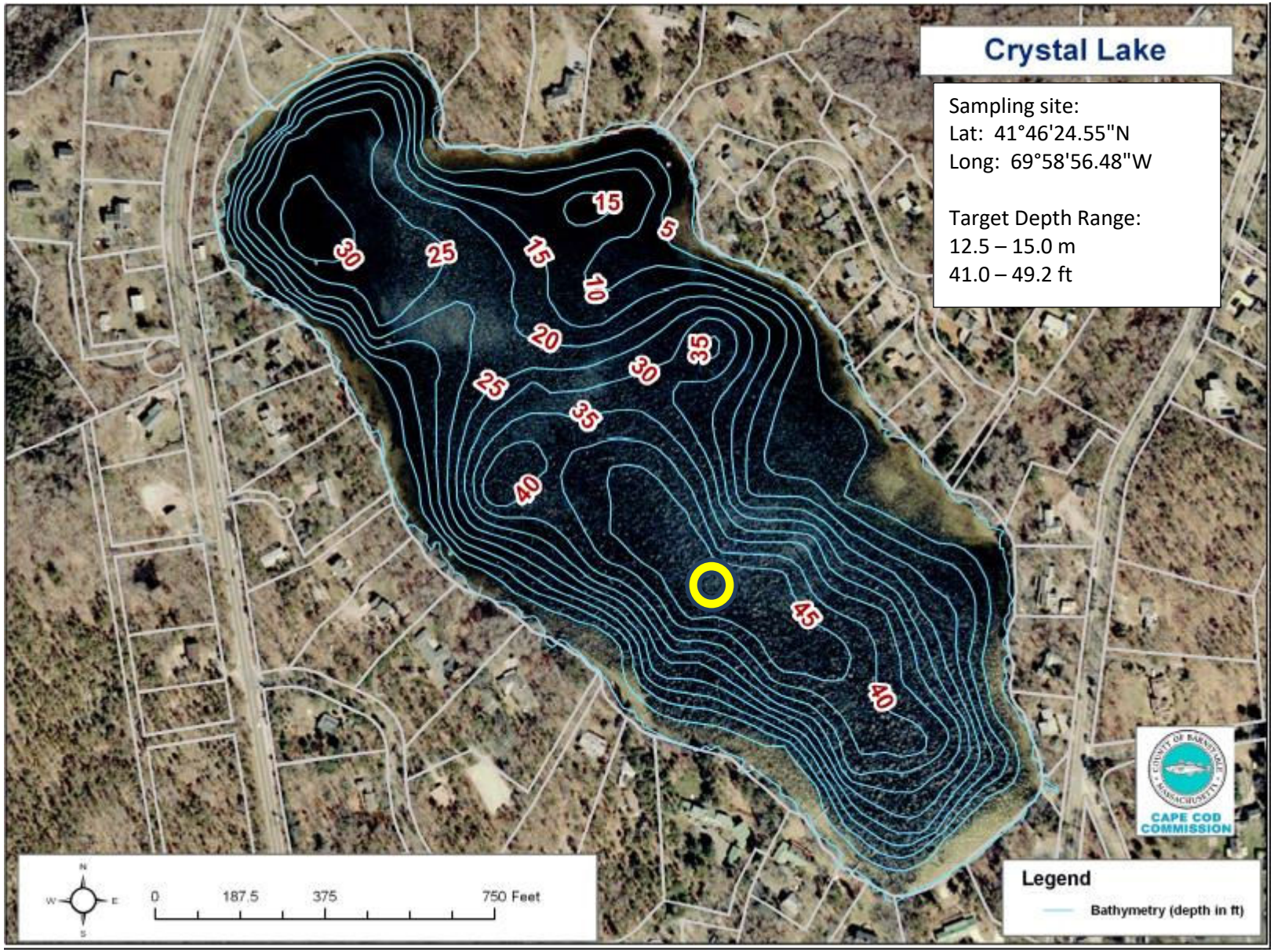
Listed below are the recommended depth increments when collecting pond dissolved oxygen and temperature profiles. In general, shallower ponds should have readings collected at 0.5 m increments, while deeper ponds should have readings collected at 1.0 m increments. Increment consistency will provide greater capacity for detecting changes in pond conditions.

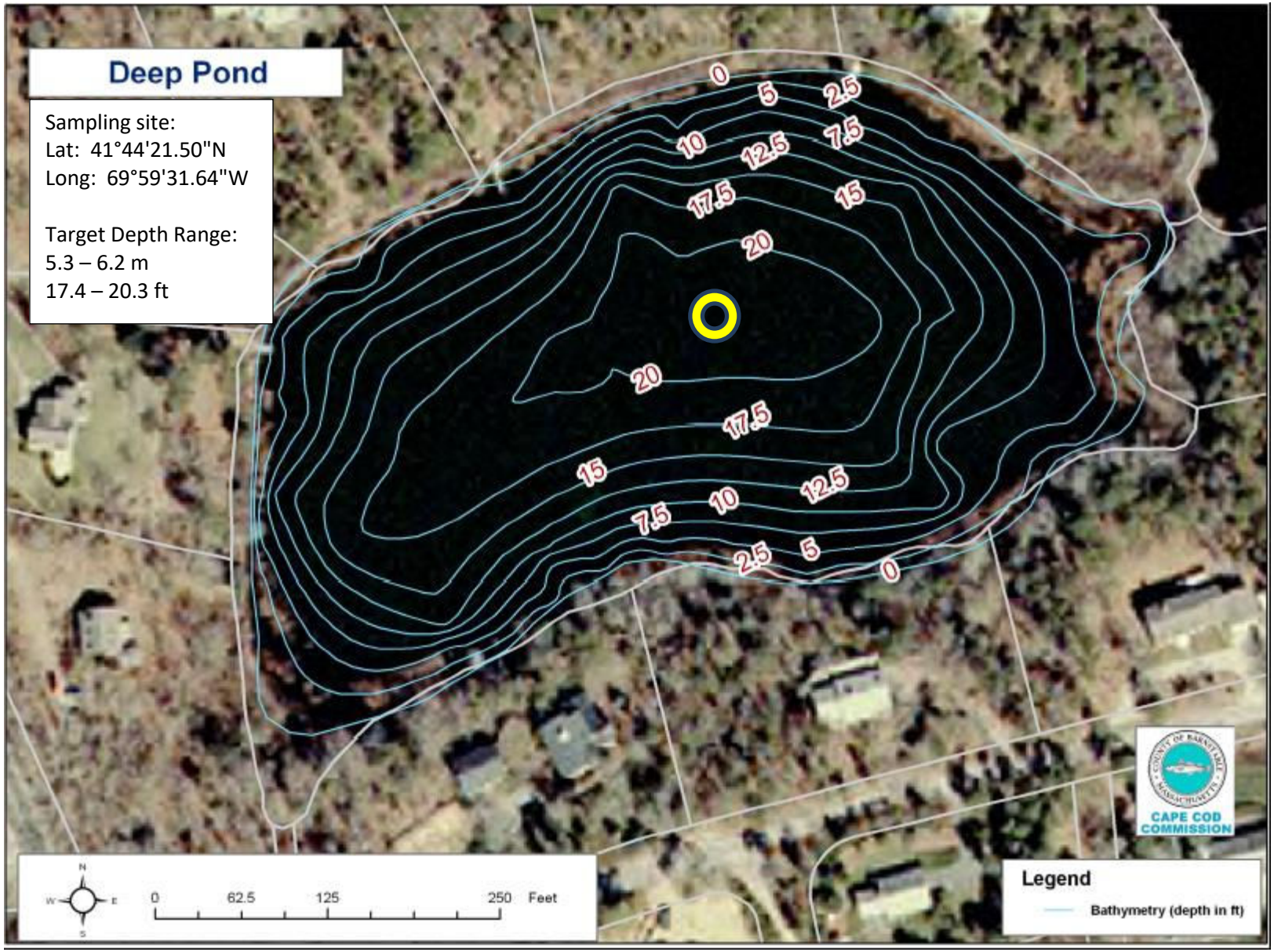
Recommended Pond Profile Increments	
Ponds with 1 m profile increments (*i.e.*, 0.5 m, 1 m, 2 m, 3 m, 4 m, etc)	Ponds with 0.5 m profile increments (*i.e.*, 0.5 m, 1 m, 1.5 m, 2 m, 2.5 m, etc)
Baker	Cedar
Boland	Critchetts
Crystal	Kettle
Deep	Meadow Bog
Gould	Reubens
Ice House	Shoal
Pilgrim	Uncle Israel's
Sarah's	Wash
Twinings	
Uncle Harvey's	
Uncle Seth's	

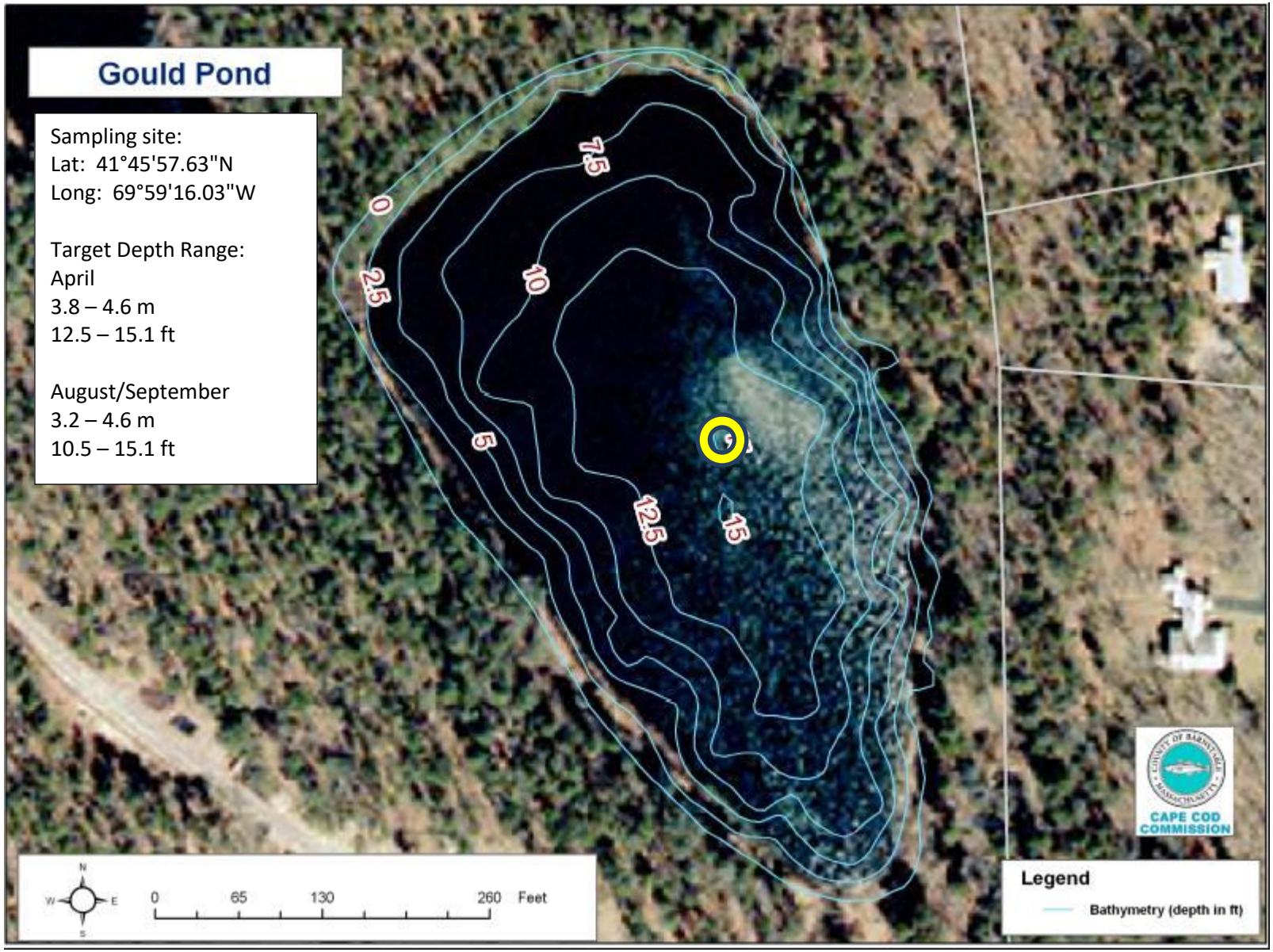

Bakers Pond
Sampling site:
Lat: 41°46'1.23"N
Long: 70° 0'13.11"W
Target Depth Range:
17.0 – 18.6 m
55.8 – 61.4 ft
10
30
0
20
50
60
40
20
20
30
10
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)
N
W
E
S
0
162.5
325
650 Feet

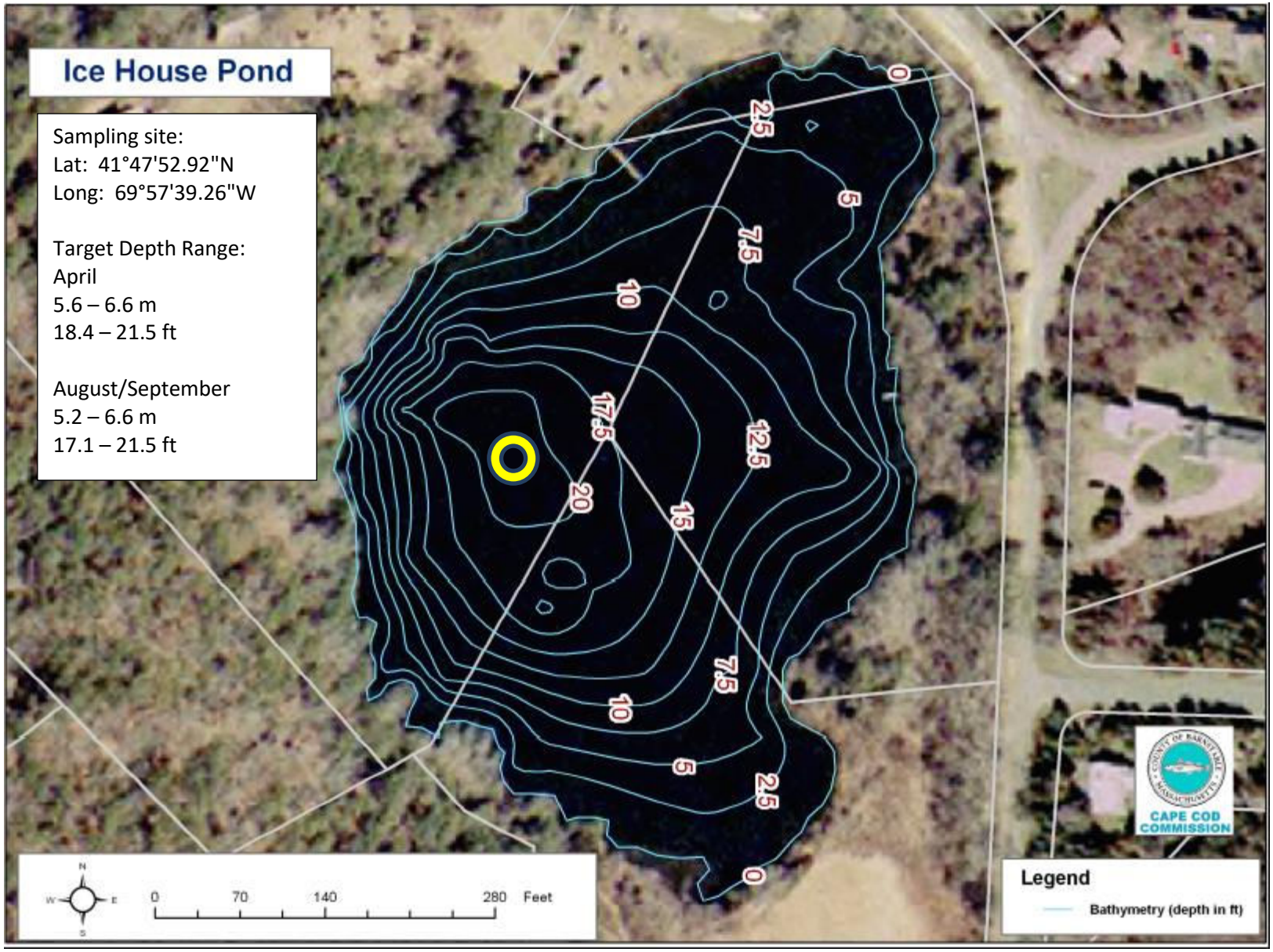

Bolands Pond
Sampling site:
Lat: 41°47'1.20"N
Long: 69°59'29.00"W
Target Depth Range:
5.0 – 6.6 m
16.4 – 21.7 ft
0
2.5
5
5
15
17.5
20
7.5
10
12.5
N
W
E
S
0
80
160
320 Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)

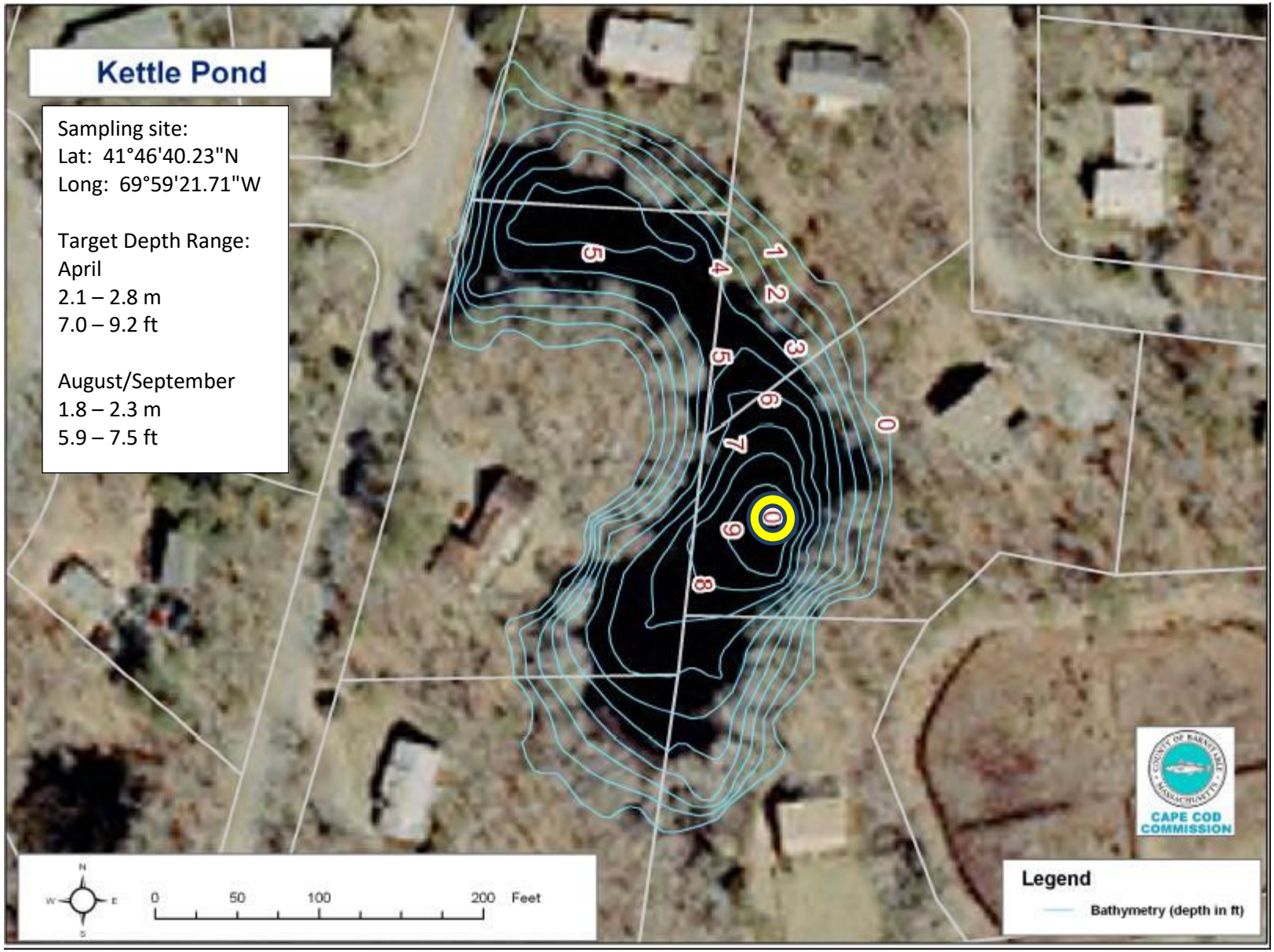

Cedar Pond
Sampling site:
Lat: 41°47'42.19"N
Long: 69°59'30.15"W
Target Depth Range:
3.2 – 4.3 m
10.5 – 14.0 ft
2
6
8
4
10
4
12
14
N
W
E
S
0
115
230
460 Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)

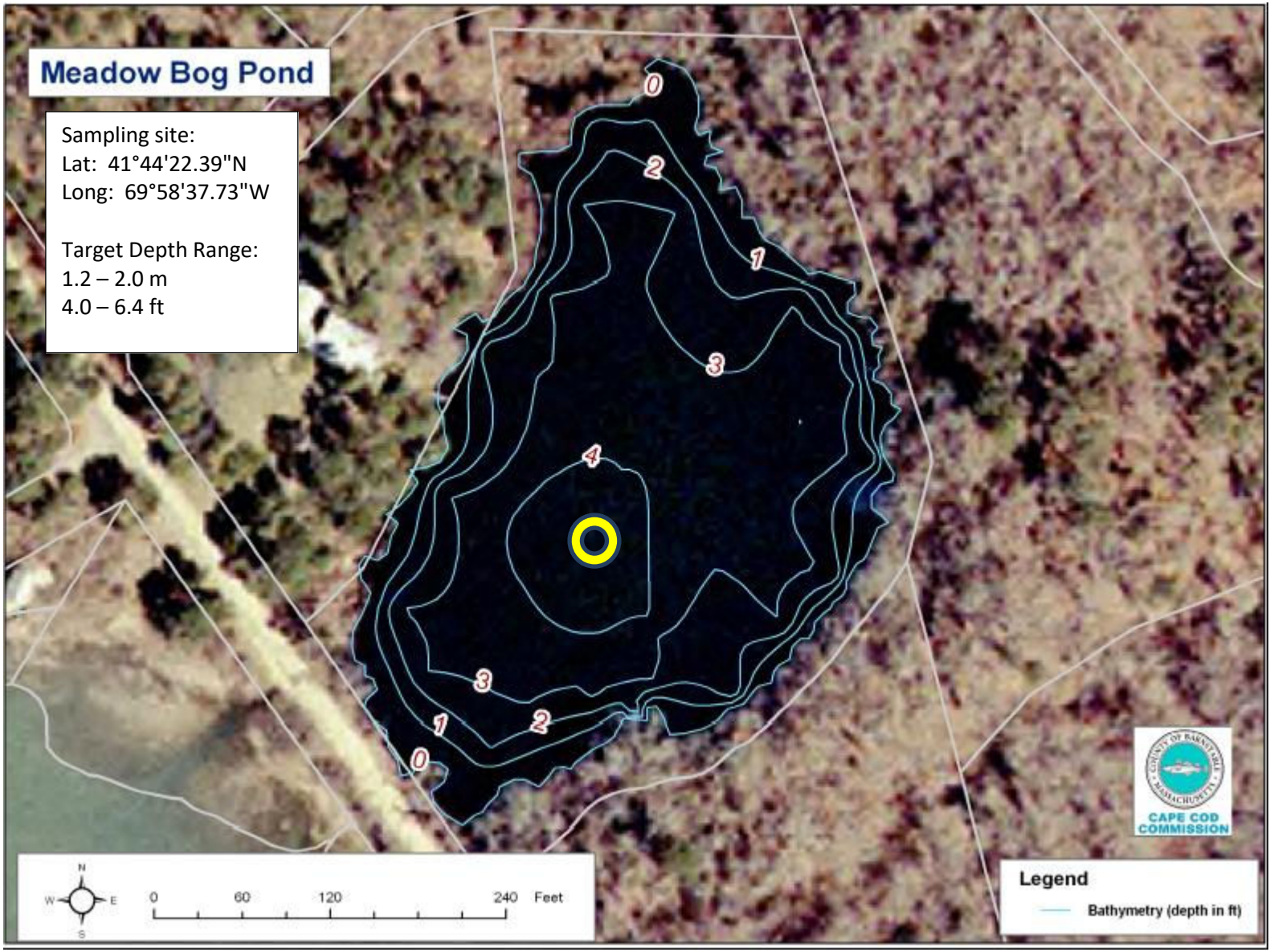

Crystal Lake
Sampling site:
Lat: 41°46'24.55"N
Long: 69°58'56.48"W
Target Depth Range:
12.5 – 15.0 m
41.0 – 49.2 ft
15
5
30
25
15
10
20
35
30
25
35
40
45
40
CAPE COD COMMISSION
0
187.5
375
750 Feet
Legend
Bathymetry (depth in ft)

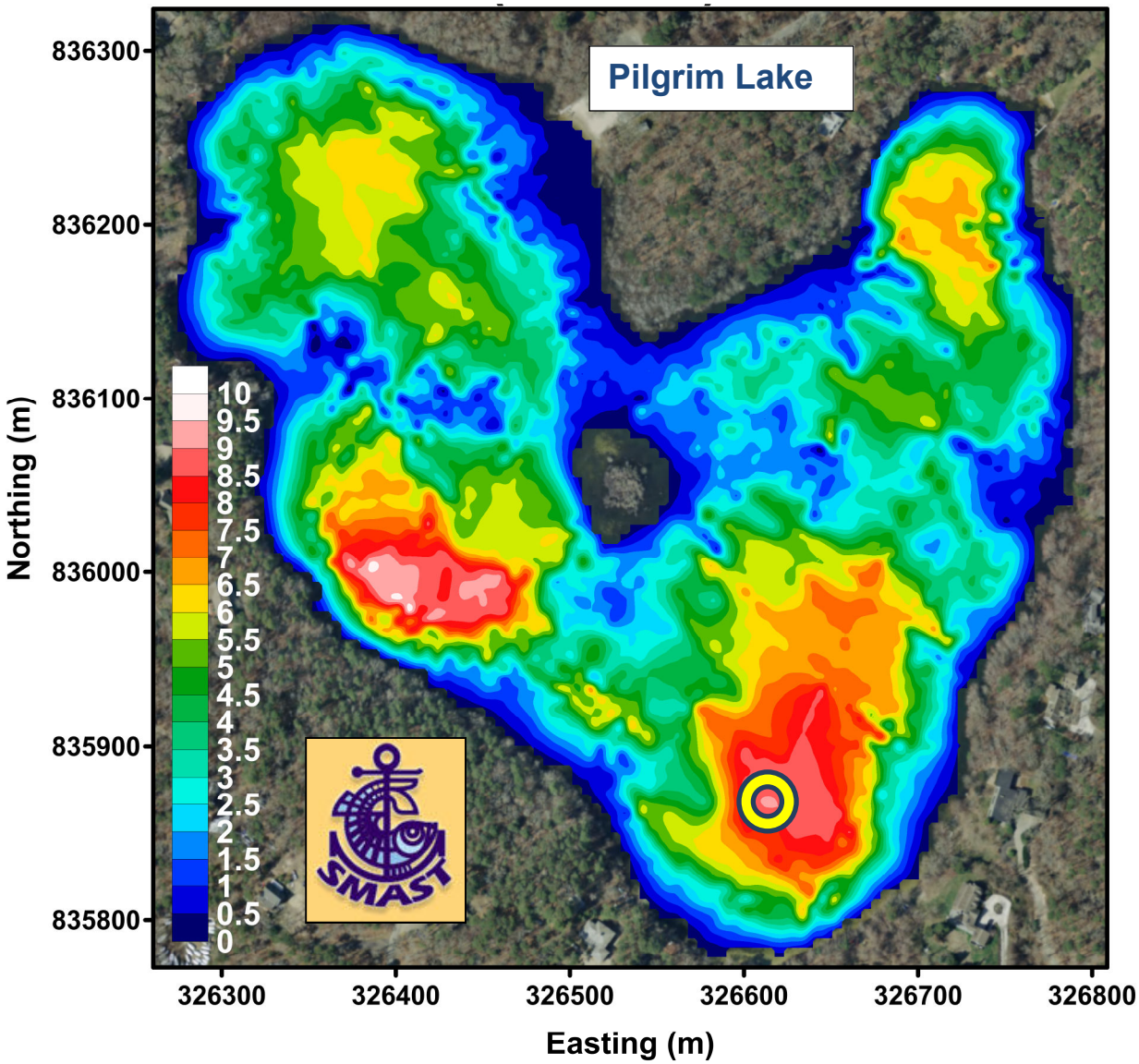

Deep Pond
Sampling site:
Lat: 41°44'21.50"N
Long: 69°59'31.64"W
Target Depth Range:
5.3 – 6.2 m
17.4 – 20.3 ft
0
5
2.5
10
12.5
7.5
17.5
15
20
20
17.5
15
12.5
7.5
10
2.5
5
0
CAPE COD COMMISSION
N
W
E
S
0
62.5
125
250
Feet
Legend
Bathymetry (depth in ft)


Gould Pond
Sampling site:
Lat: 41°45'57.63"N
Long: 69°59'16.03"W
Target Depth Range:
April
3.8 – 4.6 m
12.5 – 15.1 ft
August/September
3.2 – 4.6 m
10.5 – 15.1 ft
0
2.5
5
7.5
10
12.5
15
N
W
E
S
0
65
130
260
Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)


Ice House Pond
Sampling site:
Lat: 41°47'52.92"N
Long: 69°57'39.26"W
Target Depth Range:
April
5.6 – 6.6 m
18.4 – 21.5 ft
August/September
5.2 – 6.6 m
17.1 – 21.5 ft
0
2.5
5
7.5
10
12.5
15
17.5
20
0 70 140 280 Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)


Kettle Pond
Sampling site:
Lat: 41°46'40.23"N
Long: 69°59'21.71"W
Target Depth Range:
April
2.1 – 2.8 m
7.0 – 9.2 ft
August/September
1.8 – 2.3 m
5.9 – 7.5 ft
0
50
100
200 Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)

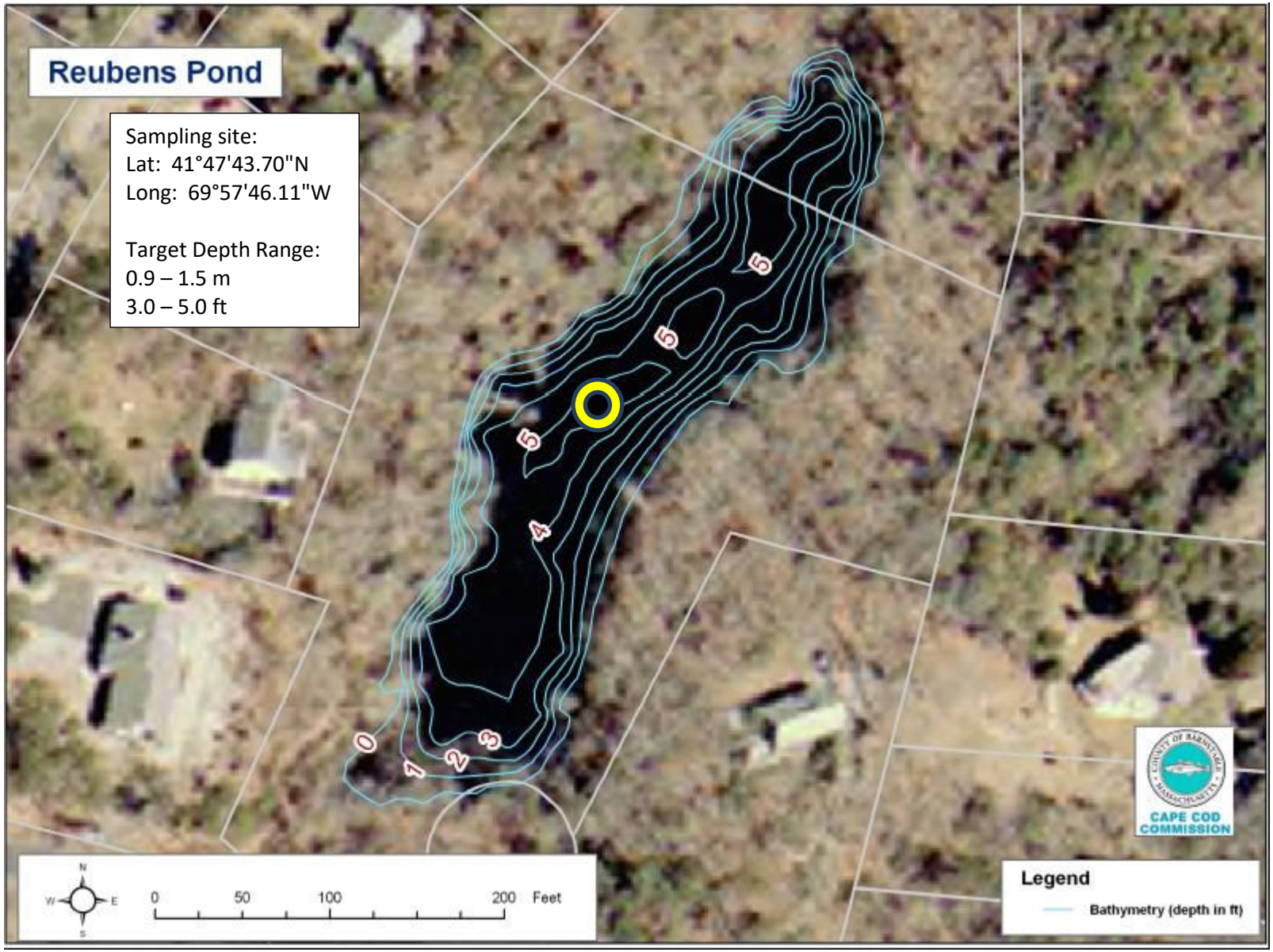

Meadow Bog Pond
Sampling site:
Lat: 41°44'22.39"N
Long: 69°58'37.73"W
Target Depth Range:
1.2 – 2.0 m
4.0 – 6.4 ft
0
2
1
3
4
3
1
2
0
N
W
E
S
0
60
120
240
Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)

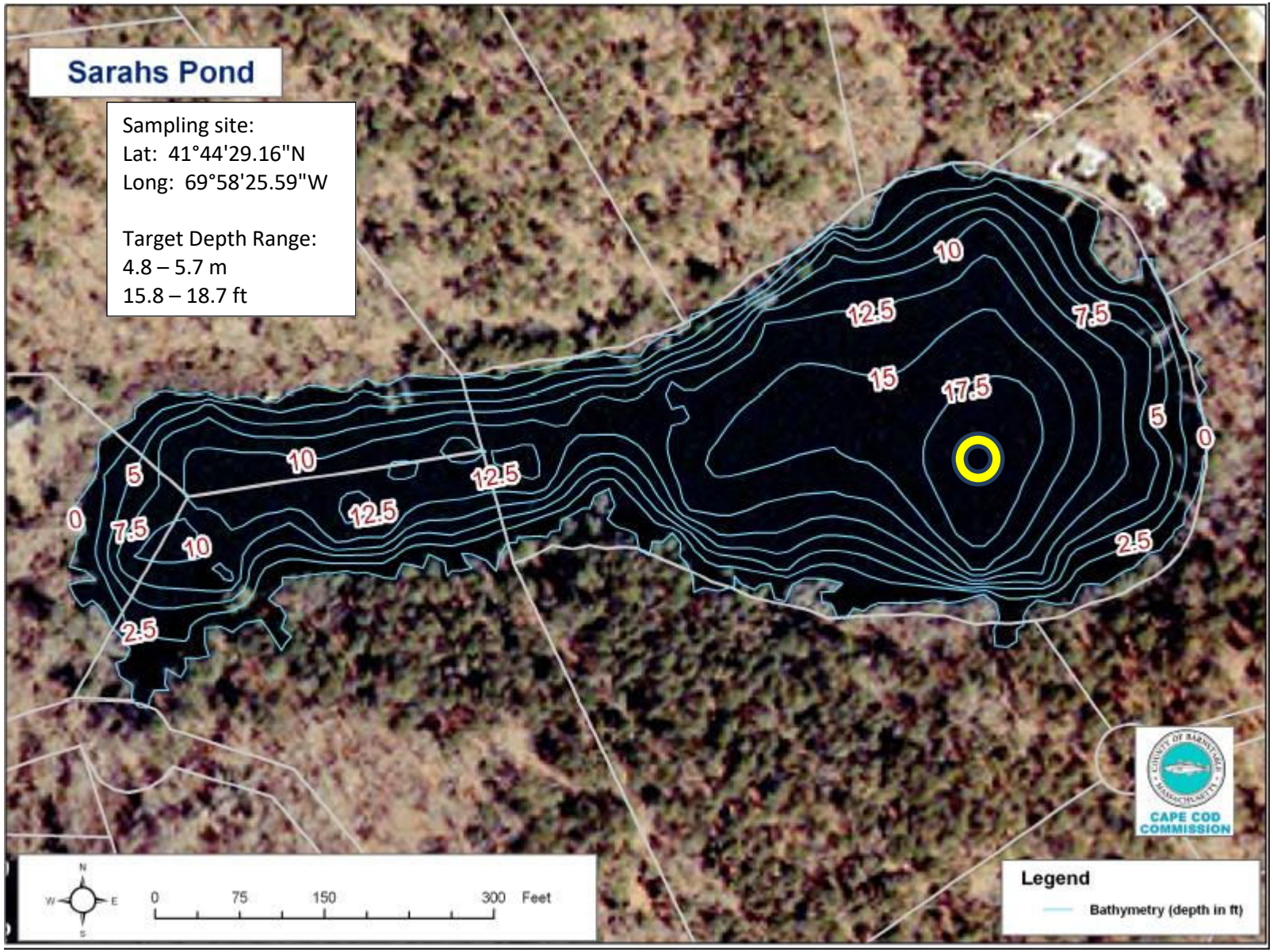


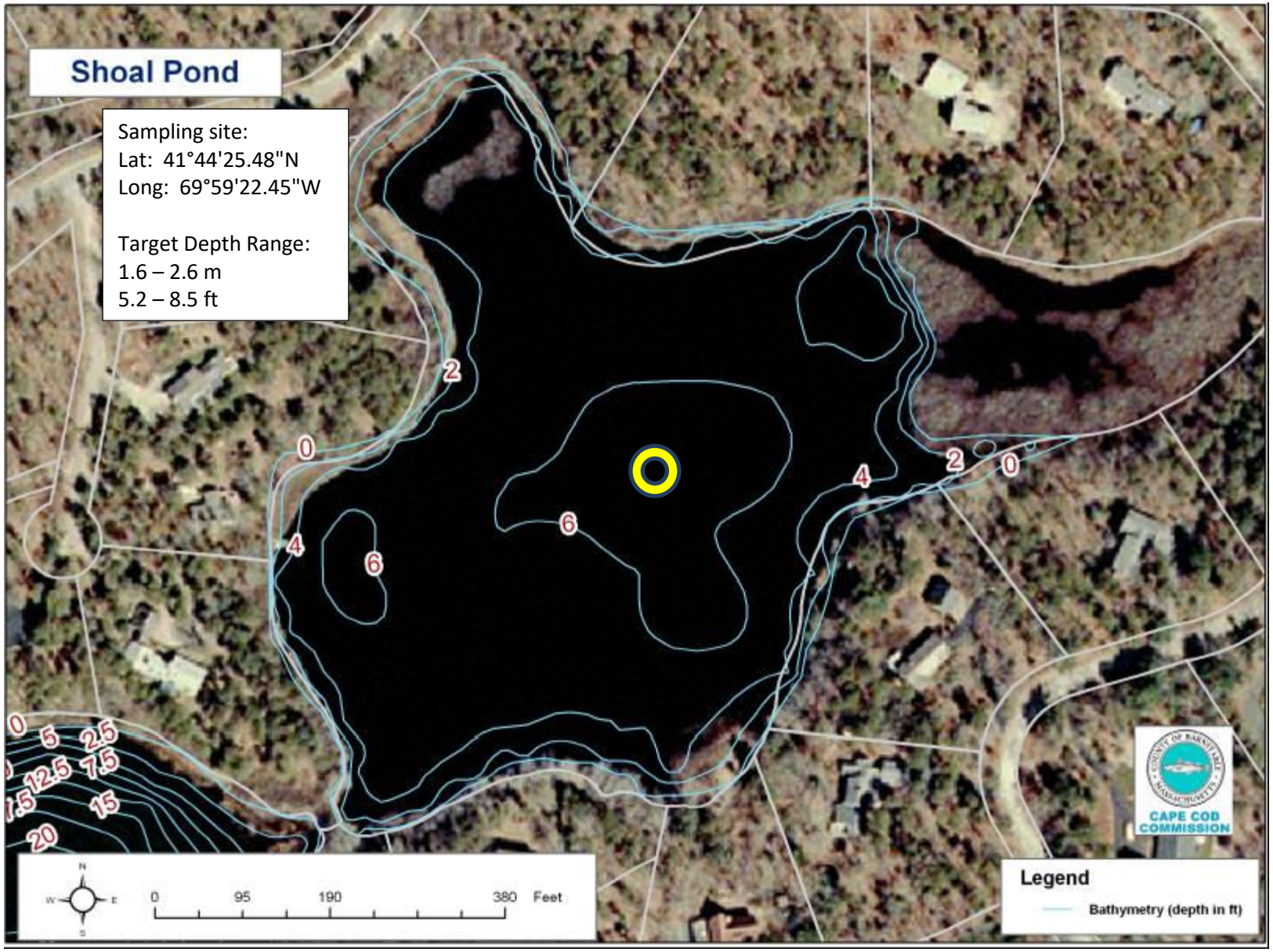
Horizontal Datum: 1983 State Plane Massachusetts Mainland (m)
Vertical Datum: NAD83 (m)

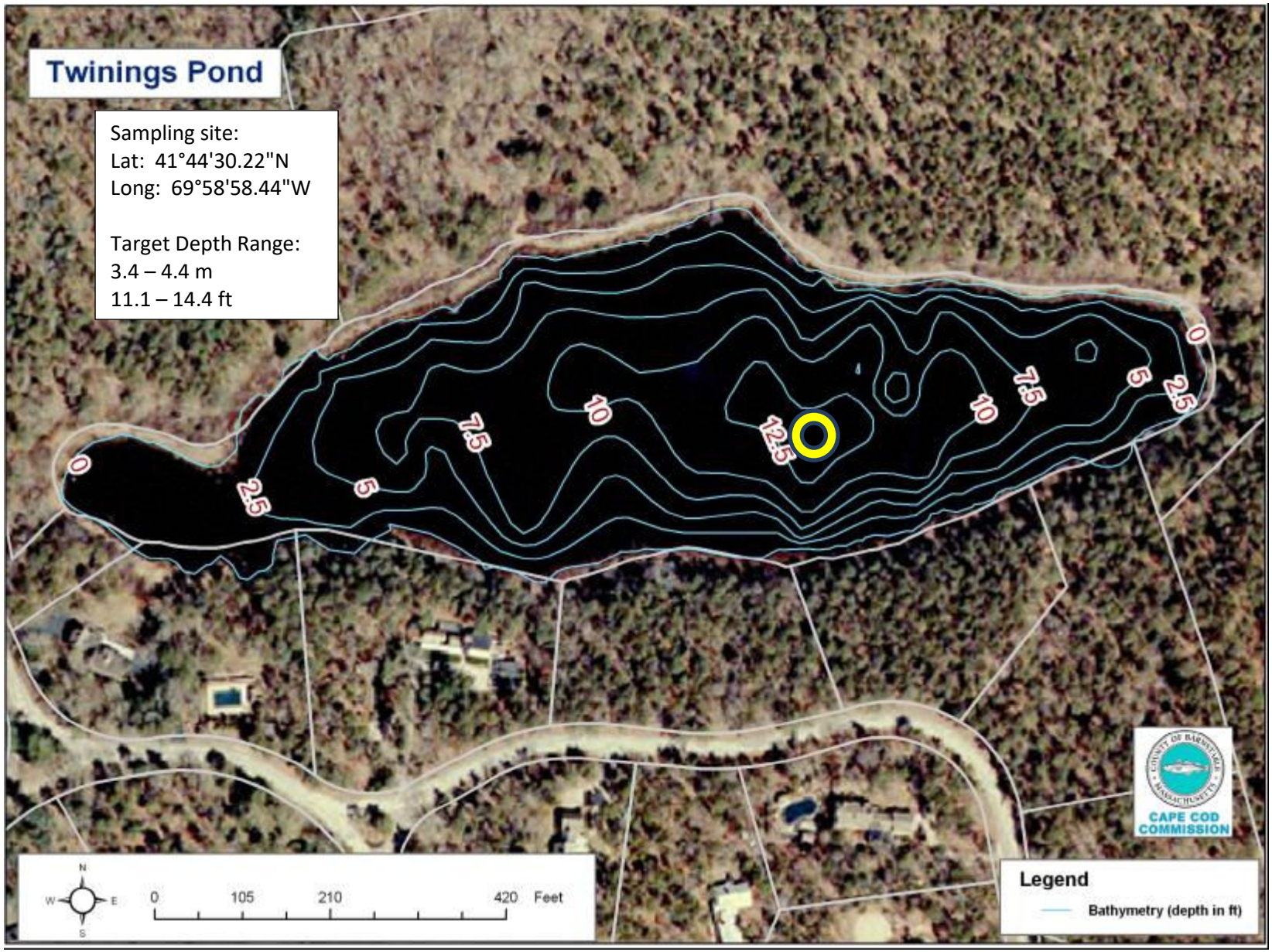
Sampling site:
Lat: 41°45'46.66"N
Long: 69°58'38.52"W

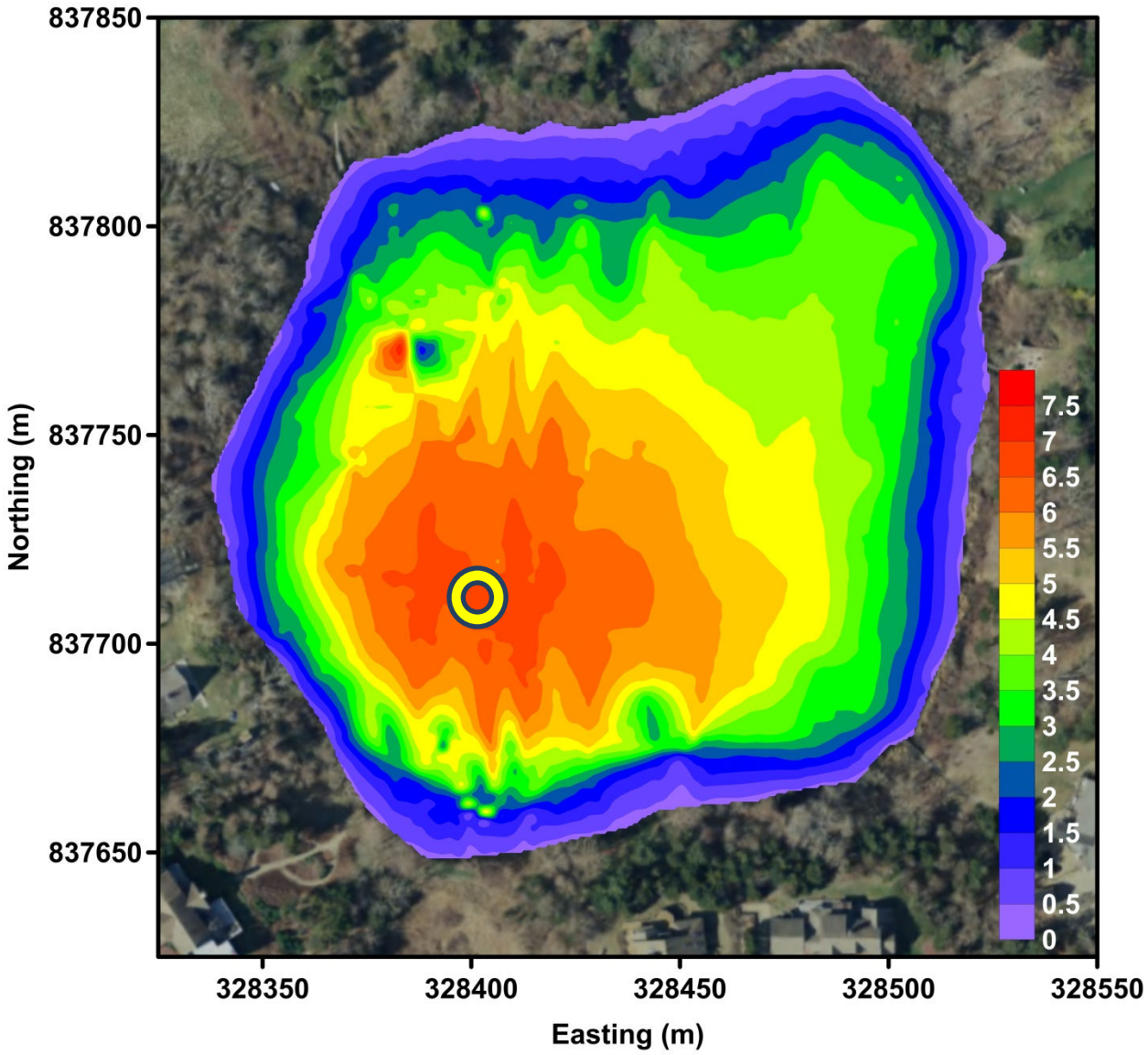
Target Depth Range:
7.6 – 10 m
25.0 – 32.8 ft


Reubens Pond
Sampling site:
Lat: 41°47'43.70"N
Long: 69°57'46.11"W
Target Depth Range:
0.9 – 1.5 m
3.0 – 5.0 ft
0
1
2
3
4
5
5
5
N
W
E
S
0
50
100
200 Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)


Sarahs Pond
Sampling site:
Lat: 41°44'29.16"N
Long: 69°58'25.59"W
Target Depth Range:
4.8 – 5.7 m
15.8 – 18.7 ft
10
12.5
7.5
15
17.5
5
0
2.5
CAPE COD COMMISSION
N
W
E
S
0
75
150
300 Feet
Legend
Bathymetry (depth in ft)


Shoal Pond
Sampling site:
Lat: 41°44'25.48"N
Long: 69°59'22.45"W
Target Depth Range:
1.6 – 2.6 m
5.2 – 8.5 ft
0
2
4
6
0
2
4
6
0
5
2.5
12.5
7.5
15
20
0
95
190
380
Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)

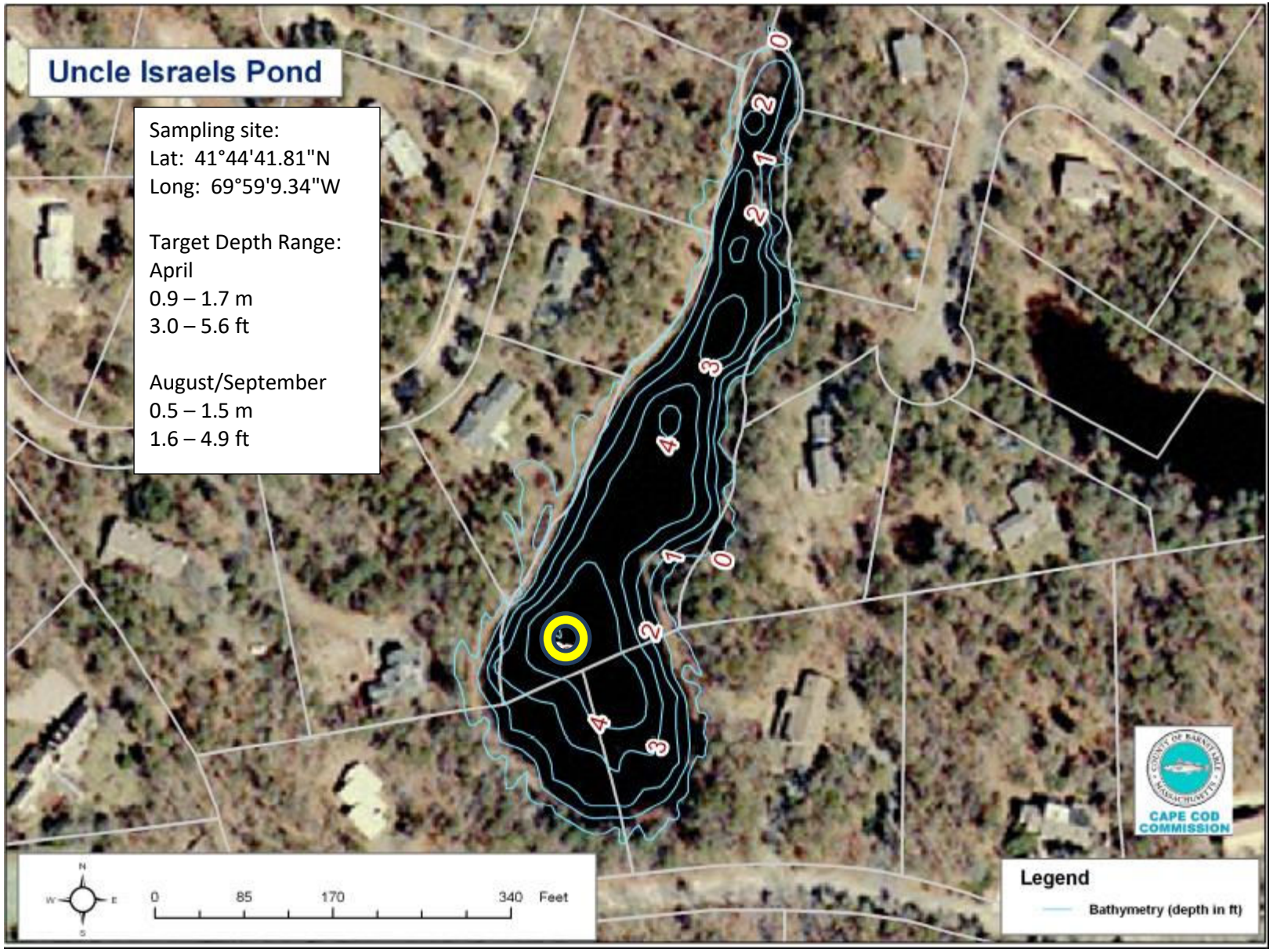

Twinings Pond
Sampling site:
Lat: 41°44'30.22"N
Long: 69°58'58.44"W
Target Depth Range:
3.4 – 4.4 m
11.1 – 14.4 ft
0
2.5
5
7.5
10
12.5
7.5
10
5
2.5
0
N
W
E
S
0
105
210
420
Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)

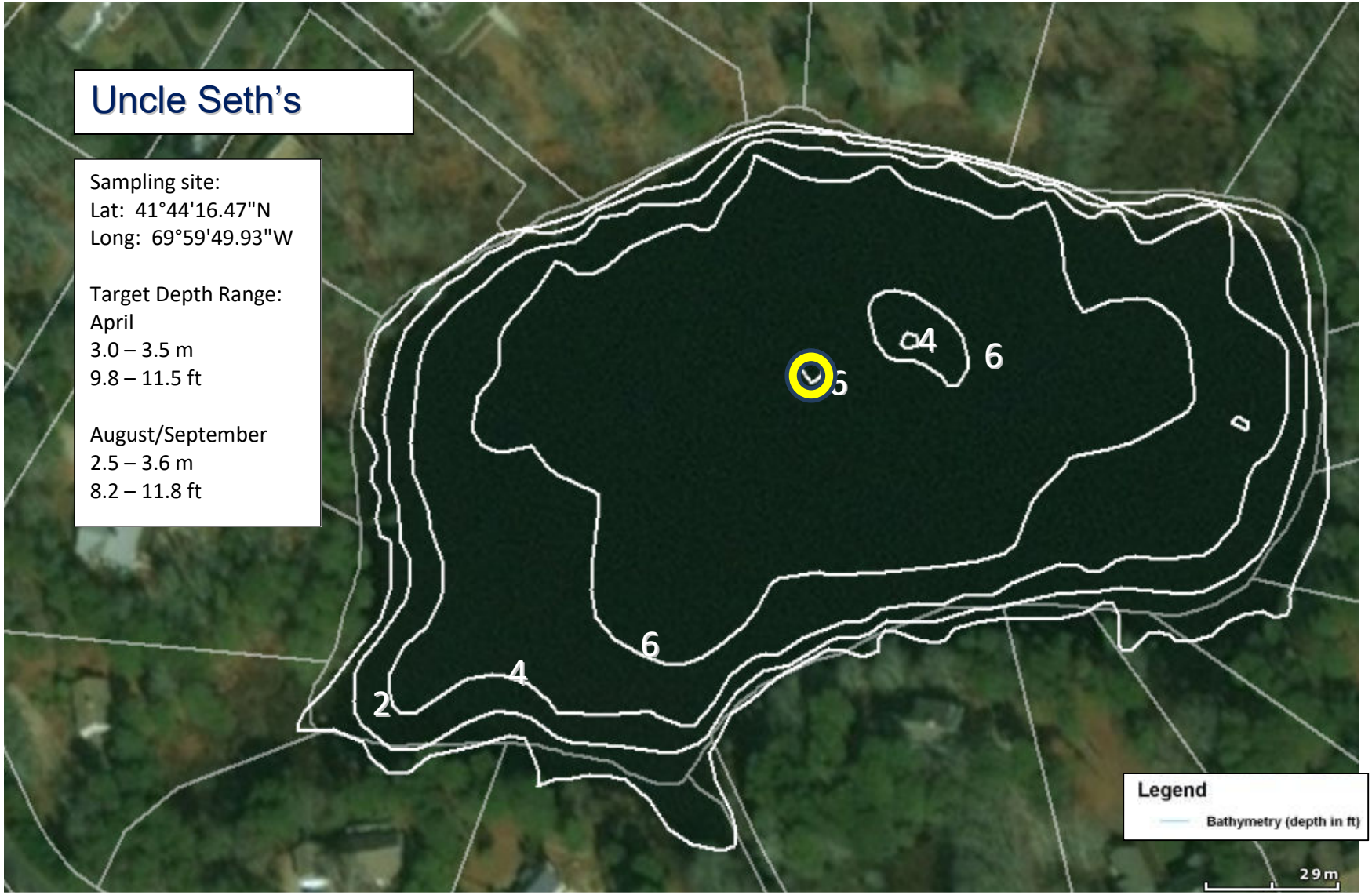


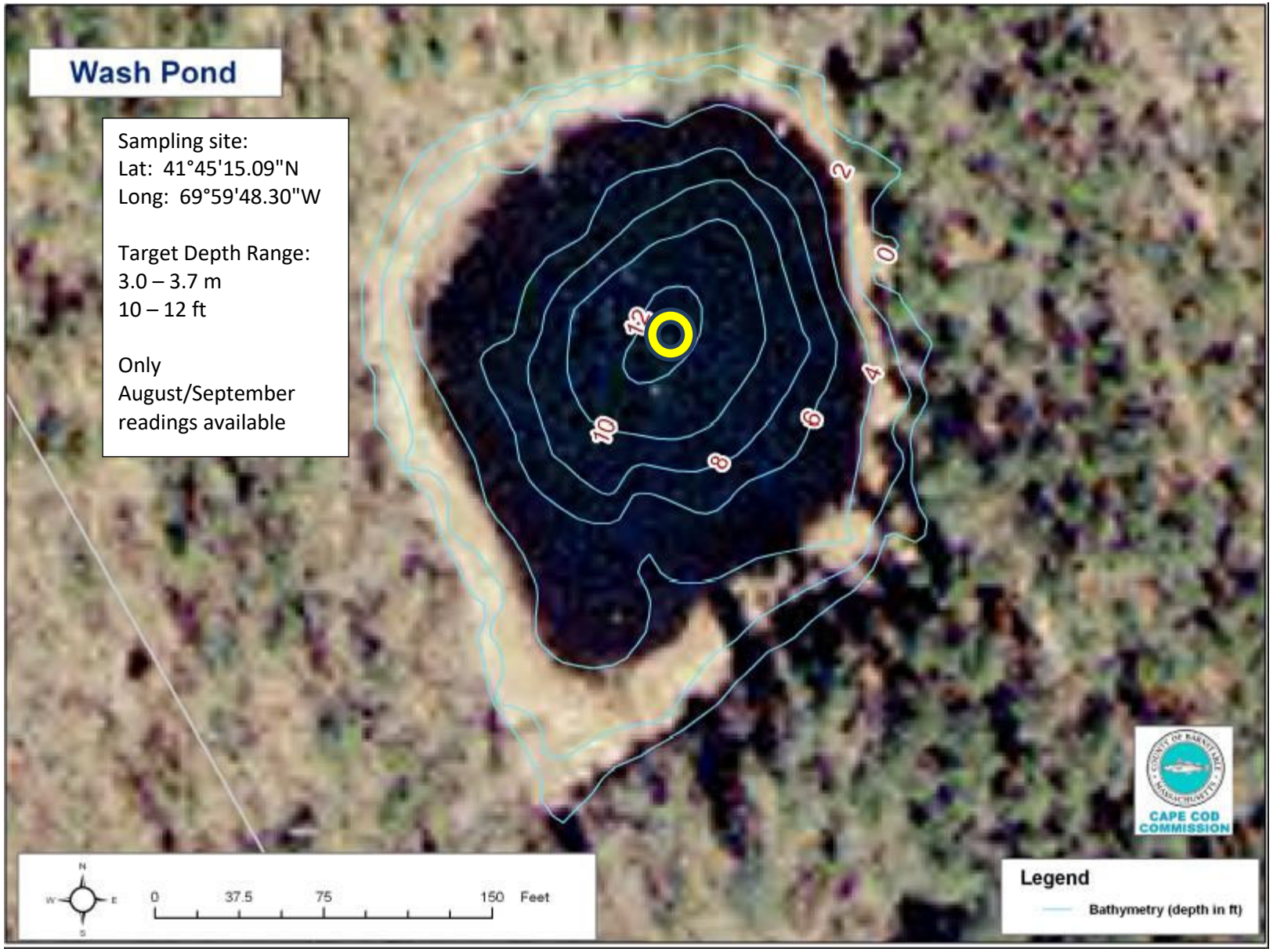
Uncle Harvey's Pond

Sampling site:
Lat: 41°46'45.19"N
Long: 69°57'19.57"W

Target Depth Range:
5.5 – 7.5 m
18.0 – 24.6 ft


Uncle Israels Pond
Sampling site:
Lat: 41°44'41.81"N
Long: 69°59'9.34"W
Target Depth Range:
April
0.9 – 1.7 m
3.0 – 5.6 ft
August/September
0.5 – 1.5 m
1.6 – 4.9 ft
0
85
170
340 Feet
Legend
Bathymetry (depth in ft)
CAPE COD COMMISSION


Uncle Seth's
Sampling site:
Lat: 41°44'16.47"N
Long: 69°59'49.93"W
Target Depth Range:
April
3.0 – 3.5 m
9.8 – 11.5 ft
August/September
2.5 – 3.6 m
8.2 – 11.8 ft
4
6
6
6
4
2
Legend
Bathymetry (depth in ft)
29 m


Wash Pond
Sampling site:
Lat: 41°45'15.09"N
Long: 69°59'48.30"W
Target Depth Range:
3.0 – 3.7 m
10 – 12 ft
Only
August/September
readings available
0
2
4
6
8
10
12
0
37.5
75
150 Feet
CAPE COD COMMISSION
Legend
Bathymetry (depth in ft)

Appendix F – Town of Orleans
Marine and Fresh Water Quality Committee Charge

Marine and Fresh Water Quality Committee Charge

The Board of Selectmen is authorized to appoint a Marine and Fresh Water Quality Committee, charged with protecting the Town's marine and fresh water resources by:

1. Monitoring the factors that impact the ecosystem health of Orleans marine and fresh waterbodies.

2. Recruiting and training a cadre of volunteers to conduct monitoring activities in accordance with established scientific procedures.

3. Maintaining, repairing and updating equipment used for water sampling.

4. Identifying problem areas, researching solutions, reviewing external reports, and recommending steps for remediation.

5. Providing technical information, data and field research to support the Town's efforts to design and carry out master planning for wastewater and stormwater disposal in an ecologically sound manner.

6. Providing communications to BOS, town departments and committees to advocate for clean waterways and resolve issues.

7. Alerting the Town to outside funding opportunities.

8. Coordinating activities with Pleasant Bay Alliance, nearby towns, and local environmental non-profit organizations.

9. Providing liaison with consultants or contractors working on Town water quality issues, when requested.

10. Providing education and outreach to the Orleans public on the importance of improving water quality.

11. Maintaining a repository of water quality data.

The Town further authorizes the Board of Selectmen to appoint seven (7) persons to the Marine and Fresh Water Quality Committee. Members will serve three-year overlapping terms and be eligible for reappointment. The Committee will hold monthly meetings at Orleans Town Hall. Members are asked to actively contribute a minimum of 2-4 hours per month to the work of the Committee. The Committee will submit minutes of meetings to the Town Clerk within 30 days of each meeting and submit an annual report to the Town Administrator's office by January 1 each year. No member of the Committee shall be an employee of the Town of Orleans but the

appointed body shall be authorized to call upon Town employees for information and recommendations for management of Orleans' marine and fresh water resources subject to the order of the Town Administrator. Future revisions to this charge will not have to be approved by Town Meeting but instead may be made by vote of the Board of Selectmen.

Approved ATM 5/8/2017