Orr&Reno

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July 28, 2017

Via Hand Delivery and Email
Pamela Monroe, Administrator
New Hampshire Site Evaluation Committee
c/o New Hampshire Public Utilities Commission
21 South Fruit St., Suite 10
Concord, NH 03301-2429

Re: SEC Docket No. 15-04, Application of Public Service Company of New Hampshire d/b/a Eversource Energy for a Certificate of Site And Facility for the Construction of a New 115 kV Transmission Line from Madbury Substation to Portsmouth Substation – Pre-filed Direct Testimony of Todd Selig

Dear Ms. Monroe:

Enclosed is the Pre-filed Direct Testimony of Todd Selig being filed by the Town of Durham and the University of New Hampshire in the above-captioned docket. Copies are being provided electronically to the Site Evaluation Committee and the Service List.

If you have any questions, please do not hesitate to contact me.

Thank you for your assistance.

Sincerely,

Douglas L. Patch

DLP/eac
Enclosures

cc (via email): Service List in SEC Docket 15-04

1868634_1

THE STATE OF NEW HAMPSHIRE
BEFORE THE
NEW HAMPSHIRE
SITE EVALUATION COMMITTEE

SEC DOCKET NO. 2015-04

APPLICATION OF PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE d/b/a EVERSOURCE ENERGY FOR CERTIFICATE OF SITE AND FACILITY

PREFILED TESTIMONY OF TODD SELIG
ON BEHALF OF
TOWN OF DURHAM
July 28, 2017

Q. Please state your name and business address.

A. My name is Todd Selig. My business address is 8 Newmarket Road, Durham, NH 03824. My position is Durham Town Manager. A copy of my curriculum vitae is included as Attachment A to this testimony.

Q. What is the purpose of your testimony?

A. The purpose of this testimony is to address concerns that the Town of Durham has with regard to the Seacoast Reliability Project ("Project" or "SRP"), a portion of which would be constructed in the Town of Durham, including through the campus of the University of New Hampshire ("UNH"), and under Little Bay. The Town of Durham wishes to go on record at this point in time as strongly recommending that the Site Evaluation Committee (the "Committee" or "SEC") look carefully at all options that would have less impact and be less disruptive from an environmental and public interest perspective. Specifically, Durham prefers in declining order of preference the following options:

i) We want to support what we understand to be the Town of Newington's testimony regarding the Gosling Road Autotransformer Solution ("Transformer Alternative"), which would be a far less impactful alternative to this Project;

ii) If the Transformer Alternative is not possible, then have the Applicant use horizontal directional drilling ("HDD") underneath Little Bay as a means of avoiding what could be significant impacts on Little Bay that would result from jet plowing and associated activities;

iii) If HDD is proven to be infeasible, then at a minimum the Committee should require the Applicant to revise its plans, as per our experts' testimony, to adequately demonstrate that cable laying will occur under impact controls that will ensure adequate protection of the Little Bay ecosystem, and thus assure the residents of Durham that there will be no unreasonable adverse effects on water quality and the natural environment of Little Bay or that the impact on natural resources will be manageably limited in the Little Bay.

I also want to address the issue of a Memorandum of Understanding ("MOU") with Eversource that would contain specific items associated with construction activities, in the event that the Committee approves the Project.

As noted below the Town of Durham believes that absent consideration of these alternatives, this Project will have an unreasonable adverse effect on water quality and the natural environment, will unduly interfere with the orderly development of the region, and will not serve the public interest.

Q. Are you familiar with the Project that is the subject of the above-captioned docket?

A. Yes. As Town Manager for the Town of Durham I have reviewed the Application and subsequent filings, have attended public hearings on the Project, and have attended a number of meetings with town officials and others in connection with this Project. I have also worked closely with UNH on this Project.

Q. What is Durham's position with regard to this Project and the impacts which it is likely to have on Little Bay?

A. Our position is set forth in the joint pre-filed testimony of Joseph J. Famely, Stephen H. Jones, Mathew F. Shultz, and Michael F. Dacey filed in this docket on July 24, 2017 ("Joint Little Bay Testimony").

Q. Why is Little Bay an important resource for Durham and the Seacoast region?

A. Little Bay is a part of the Great Bay National Estuarian Reserve ("GBNER"). The GBNER is part of the Great Bay Estuary, a complex embayment and New Hampshire's largest estuarine system. Fed by the tidal waters of the Piscataqua River that forms the boundary between Maine and New Hampshire, the estuary offers a variety of diverse habitats including eelgrass beds, mudflats, salt marsh, rocky intertidal, and upland forest and fields. The Reserve begins at the General Sullivan Bridge at Dover

Point, seven miles from the mouth of the Piscataqua River and the Gulf of Maine. The Reserve encompasses 10,235 acres, including approximately 7,300 acres of open water and wetlands. All of Great Bay and Little Bay are contained within the Reserve boundary as well as the tidal portions of five major river systems - Bellamy, Oyster, Lamprey, Squamscott and Winnicut. GBNER's cultural history is equally diverse, from paleo-Indian villages 6,000 years ago to early colonial settlements and industrial development. The effort to save Great Bay Estuary began in 1973. GBNER addresses concerns with the long-term protection of Great Bay so future generations can discover and enjoy its natural resources.

We believe that it is very important that the Committee understand that the residents of Durham consider Little Bay to be a priceless and fragile natural resource that must be protected against adverse impacts, especially when there are better alternatives available that could avoid those impacts. The Little Bay and the Great Bay Estuary as a whole provides critical wildlife habitat, nurseries for seafood production, buffering from coastal flooding, recreational enjoyment, and safe harbor for marine commerce such as lobster fishing and an emerging industry of oyster aquaculture. In turn, the wetlands, oysters, and eelgrass provide natural erosion control, water purification, nitrogen cycling, and flood protection that would otherwise require significant public and private investment to achieve with infrastructure. A less obvious, but no less important aspect of the ecosystem is its biological diversity. This is because estuaries are places where freshwater meets saltwater, and they have a vast array of creatures associated with both.

The Great Bay Estuary serves as a magnet for tourism supporting the local economy and increases the value of nearby properties. This contributes to state and local tax revenues, as well as a uniquely special region within New Hampshire and Maine to live, work, and play. Our estuaries are part of the National Estuary Program, and they are recognized broadly as exceptional natural areas in need of focused study and careful protection.

Q. What are some of the ecological issues that Little Bay is facing?

A. Unfortunately, the Great Bay Estuary is showing signs of a failing ecosystem. For hundreds of years, development of various towns around the Bay have contributed to material adverse effects on the Bay and its natural resources. The 2013 State of the Estuaries Report, published by the Piscataqua Region Estuaries Partnership, Attachment B to this testimony, showed 12 of 16 environmental indicators with negative or cautionary trends. Estuaries are complex and responsive to stresses both within and outside of our control. Changing climatic conditions, polluted runoff from paved areas, human and animal waste, and excessive fertilizer application are examples of factors that can stress the ecological balance within the estuaries. In particular, impervious cover (paved parking lots, roadways, and roofs) continues to increase throughout the region. During rain storms and snow melt, water running over impervious areas carries pollutants which negatively impact the cleanliness of our rivers, lakes, streams, and ultimately the estuaries. There are also the potential effects on the ecosystem from repeated traveling sediment plumes. While data has not been collected long enough to determine a definitive long-term trend in nitrogen/nutrient loading within the estuaries, this issue continues to be of significant concern for municipalities and for the State. Traditional signs of nutrient-related problems such as loss of eelgrass habitat, periods of low oxygen in the water of the tidal rivers, and increases of nuisance seaweeds are being carefully observed. Some progress in protecting water quality has been made in the last few years, most notably as a result of millions of dollars in improvements by municipalities to area wastewater treatment facilities intended to remove nitrogen from the ecosystem, even though such management actions are inconsistent across the watershed. Grant monies for the GBNER and other Federal and State grants, along with a diligent overseeing by the New Hampshire Department of Environmental Services ("DES") have also helped begin the process of healing the Bay. Also, public investments have been made over the last two decades to reclaim and rejuvenate oyster beds in different parts of the Bay under the scientific auspices of UNH. Therefore, today Little Bay and GBNER are on a path of slow steady recovery. It is crucial to keep this positive trend in place, and not have anything such as the SRP set the efforts back through adverse effects. At a minimum, it is imperative that the Eversource Seacoast Reliability Project not contribute in any way toward further degradation of Little Bay and the estuary.

Q. Are you familiar with the Town of Newington's position on the Gosling Road Autotransformer Solution?

A. Yes. I have discussed this issue with Newington representatives and my understanding of their position is that when compared with the Transformer Alternative the Project as proposed to this Committee is not in the public interest when you examine all of the required factors. These factors include that the Transformer Alternative would impact less geography and fewer resources than the proposed Project and that the Transformer Alternative would be better from an economic growth perspective. Durham supports Newington's position on this issue and urges the Committee to take all necessary and appropriate steps to fully explore this alternative. It is my understanding that UNH also supports this position. Both Durham and UNH believe that if there is a more viable way to provide the benefits to the electrical grid of the Project without having to construct a whole new transmission line through the Town, the campus and Little Bay that this would be far preferable.

Q. Do you have an opinion on other options that the Committee ought to consider?

A. Yes. In the event that the Committee elects not to proceed with serious consideration of the Transformer Alternative, I believe the Committee should exercise its authority under RSA 162-H:10,V and hire an independent consultant to look into the option of HDD under Little Bay as a less impactful alternative to jet plowing, concrete mats, and associated activities that would be required to install the transmission cable in Little Bay. Durham had considered hiring such an expert but does not have the resources to do so given that it has already spent a considerable amount on the experts addressing the environmental impact on Little Bay.

In connection with this position, in addition to the environmental impact concerns expressed herein and in the Joint Little Bay Testimony, Durham continues to have concerns about the visual impact of placing concrete mats in Little Bay, particularly during low tides, concerns that have not been addressed by the limited visual impact analysis which Eversource has undertaken to date. See Attachment C.

Q. Why do you think directional drilling should be considered as an alternative?

A. The Town and our residents are questioning whether Eversource has properly evaluated this option. Eversource appears to have completed a limited review of HDD, saying it will take too much time, is too expensive, has environmental risks (from slurry and bore fracking) and that it would create a high level of disturbance for residences (for the layout area) and roads. Eversource provided some generalized information (e.g., marketing brochures of HDD companies, pictures of other projects, etc.) about HDD, with their pre-filed testimony and responses to data and record requests, but in our view it has not provided adequate and specific information to support the reasons it provides for not doing HDD. See Attachment D.

The Town believes that Eversource did not complete an adequate analysis, such as a subsurface geotechnical investigation, to demonstrate to the public or the SEC why HDD is infeasible, or if it is in fact feasible, whether it is less impactful ecologically. The fact that HDD could be technically challenging should not trump the negative impact of the proposed plan to Little Bay. More specifically, such an expert should look at Eversource's costs in the context of other public costs (i.e. costs of cleaning Durham’s and other towns’ point source wastewater discharge to comply with stricter EPA requirements, costs of cleaning Little Bay over prior decades, costs of reclaiming oyster beds by reseeding done over last 20 years, and other relevant public costs expended to revitalize the Bay). We also submit that it is important that an independent, expert analysis be done that would weigh these issues, along with the environmental risks of jet plowing and associated underwater cable installation activities raised in the Joint Little Bay Testimony, as compared with HDD. Without a clear independent comparison of the risks of jet plowing versus the risks of HDD, the Town believes that we have major uncertainties that make the project risky to Little Bay. Durham residents have also raised questions about whether HDD could at a minimum be done on the western shore of Little Bay. The Town therefore requests that the SEC hire its own independent expert to determine whether HDD makes sense or not, in lieu of the Transformer Alternative or the installation of new cables underwater in Little Bay. We believe that the SEC, the affected towns and their residents, and the region as whole would benefit from such an independent analysis of whether HDD is a better alternative. Without such an independent review of HDD as compared with the current jet plowing proposal, Town residents feel they are being asked to assume significant risks without the benefit of a thoughtful and thorough analysis of what appears to be a viable and preferable alternative.

In connection with this request, Durham wishes to point out that Unitil used HDD in a different part of the same watershed fairly recently to place a natural gas line under the Piscataqua River as part of the Spaulding Turnpike widening project.

Q. Are there any other issues you would like to address?

A. Yes. It is my understanding that William Quinlan, President of the Applicant, Eversource Energy d/b/a Public Service Company of New Hampshire, during the technical session on June 7, 2017 committed to work with each town to address more specific issues through an MOU. We have had no outreach from Eversource concerning this suggestion to date and consequently have not made any progress on this front. In the event that the Committee were to approve this Project we believe there are a number of more specific construction-related issues that should be addressed through an MOU, or if not, through specific conditions which the Committee should include in any certificate which it would grant. Without going into detail, those issues include, but are not limited to: (1) the type, size, and location of poles in Durham and through UNH; (2) the hours during which construction is permitted; (3) the laydown area to be used for storing construction-related materials and vehicles; (4) the route to be used to bring materials to and from the construction site; (5) establishing a procedure for addressing construction-related complaints from Durham residents and businesses; (6) communications with town and UNH officials; (7) emergency contacts; (8) construction schedule; (9) traffic control; (10) lighting; (11) disposal of construction debris; (12) blasting; (13) liability protections; (14) protection of public roadways; and (15) requirements to protect the environment. It is my understanding that under the last approved procedural schedule for this docket supplemental testimony is due from all parties on October 2, 2017. I want to reserve the right to file such testimony to address MOU-related concerns and make recommendations for conditions in the event that we can not agree on an MOU. Such testimony may also address agency recommendations which we will then have and any other concerns that come up between now and then.

Q. Does Durham have a position on this Project at this time?

A. At this time, without having seen the agency reports that are due on August 1, 2017 and without having seen a thorough analysis of the Transformer Alternative and the HDD alternative, Durham believes that this Project as currently proposed will have an unreasonable adverse effect on water quality and the natural environment, will unduly interfere with the orderly development of the region, and will not serve the public interest.

Q. Does this conclude your testimony?

A. Yes, this concludes my testimony at this time, though I reserve the right file supplemental testimony in accordance with the Committee's procedural schedule once we have had a chance to review the recommendations to the Committee from DES and other agencies, as well as any other filings made with regard to this Project, and to evaluate whether any progress has been made on an MOU.

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Attachment A

Todd I. Selig

3 Nobel K. Peterson Drive
Durham, NH 03824
Home: (603) 868-1000
Work: (603) 868-5571

EDUCATION

SYRACUSE UNIVERSITY, Syracuse, NY
Bachelor of Arts, Phi Beta Kappa, Magna Cum Laude, 1991.
College of Arts and Sciences
Dual Major: History/Medieval Renaissance Studies

UNIVERSITY OF NEW HAMPSHIRE, Durham, NH
Master of Public Administration, 1994.
The Graduate School

HARVARD UNIVERSITY, Cambridge, MA
John F. Kennedy School of Government
Program for Senior Executives in State and Local Government, July 2003
Building Agreements Across Boundaries/Negotiation, Spring 2013

PROFESSIONAL MEMBERSHIP

Board of Directors, New Hampshire Center for Public Policy Studies
Caroline Gross Fellow, 2003; Board of Directors to Present
Municipal Management Association of NH
Full Member, International City/County Management Assoc.
Durham Human Rights Commission
Piscataqua Region Estuaries Partnership Management Committee
Great Bay Waterkeeper Advisory Group

EXPERIENCE

TOWN OF DURHAM, Durham, NH
Administrator/Town Manager (40+hrs./wk.), June 2001-Present.

* The Durham Administrator serves as the chief administrative officer of the Town of Durham (population 15,180) and supervises and is responsible for the administrative and financial affairs of the Town, carrying out the policies enacted by the Town Council. The Administrator is charged with the preservation of the health, safety, and welfare of persons and property and sees to the enforcement of the ordinances of the Town, the Durham Charter, and the laws of the State of New Hampshire. This position supervises and directs the administration of all of the Town departments and personnel therein. In addition, the Administrator is responsible for:

1. Maintaining accounting control over the finances of the Town with a budget of approximately $25 million.
2. Making financial reports and performing such other related duties as may be required by the Administrative Code.

3. Assuring the audit and approval of all authorized claims against the Town before paying same.
4. Keeping the Council informed of the condition of the needs of the Town and making such reports and recommendations as he may deem advisable or may be required of him.
5. Managing the rental and use of all Town facilities under his control.
6. Managing the maintenance and repair of all Town property under his control.
7. Keeping a full and complete inventory of all property of the Town, both real and personal.
8. Managing the prudential affairs of the municipality and exercising per state statue the powers and duties of a Town Manager.

HOPKINTON SCHOOL DISTRICT-SAU#66, Hopkinton, NH
Business Administrator (40+hrs./wk.), 1998-2001.

* Worked collaboratively with Superintendent of Schools in the daily administration and supervision of a public school system employing 185 staff members; responsible for management and oversight of all aspects of district operation in absence of Superintendent.
* Managed and oversaw $9.8 million school district operational budget; coordinated school district budget process; assisted with presentation of budget to Board of Education and Budget Committee; worked with local and regional businesses to build support for school programs.
* Liaison to Hopkinton Budget Committee, Selectmen, Town Administrator, Capital Improvement Program, Master Plan Review Committee, and municipal departments.
* Formulated and administered policies and procedures for the management of district physical plants including custodial care and maintenance, sanitation, safety, security, environment, and energy conservation; ensured compliance with Federal, state, and local regulations.
* Prepared and recommended to the Superintendent of Schools long-range plans for the operational and capital requirements of the district.
* Formulated and administered policies and procedures for purchasing activities; directed preparation of specifications and invitations for bid; oversaw purchasing, inventorying, and distribution of supplies, materials, and equipment.
* Member of district negotiating team in dealing with Hopkinton Education Association, Hopkinton Education Support Staff, and Teamster unions; handled union grievances.
* Oversaw payroll, accounting, and business operations activities.
* Prepared internal and external financial reports; oversaw all state and Federal government reporting; maximized state and Federal aid to school district.
* Closed out 1997-1998 $6.7 million construction project impacting three school facilities.
* Approved recommendations for the hiring, dismissal, transfer, and promotion of custodial, maintenance, and central office support personnel; determined salaries consistent with collective bargaining agreements; supervised, evaluated, and directed training for the above.
* Oversaw the management of district food service program including the receipt and disbursement of funds, personnel selection, quality control, and program self-sufficiency.
* Supervised all aspects of district technology function including supervision of technology coordinator, development and implementation of district technology plan, and oversight of technological acquisitions.

* Managed the transportation operation of the district serving 1,000 pupils.
* Regular attendance at School Board meetings; assisted in preparation of Board agendas.
* Other duties as assigned by Superintendent of Schools/School Board.

TOWN OF NEW BOSTON, New Boston, NH
Town Administrator (40+hrs./wk.), 1994-1998.
* Served as Chief Executive Officer of Town in absence of Board of Selectmen.
* Managed $2.1 million annual municipal budget, tracked expenditure trends on monthly basis, and reported findings to Selectmen.
* Oversaw the operation of all municipal departments on behalf of Selectmen.
* Administered personnel function for staff of 74 employees; made recommendations for hiring and firing to Board of Selectmen, disciplined employees where appropriate, and oversaw management of all personnel files and benefit plans.
* Acted as liaison between residents, department heads, and Board of Selectmen.
* Prepared postings, agendas, and minutes for weekly Selectmen's meetings.
* Served as general advisor to Board of Selectmen; informed Selectmen of correct procedure and protocol during weekly meetings; provided direct, balanced, impartial, and professional advice.
* Approved weekly payroll and accounts payable vouchers and warrants for Selectmen's signatures.
* Worked with residents to ensure local government provided satisfactory levels of service, investigated complaints of wrongdoing, and reported concerns and findings to Selectmen.
* Coordinated and oversaw budget process for Selectmen and Finance Committee, reviewed departmental requests, and provided recommendations to both boards.
* Worked with the Department of Revenue Administration in setting local tax rate; responsible for completion of all state "MS" forms required during fiscal year.
* Coordinated preparation of Town Report, Town Warrant, and all details for Town Meeting.
* Supervised Independent Appraiser in assessing process for real estate taxation, land use change assessments, and current use; oversaw town wide total revaluation in 1997-1998.
* Oversaw bid and RFP process for municipality; prepared all financial and insurance related paperwork on major equipment purchases, bond issues, & capital projects.
* Served as a general resource and central contact person for local boards, commissions, and civic organizations including: Planning Board, Capital Improvements Program, Fire Wards, Zoning Board of Adjustment, Conservation Commission, Forestry Committee, Solid Waste Committee, Library Trustees, Trustees of Trust Funds, Recreation Commission, Forest Land Evaluation & Site Assessment Committee, Historical Society, Fourth of July Association, Joe English Grange, and New Boston Artillery Company.
* Served as centralized contact point for community economic development efforts.
* Coordinated and administered all grant programs for community. Examples include: COPS FAST, COPS MORE, 20% Municipal Landfill Closure Reimbursement Program, and FEMA flood funds.
* Prepared all necessary legal documentation for Selectmen related to enforcement of ordinances and regulations in consultation with Town Counsel.
* Oversaw New Boston's Joint Loss Management Program.
* Managed all tax deeded property.
* Acted as Welfare Director for New Boston.

* Performed other duties as required by Selectmen.

CITY OF LACONIA, Laconia, NH
City Intern (30hrs./wk.), 1994.
* Rewrote the Administrative portion of City ordinances based on recent amendments and new numbering system.
* Assisted in preparation of $24.7 million Public Works Capital Improvement Plan for City Council inspection.
* Analyzed ambulance privatization plan for City Manager.
* Wrote state temporary permit requirements for solid waste transfer station.
* Researched financial impact on City of taking over responsibility for private condominium roads and utilities.
* Developed Emergency Management Plan for Laconia.
* Conducted housing rehabilitation survey for Economic Development Department as part of Community Development Block Grant application process.

TOWN OF RAYMOND, Raymond, NH
Intern/Assistant Town Manager (20-30hrs./wk.), 1993-1994.
* Assisted Town Manager in daily management of Raymond's municipal operation.
* Assisted Town Manager with 1994 Town Budget preparation totaling $3.7 million.
* Compiled information and data for creation of 1993 Raymond Annual Report.
* Presented issues and topics to Board of Selectmen as assigned by Town Manager.
* Conducted construction inspection cost analysis for proposed 1.5 million square foot Wal-Mart distribution facility.

UNIVERSITY OF NEW HAMPSHIRE, Durham, NH
Graduate Research Assistant (20hrs./wk.), Department of Political Science, 1993-1994.
* Conducted extensive research and report writing for faculty members.

NH ATTORNEY GENERAL, CONSUMER PROTECTION BUREAU, Concord, NH
Consumer Affairs Specialist/Advocate (4-10hrs./wk.), 1993-1994.
* Handled telephone inquiries regarding NH consumer laws.
* Arbitrated disputes between consumers and NH businesses.

LACONIA ADULT AND CONTINUING EDUCATION PROGRAM, Laconia, NH
Guidance Counselor (20hrs./wk.), 1992-1994.
* Total Quality Management implementation.
* Employee supervision.
* Program planning.
* Grant writing.
* Vocational and personal counseling.
* Record keeping and verification of attendance.
* Discipline concerns and building security.

Attachment B

2013

State of Our Estuaries 2013

Piscataqua Region Estuaries Partnership

STATE OF OUR ESTUARIES
2013

PREP
Piscataqua Region Estuaries Partnership

University of New Hampshire
Nesmith Hall, 131 Main Street
Durham, NH 03824
www.prep.unh.edu

LETTER FROM THE EXECUTIVE DIRECTOR

We all benefit from a clean, healthy estuary.

Each of us has an important role to play in ensuring that our waters continue to provide the essential benefits and services that our communities have come to rely upon.

Our two largest estuaries – The Great Bay Estuary and Hampton Seabrook Harbor – help define who we are as a region. Whether it's swimming in one of the many rivers of the estuary, going on a bird watch, or simply dining at one of our many local restaurants, these waters provide a profound sense of place for the tens of thousands who live and visit our region every year. Our economy – from our fishermen, to recreation, to the many businesses that call our region home – relies heavily upon a vibrant and healthy estuary system.

For those of us who live, work and play in the waters of the estuary, it is imperative that we monitor, study, report and educate ourselves on the challenges facing the estuary. And, we also need to identify solutions to the challenges we face that each of us can undertake – from policymakers to businesses to citizens – to keep our estuaries in balance. That is the purpose of the State of Our Estuaries Report: to provide you with information on the relative health of our estuaries as measured by 22 indicators, and ways that you can help make our waters healthier.

Scientists often say that estuaries are some of the most complicated ecosystems in the world to study – due to the dynamic nature of tides, human activity and the mixing of fresh and salt water. Through extensive monitoring and data collection, this State of Our Estuaries Report paints a complicated and dynamic picture of our estuarine ecosystem – one that is altered by the natural forces of weather and climate, and damaged by human activity such as pollution and loss of habitat.

Even though our estuaries show troubling signs of decline, the news is not all bad. Through the work of many organizations, municipalities and individuals, about 90,000 acres in the estuary watershed have been permanently protected. Restoration projects have begun to rebuild lost oyster reefs, restore nearly 300 acres of saltmarsh, and re-open about 18 miles of our coastal rivers to migratory fish runs. You will read about many of these success stories in this report.

We hope that this report provides you with a sense of both hope and concern – because fundamentally, that is the story behind these dynamic estuary systems.

Perhaps most importantly, we have seen our communities come together to discuss the challenges facing our estuaries, and ways in which we can work together towards solutions. PREP remains committed to providing you with the information, data and research needed to make informed decisions that benefit our estuaries and the communities that rely upon them.

We hope that this report provides you with a sense of both hope and concern – because fundamentally, that is the story behind these dynamic estuary systems. But above all, we hope that this report better connects you with the place and with the community in which you live, work and play. Let's work together to improve our estuaries for today and for our future generations.

Sincerely,

Rachel Rouillard

PISCATAQUA REGION WATERSHED

Rivers flowing from 52 communities in New Hampshire and Maine converge with the waters of the Atlantic Ocean to form the Great Bay and Hampton-Seabrook estuaries. The watershed covers 1086 square miles. These bays provide critical wildlife habitat, nurseries for seafood production, buffering from coastal flooding, recreational enjoyment, and safe harbor for marine commerce. Our estuaries are part of the National Estuary Program, and recognized broadly as exceptional natural areas in need of focused study and protection.

EXECUTIVE SUMMARY OF THE STATE OF OUR ESTUARIES

We all benefit from keeping our estuaries healthy and clean. The Great Bay and Hampton-Seabrook estuaries are recognized as two premiere model systems in our nation for protection and study.

Every three years the Piscataqua Region Estuaries Partnership (PREP) produces this condition and environmental trends report in an effort to provide communities and citizens with an informed and comprehensive evaluation of what is being observed in our estuaries. This report presents our assessment of 22 key indicators of the health of our bays: 15 of which are classified as having cautionary or negative conditions or trends, while 7 show positive conditions or trends. The overall assessment shows that there is reason to be concerned about the health of our estuaries, and that increased efforts to study and restore our estuaries are needed. It also shows that there are effective efforts that can be made now to begin to reverse trends of concern.

We also recognize that the topic of nutrient levels in wastewater has become a publicly debated and contentious issue, but urge citizens and decision makers to examine all 22 indicators that together illustrate the wide-ranging challenges our system faces. While those challenges are many, this report also highlights the good work of many partners who are implementing solutions in their communities to address these environmental concerns, and perhaps most importantly, reaffirms our goals and priorities for future action.

What has been observed?

Indicators of Stresses on Our Estuaries

Our estuaries are complex and responsive to factors (stresses) both within and outside of our control. Changing climatic conditions resulting in more intense storms, polluted runoff from paved areas, human and animal waste, and excessive fertilizer application are examples of factors that can stress the ecological balance in our bays. There are two indicators that help us better understand these stresses.

- Impervious cover (paved parking lots, roadways and roofs) continued to increase throughout the region over the past three years. During rain storms and snow melt, water running over impervious areas carries pollutants which negatively impact the cleanliness of our rivers, lakes, streams and bays.
- While data has not been collected long enough to determine a long-term trend in nitrogen/nutrient loading to the Great Bay Estuary, this issue continues to be of concern. Traditional signs of nutrient-related problems such as loss of eelgrass habitat, periods of low oxygen in the water of the tidal rivers, and increases of nuisance seaweeds have been observed.

Indicators of Conditions in Our Estuaries

There are 14 indicators that help us understand more about the health and condition in the estuaries themselves. They provide a diverse picture of a number of key factors, integral to a healthy and productive system.

- Where measured in Great Bay, concentrations of the most reactive form of nitrogen, dissolved inorganic nitrogen, have increased significantly over the long term.
- Microalgae (phytoplankton) in the water have not shown a consistent long term trend in Great Bay. However, invasive and nuisance seaweed populations have increased.
- Dissolved oxygen levels in the water are at good levels in the bays and harbors, but are frequently too low in the tidal rivers with possible negative effects on marine life.

Stresses impacting the health of our estuaries are increasing, and there is reason to be concerned.

- The long term decline of eelgrass throughout most of the Great Bay Estuary is of continued concern. In spite of small increases in some areas, the total eelgrass coverage in all the bays and rivers shows a declining trend.
- Suspended sediment conditions, where measured in Great Bay, have increased over the long term which means that the water appears to be getting cloudier. Cloudy water can have adverse impacts on eelgrass, oysters, and fish.
- Bacterial contamination in Great Bay has declined substantially since 1989, but still contributes to shellfish harvest closures during rainy periods.
- The population status of oysters in the Great Bay Estuary and clams in the Hampton-Seabrook Estuary are in generally poor condition, falling well below recent historical abundances.
- Migratory fish populations exhibit cautionary trends, with high variability between years and among different rivers.
- Our region's beaches are almost always safe for swimming and the concentration of toxic chemicals in shellfish are almost all below levels deemed safe for human consumption.

Indicators of Progress on Conservation and Restoration of the Estuaries

- Gains have been made in overall land conservation, oyster bed restoration, and stream miles re-connected to the estuaries for migratory fish. However, many of the region's best natural areas are not being protected fast enough, and the results of eelgrass restoration efforts have been poor.
- Substantial progress has been made on restoring salt marshes since 2000, but there has been insufficient progress made on needed salt marsh enhancement work.

Where Do We Go From Here?

The conditions and trends documented here emphasize the need for both more research and action. In this report there are sections on emerging issues and research priorities that identify questions and target knowledge gaps in order to better inform our work over the next three to seven years. As a community of people who want to ensure a healthy environment and economy, we need to take action to:

- Expand the monitoring of our estuaries and fund additional research to address knowledge gaps.
- Protect important natural areas and waterways through land conservation and improved land use planning and development practices.
- Increase the pace and scale of restoration efforts for oysters, eelgrass, salt marsh, and migratory fish populations.
- Invest in clean water through appropriate infrastructure upgrades and reduce stormwater pollution from paved areas.

These priorities are part of the 2010 Piscataqua Region Comprehensive Conservation and Management Plan, which is a stakeholder-developed, 10-year strategy for protecting and restoring our estuaries. In addition, along with a number of public and private sector partners, PREP is building a Community for Clean Water movement to work together to make a difference. Join us at www.prep.unh.edu.

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ENVIRONMENTAL INDICATORS

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INDICATOR TABLE

Indicator Organization

Indicators are things that we can measure to characterize the pressures on our estuaries, the conditions in our estuaries, and the steps we are taking to respond to challenges in our estuaries. This report is organized with pressure indicators first, followed by condition indicators, and ending with response indicators.

There are many, many more things that are being done to respond to challenges and to restore our estuary. Look for the "Success Stories" and "Case Studies" in the sidebars of the indicator spreads as well as in the "Citizens' Guide to the State of Our Estuaries" to learn more about what's being done and how you can help.

This list of indicators is not exhaustive and does not reflect every pressure, condition, or response that does or could exist for our estuaries. Several important indicators that are missing are harmful algal blooms, fishing pressure, and climate change. However, the list of indicators covers the major issues and provides a reasonably complete picture of the State of Our Estuaries.

Pressure Indicators

Pressure Indicators measure key human stresses on our estuaries

Condition Indicators

Condition indicators monitor the current conditions in our estuaries

Response Indicators

Response indicators track what we are doing to restore our estuaries

- **POSITIVE** Demonstrates good or substantial progress toward the management goal.
- **CAUTIONARY** Demonstrates moderate progress relative to the management goal.
- **NEGATIVE** Demonstrates minimal progress relative to the management goal.

- **POSITIVE** Demonstrates improving or generally good conditions or a positive trend.
- **CAUTIONARY** Demonstrates a possibly deteriorating condition(s) or indicates concern given a negative trend.
- **NEGATIVE** Demonstrates deteriorating conditions or generally poor conditions or indicates concern given a negative trend.
- ↑ **NEGATIVE INCREASE** Statistically significant trend over the full period of record.
- ↓ **NEGATIVE DECREASE** Statistically significant trend over the full period of record.
- ↓ **POSITIVE DECREASE** Statistically significant trend over the full period of record.

PRESSURE INDICATORS: STRESSES ON THE ESTUARY

INDICATOR	STATUS	STATE OF THE INDICATOR	PAGE
Impervious Surfaces	↑	In 2010, 9.6% of the land area of the Piscataqua Region watershed was covered by impervious surfaces. Since 1990, the amount of impervious surfaces has increased by 120% while population has grown by 19%.	10
Nutrient Load		Total nitrogen load to the Great Bay Estuary in 2009-2011 was 1,225 tons per year. There appears to be a relationship between total nitrogen load and rainfall. Although typical nutrient-related problems have been observed, additional research is needed to determine and optimize nitrogen load reduction actions to improve conditions in the estuary.	12

CONDITION INDICATORS: THE CURRENT STATE OF CONDITIONS IN THE ESTUARY

INDICATOR	STATUS	STATE OF THE INDICATOR	PAGE
Nutrient Concentration	↑	Between 1974 and 2011 data indicates a significant overall increasing trend for dissolved inorganic nitrogen (DIN) at Adams Point, which is of concern. When examining variability at other monitoring stations with shorter periods of data, no consistent patterns can be found. Recent data considered in the context of long-term data show no pattern or trend.	14
Microalgae		Microalgae (phytoplankton) in the water, as measured by chlorophyll-a concentrations, has not shown a consistent positive or negative trend in Great Bay between 1975-2011.	16
Macroalgae		Macroalgae, or seaweed, populations have increased, particularly nuisance algae and invasives.	16
Dissolved Oxygen (Bays)		State standards for dissolved oxygen are nearly always met in the large bays and harbors.	18
Dissolved Oxygen (Rivers)		State standards for dissolved oxygen in the tidal rivers are not met for periods lasting as long as several weeks each summer.	18
Eelgrass	↓	Data indicate a long-term decline in eelgrass since 1996 that is not related to wasting disease. Due to variability even recent gains of new eelgrass still indicate an overall declining trend.	20
Sediment Concentrations	↑	Suspended sediment concentrations at Adams Point in the Great Bay Estuary have increased significantly between 1976 and 2011.	22
Bacteria		Between 1989 and 2011, dry weather bacteria concentrations in the Great Bay Estuary have typically fallen by 50 to 92% due to pollution control efforts in most, but not in all, areas.	23
Shellfish Harvest Opportunities		Only 36% of estuarine waters are approved for shellfishing and, in these areas, periodic closures limited shellfish harvesting to only 42% of the possible acre-days in 2011. The harvest opportunities have not changed significantly in the last three years.	24
Beach Closures		Poor water quality prompted advisories extremely rarely in 2011. There are no apparent trends.	26
Toxic Contaminants	↓	The vast majority of shellfish tissue samples do not contain toxic contaminant concentrations greater than FDA guidance values. The concentrations of contaminants are mostly declining or not changing.	28
Oysters		The number of adult oysters decreased from over 25 million in 1993 to 1.2 million in 2000. The population has increased slowly since 2000 to 2.2 million adult oysters in 2011 (22% of goal).	30
Clams		The number of clams in Hampton-Seabrook Harbor is 43% of the recent historical average. Large spat or seed sets may indicate increasing populations in the future.	32
Migratory Fish		Migratory river herring returns to the Great Bay Estuary generally increased during the 1970-1992 period, remained relatively stable in 1993-2004, and then decreased in recent years.	34

RESPONSE INDICATORS: WHAT WE'RE DOING TO RESTORE THE ESTUARY

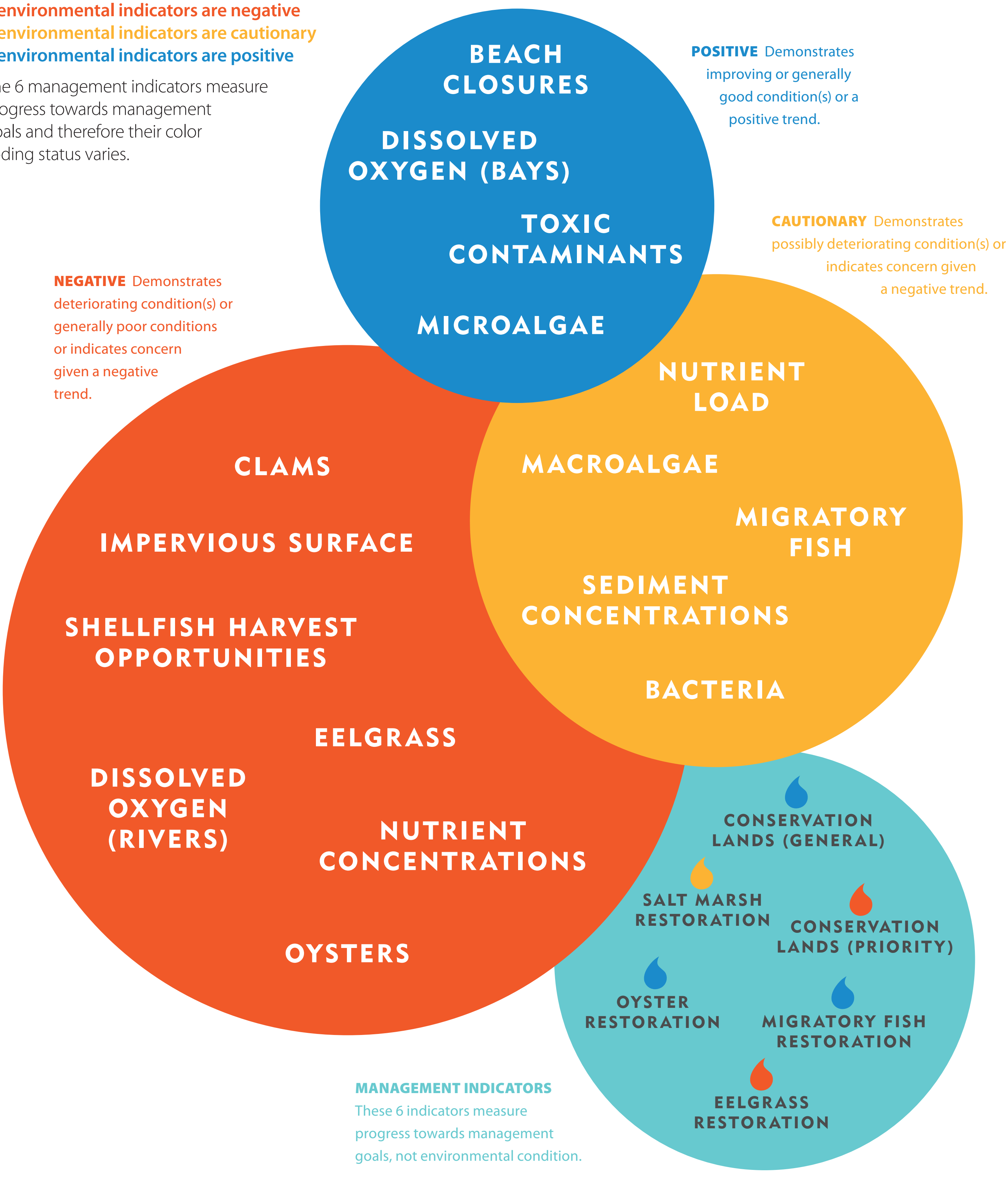
INDICATOR	STATUS	STATE OF THE INDICATOR	PAGE
Salt Marsh Restoration		280.5 acres of salt marsh have been restored since 2000, and 30.6 acres of salt marsh have been enhanced since 2009, which is moderate overall progress towards PREP's goals.	35
Conservation Lands (General)		At the end of 2011, 88,747 acres in the Piscataqua Region watershed were conserved which amounted to 13.5% of the land area. At this pace, the goal of conserving 20% of the watershed by 2020 is likely to be reached.	36
Conservation Lands (Priority)		In 2011, 28% of the core priority areas in New Hampshire and Maine were conserved. At this pace, the goal of conserving 75% of these lands by 2025 is unlikely to be reached.	38
Oyster Restoration		A total of 12.3 acres of oyster beds have been created in the Great Bay Estuary, which is 61% of the goal. Mortality due to oyster diseases is a major impediment to oyster restoration.	40
Eelgrass Restoration		A total of 8.5 acres of eelgrass beds have been restored which is only 17% of the goal. Poor water quality is often the limiting factor for eelgrass transplant survival.	41
Migratory Fish Restoration		River herring access has been restored to 42% of their historical distribution within the mainstems of the major rivers in the Piscataqua Region. This represents substantial progress in meeting PREP's goal of restoring 50% of the historical distribution of river herring by 2020.	42

INDICATOR SUMMARY

There are 16 environmental indicators and 6 management indicators presented in this report:

7 environmental indicators are negative
5 environmental indicators are cautionary
4 environmental indicators are positive

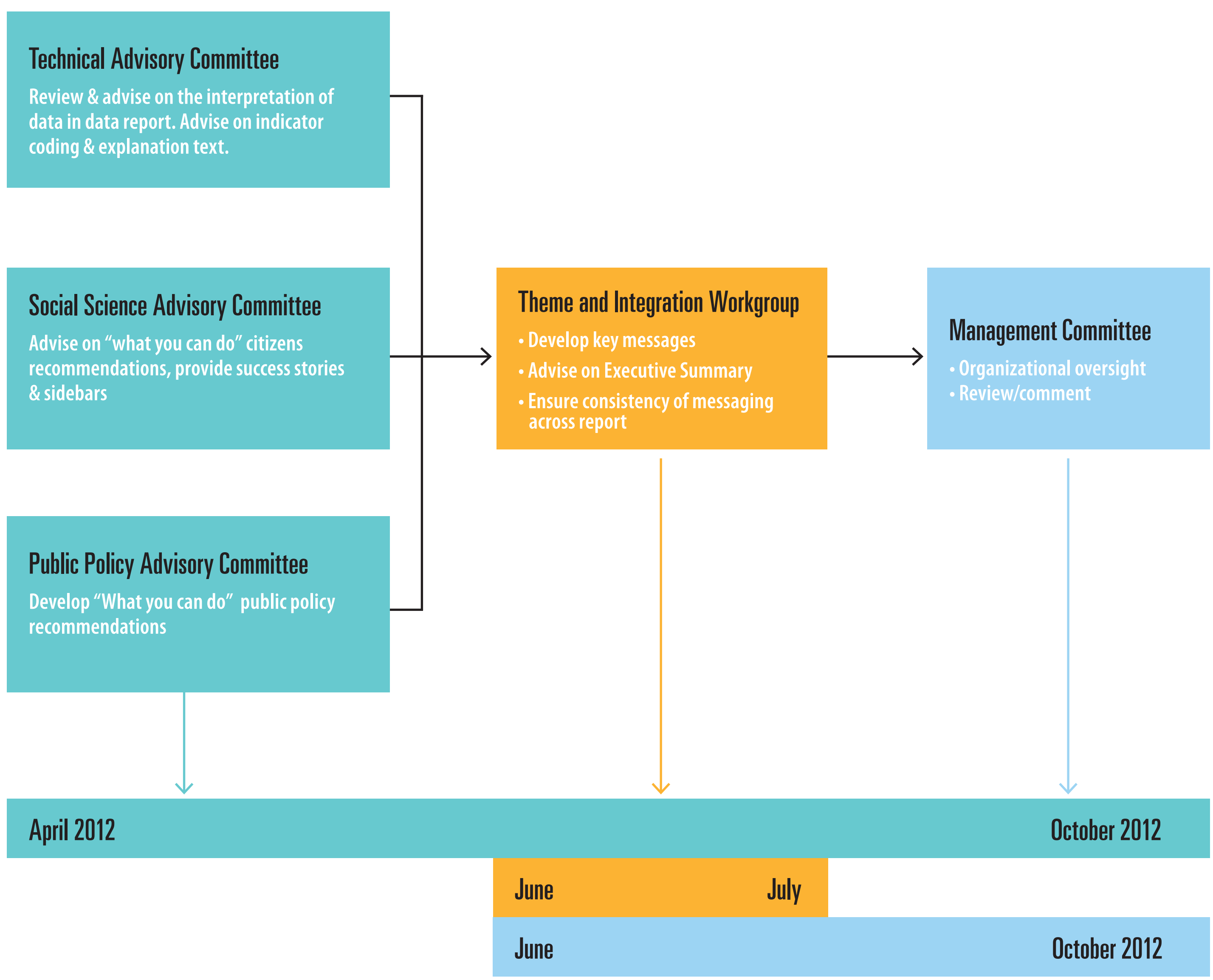
The 6 management indicators measure progress towards management goals and therefore their color coding status varies.



REPORT DEVELOPMENT PROCESS

This 2013 State of Our Estuaries report was developed somewhat differently than in previous years. Given the recent environmental and social changes in our watershed, it was important to construct a new, stakeholder driven process to inform the development of the report. As a science-based, stakeholder-driven organization, PREP maintained its Technical Advisory Committee (TAC) with the core function of reviewing and interpreting the data used in this report.

The TAC is comprised of 24 independent scientists; 13 from University of New Hampshire and other partner groups including the US Environmental Protection Agency, The National Oceanic and Atmospheric Administration, NH Department of Environmental Services, The Nature Conservancy, NH Fish and Game Department, United States Geological Survey, Northeastern Regional Assoc. of Coastal & Ocean Observing Systems, Great Bay National Estuarine Research Reserve, and US Fish and Wildlife Service. In addition, PREP convened three other stakeholder groups to provide input during the process, as noted below. The purpose of these groups was to increase the diversity of feedback and perspectives from municipal, state, private, regional, public policy, and social science leaders and practitioners. A full listing of those who participated is noted on page 46 of this report in acknowledgement and appreciation of their dedication and efforts in helping to develop a comprehensive report that can be used by many as a resource over the next three years.



Impervious Surfaces

How much of the Piscataqua Region is currently covered by impervious surfaces and how has it changed over time?

Rain into a stormdrain in Portsmouth. Photo by D. Kellam

In 2010, 9.6% of the land area of the Piscataqua Region watershed was covered by impervious surfaces. Since 1990, the amount of impervious surfaces has increased by 120% while population has grown by 19%.

EXPLANATION The amount of impervious surface covering our land has grown from 28,695 acres in 1990 to 63,241 acres in 2010. On a percentage basis, 9.6% of the land in the watershed was covered by impervious surfaces in 2010 (Figure 1.1).

The impervious surfaces were not evenly spread out across the watershed. The percent of impervious surfaces in each of the Piscataqua Region subwatersheds in 2010 is shown in Figure 1.2. The watersheds with greater than 10 percent impervious surfaces are along the Atlantic Coast, Exeter River watershed and up the Route 16 corridor along the Cocheco River. The highest percent impervious values of 35 to 40 percent were found in the Portsmouth-New Castle area. Town-by-town information on impervious surfaces in 2010 is shown in Figure 1.3.

Between 1990 and 2005, impervious surfaces were added at an average rate of 1,441 acres per year. Between 2005 and 2010, the rate of new impervious surfaces nearly doubled to 2,585 acres per year. On average, 1,840 acres of impervious surfaces were added to the watershed each year for the 20-year period between 1990 and 2010.

Overall, the population for the 52 municipalities in the watershed has grown by 19% from 316,404 in 1990 to 377,427 in 2010. During this same period, the total impervious surfaces within the towns grew by 120%. Therefore, the rate of increasing impervious surfaces has been six times the rate of population growth.

Success Story

The Hodgson Brook Restoration Project in Portsmouth has worked to install over 7 residential rain gardens in neighborhoods across the city. Rain gardens help to soak up the rain and snow melt from impervious surfaces and let it seep into the ground where pollutants can be filtered out through the soil.

Residential rain garden. Photo by PREP

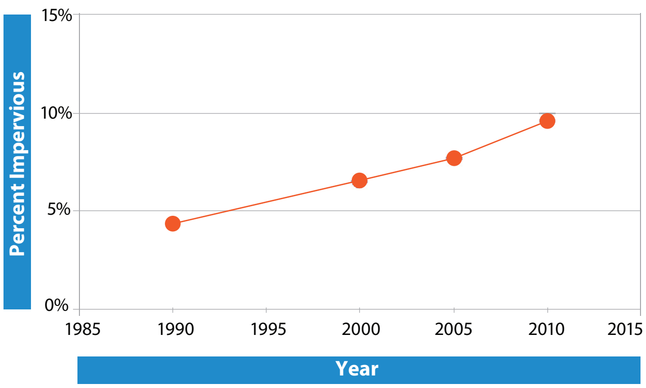
Why This Matters

Impervious surfaces are paved parking lots, roadways, and roofs. During rain storms and snow melt, water running off of impervious surfaces carries pollutants and sediments into streams, rivers, lakes and estuaries. To keep waters clean, impervious surfaces should be a low percentage of the total amount of land area of the watershed basin.

PREP GOAL No increases in the number of watersheds and towns with >10% impervious cover and no decreases in the number of watersheds and towns with <5% impervious cover.

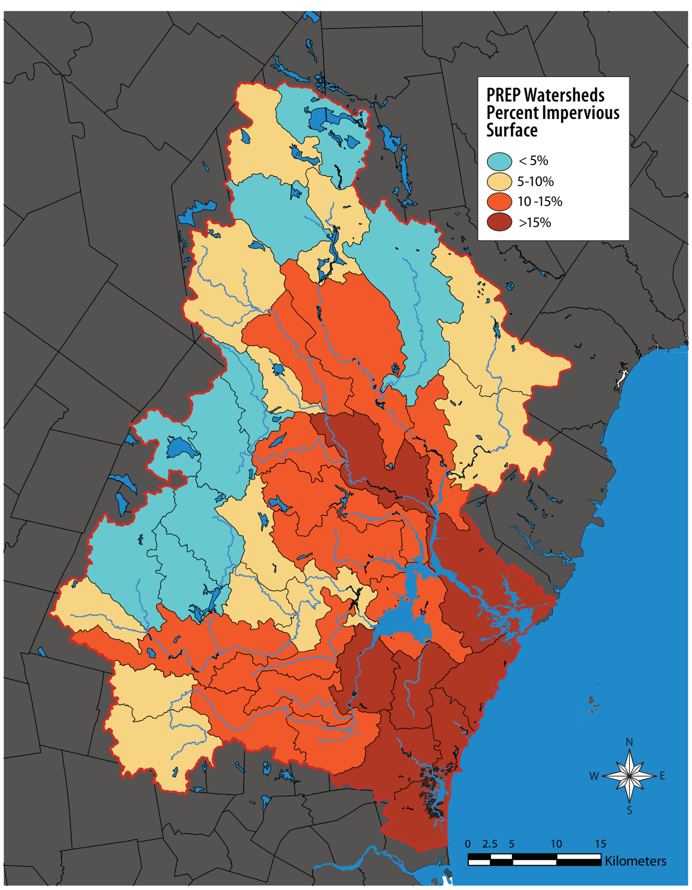
Between 2005 and 2010, the rate of new impervious surfaces nearly doubled to 2,585 acres per year.

FIGURE 1.1 Percent of land area covered by impervious surfaces in the Piscataqua Region watershed, 1990-2010



Data Source: UNH Complex Systems Research Center

FIGURE 1.2 Impervious surface cover in Piscataqua Region subwatersheds



Data Source: UNH Complex Systems Research Center

FIGURE 1.3 Percent of land area covered by impervious surfaces for coastal municipalities, 1990-2010

		Percent Imperviousness (%)			
Town	**Land Area (Acres)**	**1990**	**2000**	**2005**	**2010**
Barrington, NH	29,718	2.6	4	4.7	6.3
Brentwood, NH	10,738	5	7.7	9.5	12.2
Brookfield, NH	14,593	1	1.3	1.4	1.8
Candia, NH	19,340	2.7	4.1	4.8	6.4
Chester, NH	16,618	2.5	4.3	5.1	6.8
Danville, NH	7,439	3.5	6	7.2	9.5
Deerfield, NH	32,584	1.5	2.4	3	4
Dover, NH	17,033	11	15.4	18.7	22.7
Durham, NH	14,252	4.7	7.2	7.7	9.9
East Kingston, NH	6,318	3.5	5.3	6.9	8.9
Epping, NH	16,465	4	6.5	7.8	10.3
Exeter, NH	12,549	7.5	10.9	12.4	15.6
Farmington, NH	23,218	3	4.2	4.7	6.1
Fremont, NH	11,035	3	4.9	6	7.9
Greenland, NH	6,722	6.7	10.5	12.5	15.7
Hampton, NH	8,017	14.7	20.1	21.5	25.6
Hampton Falls, NH	7,519	4.5	7.1	9.3	12
Kensington, NH	7,636	3.2	5	6.2	7.8
Kingston, NH	12,494	5.2	8.2	9.7	12.5
Lee, NH	12,686	3.7	5.8	6.6	8.8
Madbury, NH	7,399	3.4	5.3	5.3	7.2
Middleton, NH	11,559	1.8	2.5	3	4.1
Milton, NH	21,089	2.8	4	4.7	6.2
New Castle, NH	506	21.4	30.6	33.8	41
New Durham, NH	26,345	1.7	2.4	2.8	3.8
Newfields, NH	4,541	3.1	5.5	6.8	8.6
Newington, NH	5,216	13	17.9	20.1	23.8
Newmarket, NH	7,939	6	8.9	10.3	12.7
No. Hampton, NH	8,862	7.3	10.8	12.4	15.4
Northwood, NH	17,973	2.4	3.4	4	5.4
Nottingham, NH	29,874	1.5	2.3	2.8	3.8
Portsmouth, NH	10,002	21.4	27.3	30.6	35.1
Raymond, NH	18,439	5.3	8	9.3	11.8
Rochester, NH	28,322	8.5	11.7	13.9	17.4
Rollinsford, NH	4,681	5.7	8.2	9.3	11.9
Rye, NH	7,997	7.2	10.9	12.7	15.5
Sandown, NH	8,888	3.8	6.1	7.9	10.5
Seabrook, NH	5,215	15.4	23.1	29.5	34.7
Somersworth, NH	6,219	12.3	16.4	20.1	24.4
Strafford, NH	31,151	1.4	2	2.3	3.2
Stratham, NH	9,657	6.5	10.1	12.9	16.2
Wakefield, NH	25,264	3.5	4.8	5.6	7.4
Acton, ME	24,120	1.6	2.5	2.9	3.8
Berwick, ME	23,786	2.6	4.4	5.5	6.8
Eliot, ME	12,610	4.1	7.4	9.2	11.3
Kittery, ME	11,308	8.1	11.9	13.9	16.4
Lebanon, ME	35,055	1.8	3	3.7	4.7
North Berwick, ME	24,265	2.2	3.5	4.2	5.2
Sanford, ME	30,315	5.9	9.1	10.1	11.8
South Berwick, ME	20,469	2.4	3.9	4.7	5.9
Wells, ME	36,749	3.7	6	7.4	8.8
York, ME	34,908	4.3	7.1	8.3	9.9

Data Source: UNH Complex Systems Research Center

Nutrient Load

How much nitrogen is coming into the Great Bay Estuary and have nutrient-related problems been observed?

Sagamore Creek Panne, Portsmouth. Photo by D. Kellam

Total nitrogen load to the Great Bay Estuary in 2009-2011 was 1,225 tons per year. There appears to be a relationship between total nitrogen load and rainfall. Although typical nutrient-related problems have been observed, additional research is needed to determine and optimize nitrogen load reduction actions to improve conditions in the estuary.

EXPLANATION The load of all forms of nitrogen into the Great Bay Estuary in 2009-2011 was 1,225 tons per year (Figure 2.1). Nitrogen loads to the bay tend to be higher in years with more rainfall. Since 2003, when nitrogen loads began to be measured, the total nitrogen load to the bay was highest in 2005-2006. The increase appeared to be driven by higher amounts of nitrogen carried into the bay by rain runoff and river flow during years with heavy rainfall, especially 2005 and 2006 (Figure 2.2). In more recent years load has decreased, which again may be related to drier years with less rainfall. It is due to these fluctuations in data that no long or short term trends can be determined.

One important component of nitrogen needing consideration is the most reactive type called dissolved inorganic nitrogen (DIN). This type is known to cause faster plant and algae growth than other forms of nitrogen. Between 2009-2011, 597 of the 1,225 tons of nitrogen entering the bay was DIN.

Nitrogen enters the bay primarily in two ways. First, nitrogen from fertilizers from lawns and farms, septic systems, animal wastes, and air pollution from the whole watershed is carried into the bay through rain and snowmelt runoff, river flow, and groundwater flow. These sources account for 68% of the nitrogen entering our system (Figure 2.1). Second, there are 18 municipal sewer treatment plants that discharge treated wastewater out through pipes either into the bay or into rivers that flow into the bay. Wastewater discharges are concentrated sources of nitrogen, primarily in the reactive DIN form (Figure 2.1).

Regardless of the particular sources, the major contributors of nitrogen to the bay are related to population growth and associated building and development patterns. The PREP goal is to reduce nutrient loads to the estuaries and the ocean so that adverse, nutrient-related effects do not occur. At this time the Great Bay Estuary exhibits many of the classic symptoms of too much nitrogen: low dissolved oxygen in tidal rivers, increased macroalgae growth, and declining eelgrass. Although the specific causal links between nitrogen load and these concerning symptoms have not yet been fully determined for Great Bay, global, national and local trends all point to the need to reduce nitrogen loads to the estuary.[3] Additional data collection and research is critical to a better understanding of these links and where the most effective reductions can be targeted.

Why This Matters

Nitrogen is a nutrient that is essential to life in the estuaries. However, scientific understanding of estuaries is that high levels of nitrogen may cause problems like the excessive growth of plants and algae.[1] When the plants die, oxygen needed by fish is pulled out of the water and can cause fish to suffocate. The rapid plant growth can also shade or smother underwater eelgrass meadows and other important habitats, limiting important functions such as providing food and shelter and cleaning the water. Excess nitrogen is a problem across the US and around the world.[2]

PREP GOAL **Reduce nutrient loads to the estuaries and the ocean so that adverse, nutrient-related effects do not occur.**

Non-point sources of nitrogen include lawn fertilizers, septic systems, animal wastes, and atmospheric deposition on to land.

FIGURE 2.1 Nitrogen loads to the Great Bay Estuary from different sources, 2009-2011

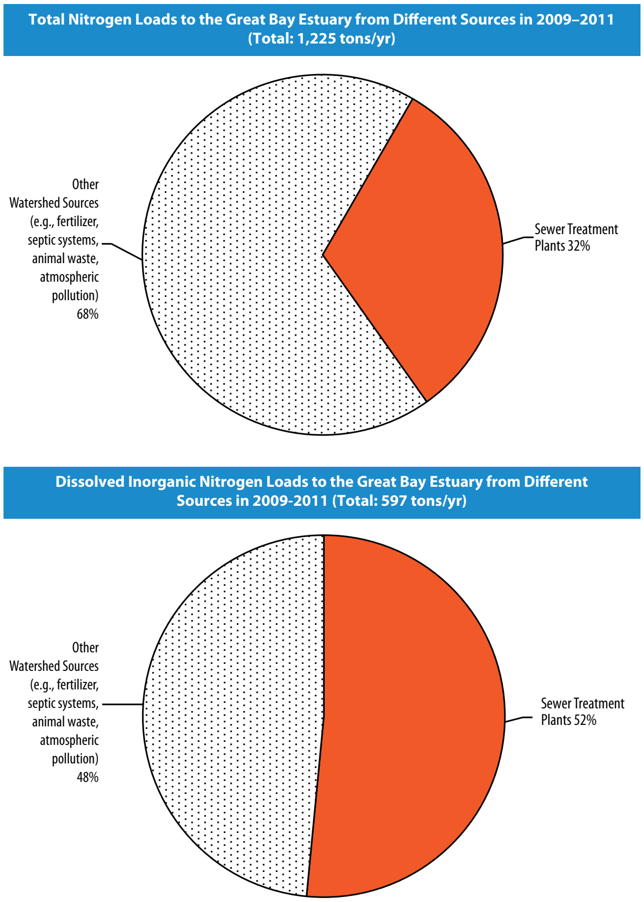


FIGURE 2.2 Trends in nitrogen loads and precipitation, 2003-2011

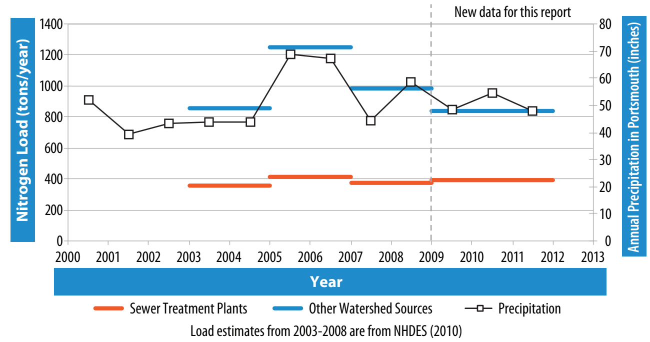
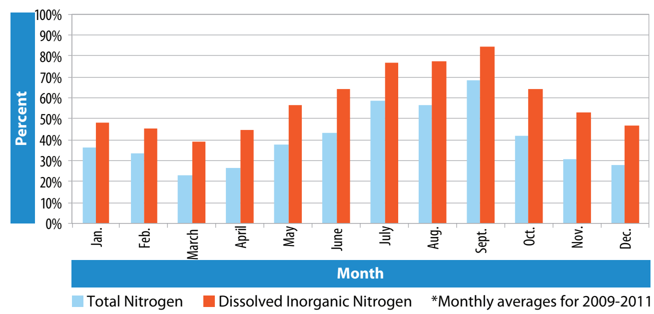


FIGURE 2.3 Percent of nitrogen load to the Great Bay Estuary from sewer treatment plants by month



The percent of the nitrogen load to the estuary from sewer treatment plants varies month-to-month over the course of the year. Sewer treatment plants contribute the majority of the nitrogen load during the warmer months when algae growth typically occurs.

Success Story

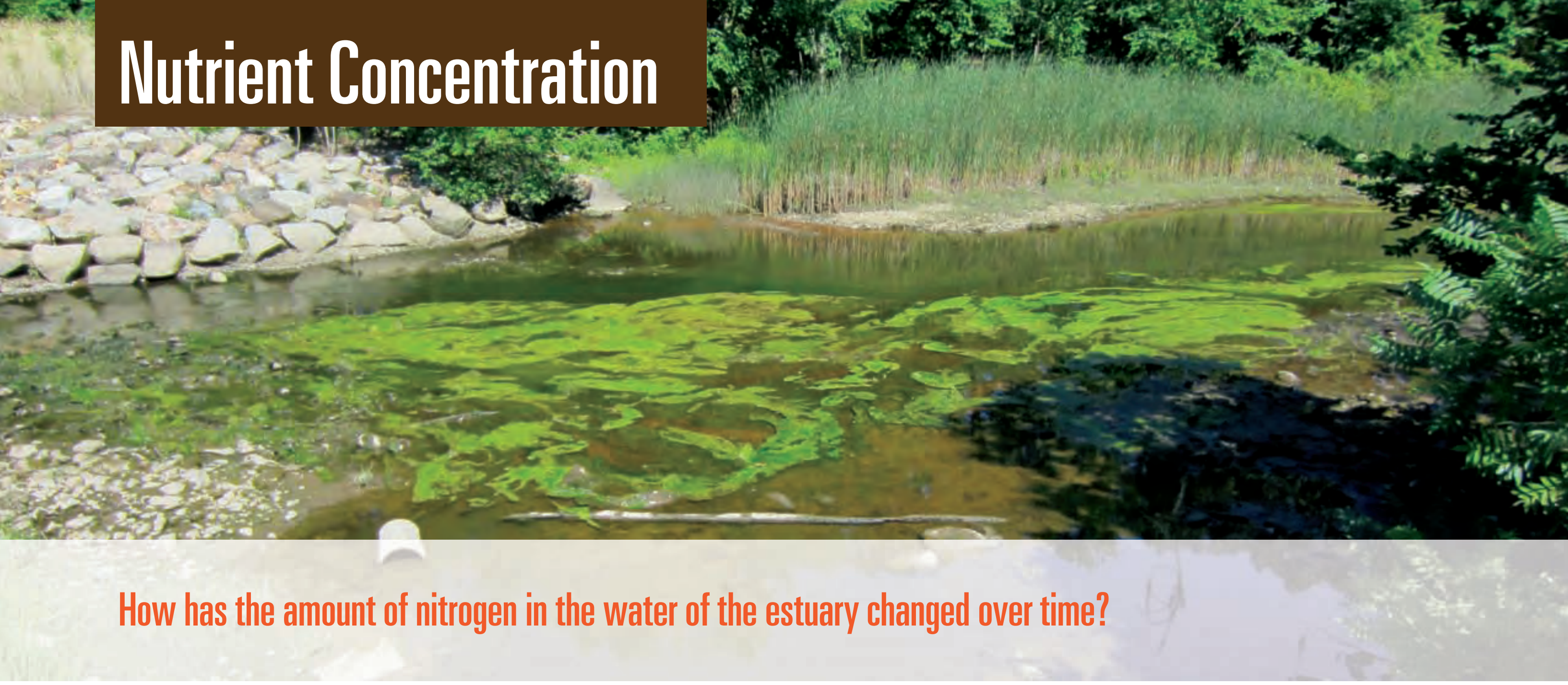
York's Lawns to Lobsters

The Town of York, Maine has created a public education effort focused on environmentally sound lawn care practices focused on having a beautiful lawn without harming the rivers or the ocean from increased nutrients or pesticides. The program has spread around the coast of Maine and is now being adopted by the town of New Castle as well. The program has 10 tips every homeowner can practice visit www.lawns2lobsters.org to learn more.

Photo by PREP

NUTRIENT LOAD

Nutrient Concentration



How has the amount of nitrogen in the water of the estuary changed over time?

Algae growth in the Winnicut River below the fish ladder, Greenland, NH. Photo by S. Demers

Between 1974 and 2011 data indicates a significant overall increasing trend for dissolved inorganic nitrogen (DIN) at Adams Point, which is of concern. When examining variability at other monitoring stations with shorter periods of data, no consistent patterns can be found. Recent data considered in the context of long-term data show no pattern or trend.

EXPLANATION Total nitrogen measures all of the nitrogen in the water, both the nitrogen dissolved in the water and the nitrogen in floating algae. Total nitrogen concentrations in Great Bay have been monitored since 2003, but have not shown any consistent trends (Figure 3.1). The average concentration of total nitrogen in Great Bay in 2009-2011 was 0.38 mg/L.

Photo by PREP

However, as previously noted in this report, there is concern for the implications of dissolved inorganic nitrogen (DIN) as it is the most reactive form of nitrogen in the system. The long-term trend for all of the data collected between 1974 and 2011 shows an average increase of 68% for DIN (Figure 3.2). The DIN concentrations in the last three years fell below the average trend line to 0.116 mg/L. These levels are comparable to the DIN concentrations that were measured for some of the years in the 1970s.

The apparent conflict between the long-term increasing trend for DIN at Adams Point and recent overall low concentrations for DIN may be explained by the fact that DIN is highly variable. It is rapidly taken up into plants and removed from the water or converted to other forms of nitrogen. Total nitrogen concentrations are a better measure of overall nitrogen availability in the estuary.

In other areas of the estuary besides Great Bay, some trends for total nitrogen and other forms of nitrogen have been observed. Increasing trends for total nitrogen and total dissolved nitrogen were apparent in the Squamscott River, while decreasing trends for DIN were observed in the Oyster River.

The variety of results highlights the complexity of nitrogen cycling in the estuary. More data and study is needed to better understand these relationships.

Why This Matters

Nitrogen is an essential nutrient to life in the estuaries. However, scientific understanding of estuaries is that high levels of nitrogen may cause problems from the excessive growth of plants and algae. The amount of nitrogen present in the water (the nitrogen "concentration") is an important indicator of nutrient availability for plants and algae[1] growth in the estuary. However, because nitrogen is rapidly removed from the water by plants, the nitrogen concentration in the water does not always reflect the amount of nitrogen that has been loaded into the estuary.

PREP GOAL **No increasing trends for any nitrogen or phosphorus species.**

The long-term trend for all of the data collected between 1974 and 2011 shows an average nutrient concentration increase of 68%.

FIGURE 3.1 Total nitrogen concentration trends at Adams Point in the Great Bay Estuary

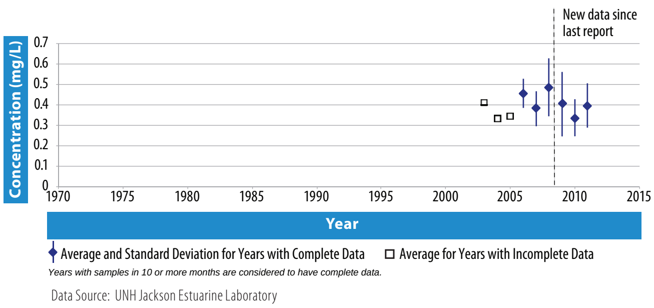
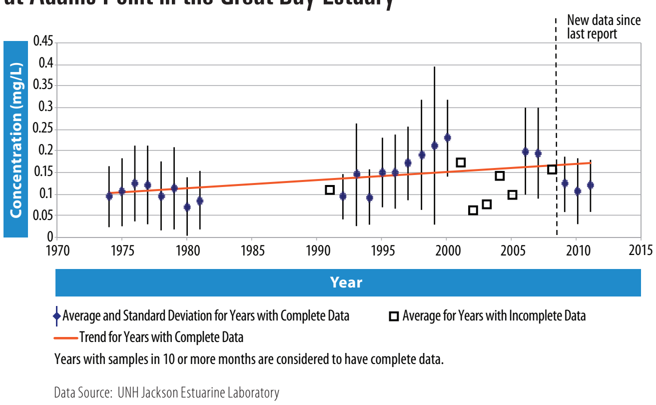
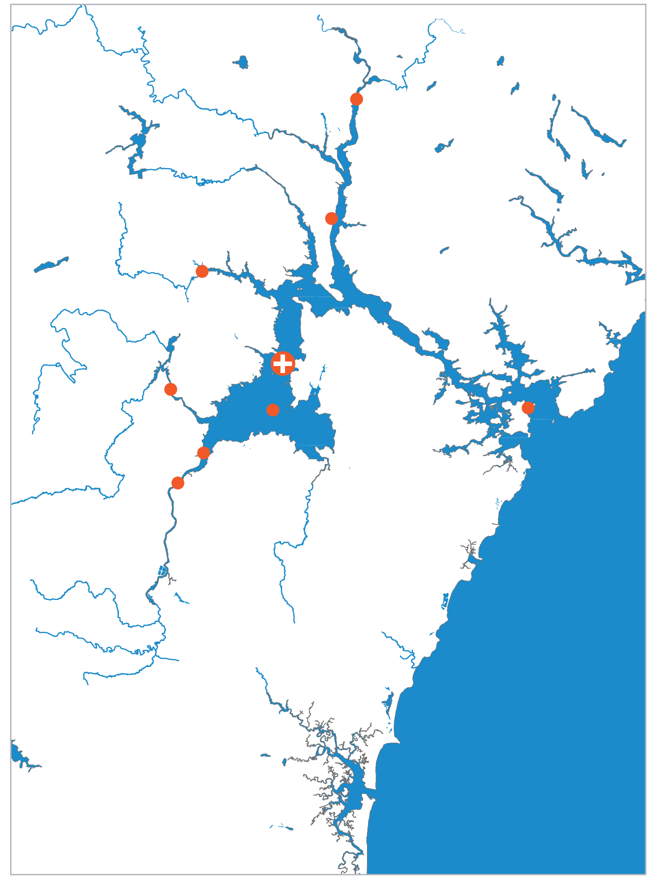


FIGURE 3.2 Dissolved inorganic nitrogen concentration trends at Adams Point in the Great Bay Estuary



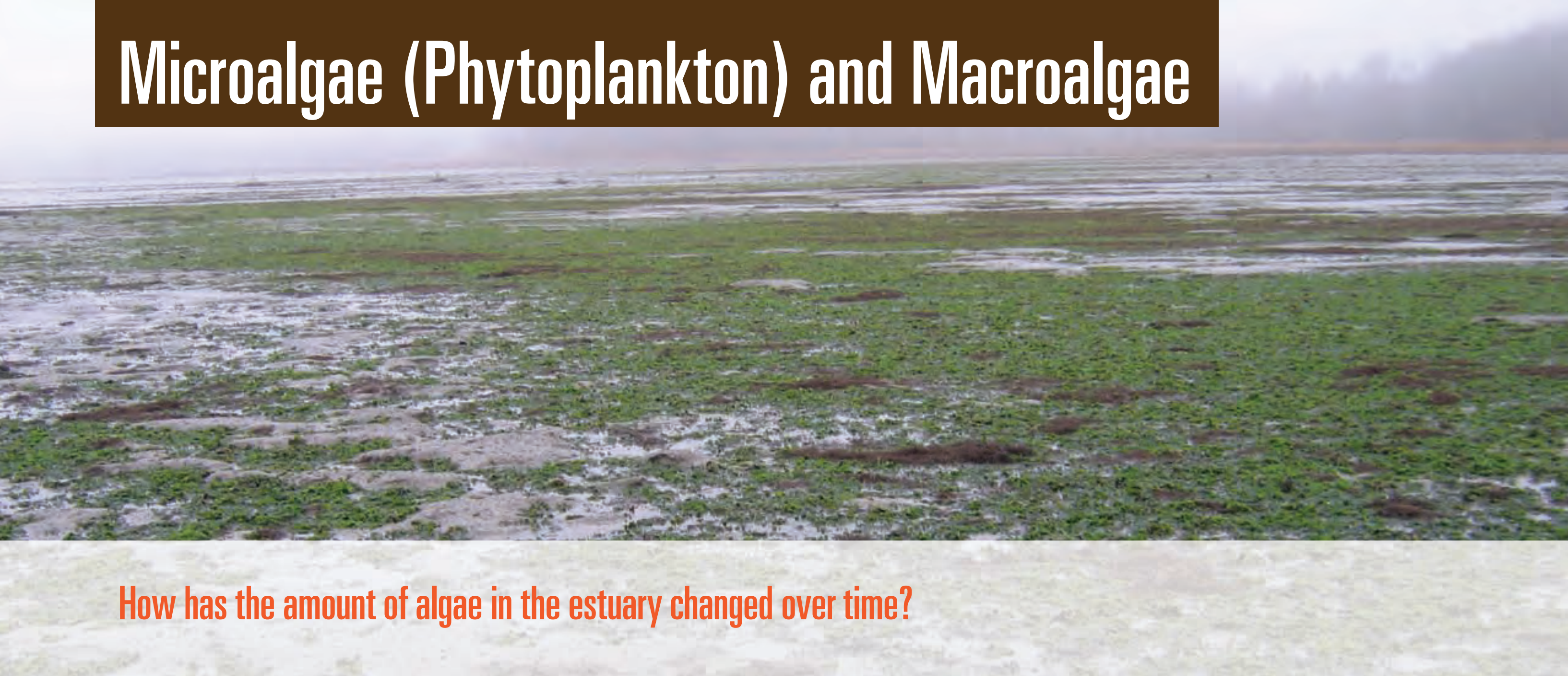


Monitoring location for Fig. 3.1 & 3.2 is marked by a red circle with a white plus sign. Other red dots indicate additional water quality monitoring locations.

Flooding in Newmarket, NH. Photo by PREP

Climatic trends, including extreme rain and snow events, can affect the delivery of nitrogen loads to our estuaries. The highest nitrogen loads calculated for the Great Bay Estuary appear to correlate with years of high annual precipitation (Figure 2.2). It appears that more nitrogen is "flushed" from the landscape during wet periods. New England is experiencing more frequent higher intensity rain storms, and this trend is anticipated to continue. Therefore additional research on how climate and weather affect the amount and timing of nitrogen delivery to the estuary is needed.

Microalgae (Phytoplankton) and Macroalgae



How has the amount of algae in the estuary changed over time?

Ulva Lactuca in Great Bay off of Portsmouth Country Club, Greenland, NH. Photo by J. Nettleton

Microalgae (phytoplankton) in the water, as measured by chlorophyll-a concentrations, has not shown a consistent positive or negative trend in Great Bay between 1975-2011.

Macroalgae, or seaweed, populations have increased, particularly nuisance algae and invasives.

EXPLANATION This is a new indicator for this year's report because of its known relationship to nutrients and the role algae plays in an estuarine system. Plant growth can take many forms in estuaries. There can be microscopic plants, called phytoplankton, that float in the water. The amount of chlorophyll-a present in the water is a measure of these microscopic plants. In addition, there can be larger rooted and un-rooted seaweeds, called macroalgae, that grow in the estuary. Of particular concern are certain types of nuisance macroalgae that grow quickly in high nutrient environments and crowd out or smother the slower growing eelgrass populations.[5]

Measurements of chlorophyll-a in the water in Great Bay since 1975 have not shown any consistent long-term trends, nor were there any short term changes in the last three years (Figure 4.1). Blooms of microscopic plants are episodic and variable in size depending on factors such as weather. As a result, it can be difficult to detect trends in chlorophyll-a based on a monthly monitoring program which is how monitoring is currently conducted.

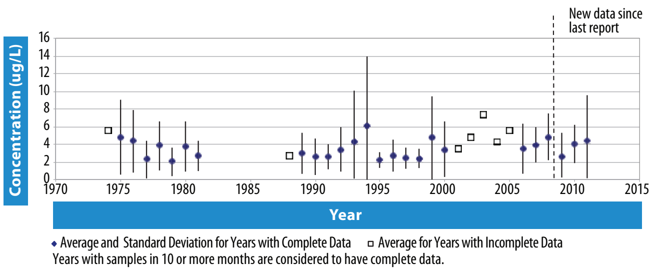
For nuisance macroalgae, there is evidence that populations have increased. Baseline measurements of some macroalgae species at some locations were made by UNH researchers between 1972 and 1980.[7] In 2008-2010, these field studies were repeated using the same methods to document changes in populations.[7] The report concluded that "Great increases in both mean and peak *Ulva* and *Gracilaria* biomass and percent cover have occurred in the Great Bay Estuarine System."[8] For example, at a site in Lubberland Creek in the Great Bay, the mean percent cover of a common macroalgae, *Ulva lactuca,* had increased from 0.8% of the area covered in 1979-1980 to 39% of the area covered in 2008-2010. (Figure 4.2) Increases in macroalgae cover of up to 90% have been measured at some sites in the Great Bay Estuary on some dates. In 2007, another UNH field study[9] documented that there were 137 acres of macroalgae mats in the Great Bay in August 2007, which amounted to over 3% of the entire bay surface (Figure 4.3) and occupying areas formerly covered with eelgrass. Due to the variable nature of algae, more data collection and study is needed to gain a better understanding of the extent and causes of these increases.

Why This Matters

Increasing nitrogen inputs to estuaries can stimulate plant growth. Excessive algae growth in the water and on the bottom can make the water cloudy, deplete dissolved oxygen in the water, or can entangle, smother and cause the death of important eelgrass habitat.[4]

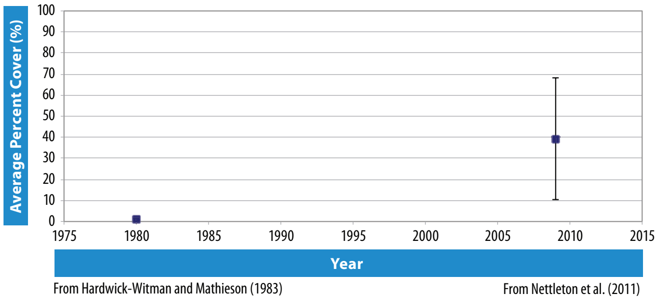
PREP GOAL **No increasing trends for algae.**

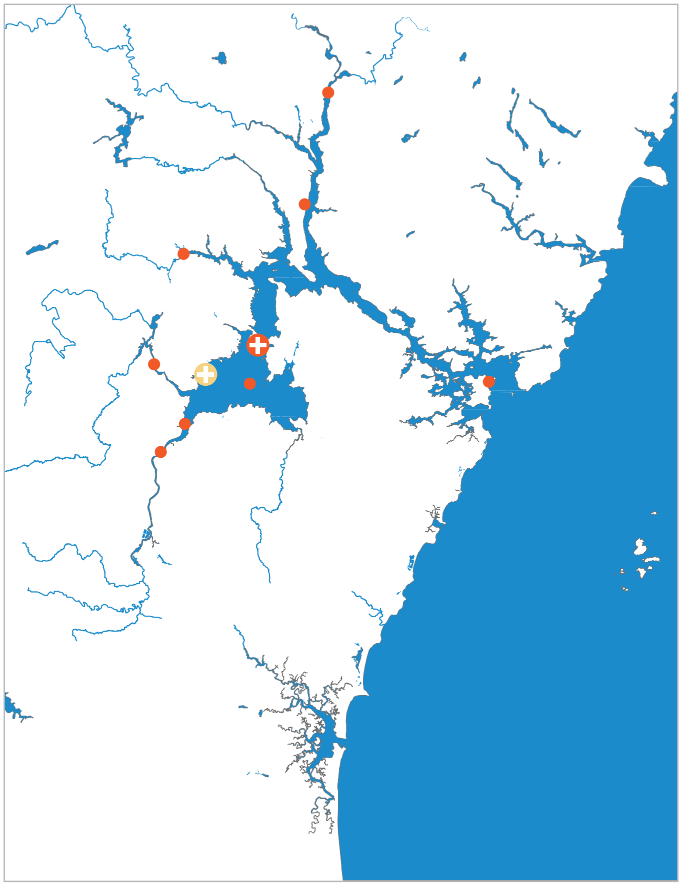
FIGURE 4.1 Chlorophyll-a trends at Adams Point in the Great Bay Estuary



Data Source: UNH Jackson Estuarine Laboratory

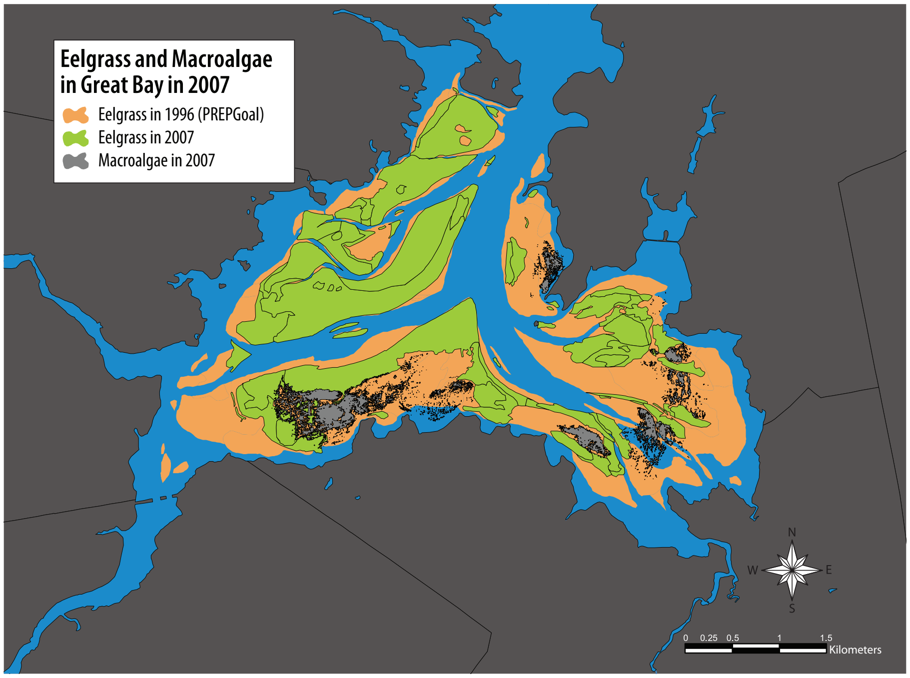
FIGURE 4.2 Macroalgae percent cover at the Lubberland Creek site in Great Bay in 1979-1980 and 2008-2010





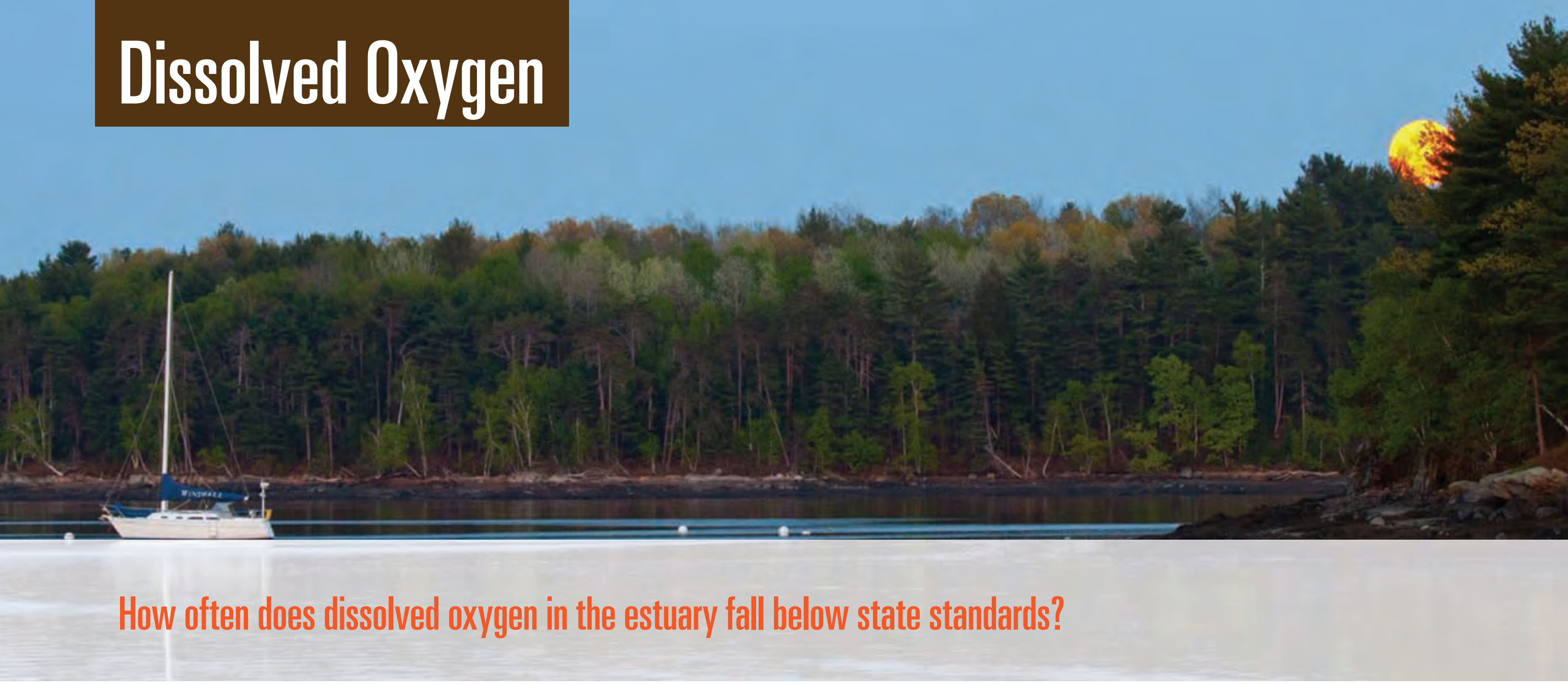
Monitoring location for Fig. 4.1 is marked by a red circle with a white plus sign. Monitoring location for Fig. 4.2 is marked by a yellow circle with a white plus sign. Other red dots indicate water quality monitoring locations.

FIGURE 4.3 Eelgrass and macroalgae in Great Bay in 2007



Data Source: Eelgrass data provided by UNH Seagrass Ecology Laboratory Macroalgae data from Pe'eri et al. (2008)

Dissolved Oxygen



How often does dissolved oxygen in the estuary fall below state standards?

Moon over Great Bay. Photo by C. Keeley

State standards for dissolved oxygen are nearly always met in the large bays and harbors.
State standards for dissolved oxygen in the tidal rivers are not met for periods lasting as long as several weeks each summer.

EXPLANATION The most accurate measurements of dissolved oxygen (DO) are made using datasonde instruments (see figure 5.1) that are installed in the water to collect measurements every 15 minutes. The six locations where datasondes are deployed are shown on Figure 5.2. The figure also contains charts summarizing the number of days in the summer when the DO fell below the water quality standard (5 mg/L) at each station (Figure 5.3).

The dissolved oxygen concentrations in Great Bay in the summer have never been measured below 5 mg/L. In Portsmouth Harbor there has been only one day with dissolved oxygen less than 5 mg/L (in 2010). Based on these data, the well mixed areas of Great Bay and Portsmouth Harbor typically meet the water quality standard for DO.

In contrast, there have been persistent and numerous violations of the dissolved oxygen standards at stations in the tidal rivers that flow into the estuaries. The number of summer days with violations varied over time at the stations. No major fish kills due to low dissolved oxygen have been reported for the tidal rivers in recent years. However, fish and other organisms may still experience negative effects in areas where the state standard is not attained.

The most exceedences and the lowest dissolved oxygen concentrations have been observed in the tidal rivers, particularly the Lamprey River. UNH conducted a detailed study of this river and concluded that the datasonde accurately represents the dissolved oxygen in the river but that density stratification was a significant factor related to the low dissolved oxygen concentrations that were observed.[12]

Similarly, the Great Bay Municipal Coalition hired HydroQual to conduct a study of dissolved oxygen in the Squamscott River in 2011.[13] The study confirmed that dissolved oxygen concentrations in the river periodically exceeded the state standard and that algae discharged in the wastewater from the Exeter sewer treatment plant was a factor affecting dissolved oxygen levels. Overall, the relationship between nutrients, dissolved oxygen and algae growth is a complex one and more data/study is needed to specifically understand those linkages in our system.

Why This Matters

Low dissolved oxygen (DO) concentrations in bays are a common impact of excessive nitrogen in estuaries.[10] Fish and many other aquatic organisms need dissolved oxygen in the water to survive. Prolonged periods of low dissolved oxygen are harmful or lethal to aquatic life.[11] There are state water quality standards for dissolved oxygen to protect against these effects. Other factors besides nutrients may cause or contribute to periods of low DO.

PREP GOAL **Zero days with exceedences of the state water quality standard for dissolved oxygen.**

FIGURE 5.1 Datasonde buoy deployed in Great Bay

The most exceedences and the lowest dissolved oxygen concentrations have been observed in the tidal rivers, particularly the Lamprey River.

FIGURE 5.2 Locations of Datasondes in the Piscataqua Region Estuaries

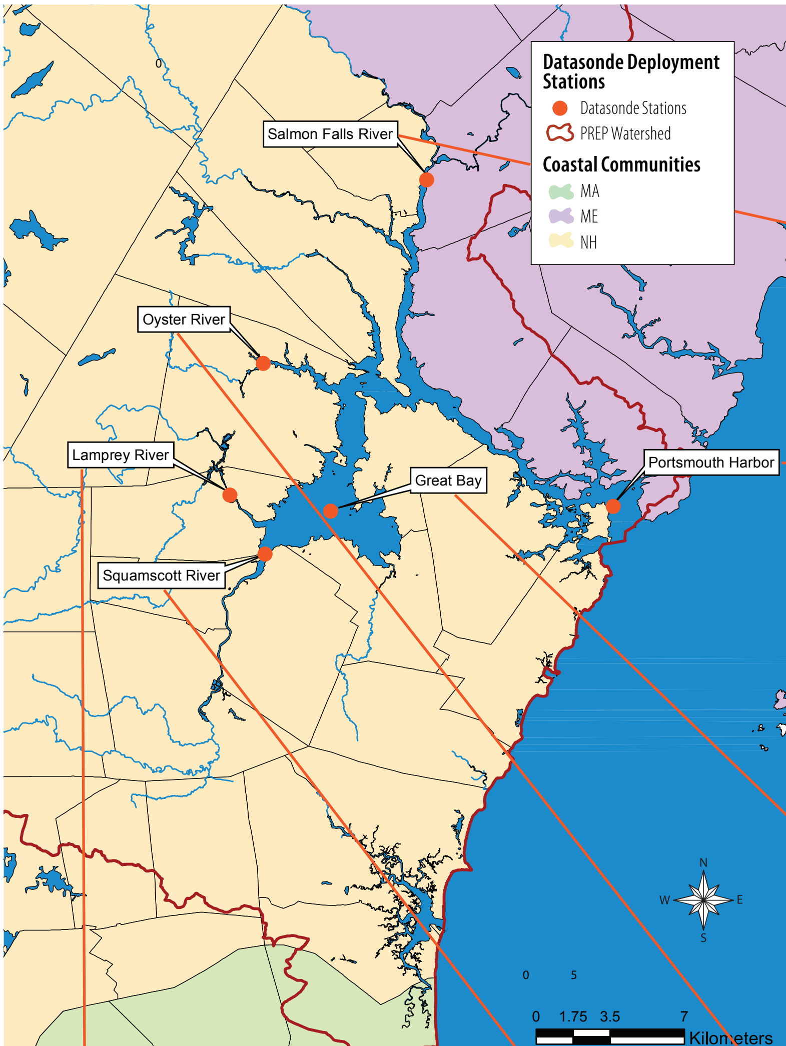
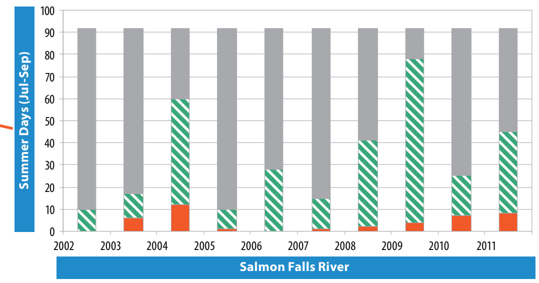
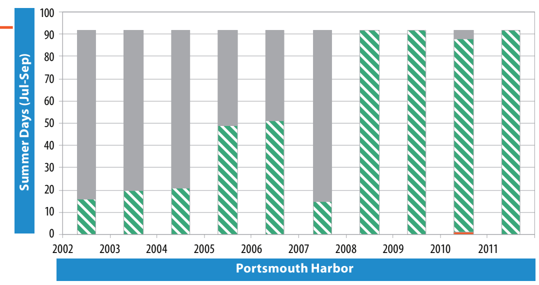
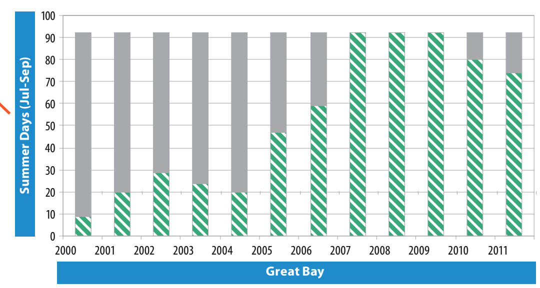
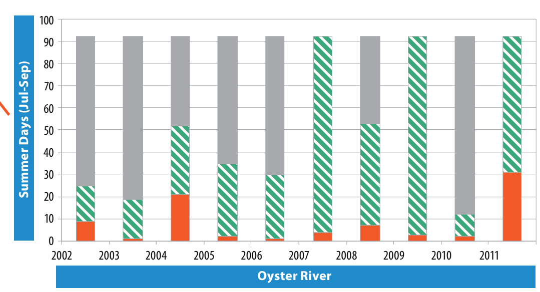


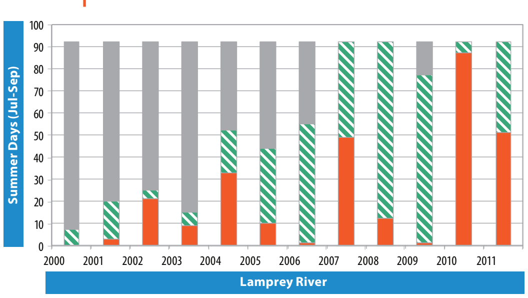
FIGURE 5.3 Number of days during summer months of each year when datasondes measured violations of state standards for dissolved oxygen (less than 5 mg/L)

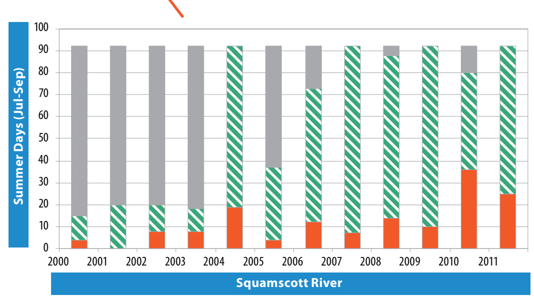












No Data No Violations Violations

Data Source: UNH Jackson Estuarine Laboratory

DISSOLVED OXYGEN

Eelgrass

How much eelgrass habitat is in the Great Bay Estuary and how has it changed over time?

Eelgrass on the bottom of Little Bay. Photo by J. Carroll

Data indicate a long-term decline in eelgrass since 1996 that is not related to wasting disease. Due to variability even recent gains of new eelgrass still indicate an overall declining trend.

EXPLANATION The total eelgrass cover in the entire Great Bay Estuary for years with complete data is plotted in Figure 6.1. In 2011, the total eelgrass cover in the estuary was 1,891 acres, 35% below the PREP goal of 2,900 acres derived from the 1996 eelgrass maps. The total acreage has been relatively steady for the past three years and higher than the previous three years (2006-2008), which were 44 to 48% below the goal. There are also indications, based on estimates of the density of the eelgrass beds, that the remaining beds contain fewer plants and, therefore, provide less habitat.

The majority of the eelgrass in the estuary is in the Great Bay itself. Eelgrass in this important area has been mapped each year. The data show that, since 1990, there has been a statistically significant, 38% decline of eelgrass in Great Bay (Figure 6.2). Statistically significant declines of eelgrass have also been observed in other sections of the estuary: the Winnicut River, Little Harbor, Portsmouth Harbor, and the Piscataqua River. However, the total amount of eelgrass lost in these areas is much smaller than the losses in Great Bay.

The actual location and connectivity of the remaining eelgrass in the estuary is important. Figures 6.3, 6.4, and 6.5 show the 2011 eelgrass maps relative to the 1996 eelgrass maps. These figures show that: (1) the loss of eelgrass in the Piscataqua River disrupts the connectivity of eelgrass between Portsmouth Harbor and Great Bay, (2) eelgrass is absent from the tidal rivers, and (3) the new eelgrass bed in Little Bay is larger than the one that was mapped in 1996.

The new eelgrass bed in Little Bay may be a positive sign. Starting in 1996, eelgrass had declined in this area over time and was essentially absent from 2007 through 2010. However, in 2011, a 48-acre eelgrass bed was observed in this area. The large variance in eelgrass cover in this area shows the variability of eelgrass recovery. Data from 2012 and future years are needed to determine if this bed will persist showing an improving trend in Little Bay.

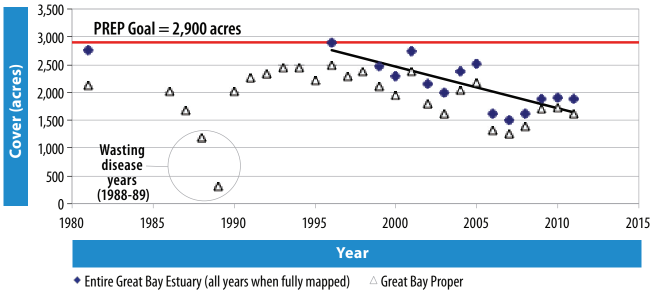
Why This Matters

Eelgrass (*Zostera marina*) is at the base of the estuarine food web in the Great Bay Estuary. Healthy eelgrass beds filter water and stabilize sediments[14] and provide habitat for fish and shellfish.[15] While eelgrass is only one species in the estuarine community, the presence of eelgrass is critical for the survival of many species.

PREP GOAL Increase the aerial extent of eelgrass cover to 2,900 acres and restore connectivity of eelgrass beds throughout the Great Bay Estuary by 2020.

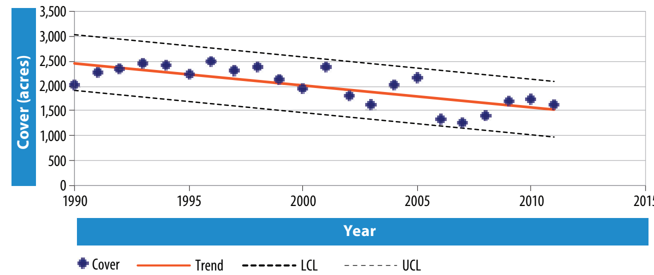
There are indications that remaining beds contain fewer plants and, therefore, provide less habitat.

FIGURE 6.1 Eelgrass Cover in the Great Bay Estuary



Data Source: UNH Seagrass Ecology Laboratory

FIGURE 6.2 Eelgrass cover in Great Bay proper



Data Source: UNH Seagrass Ecology Laboratory Statistically significant trend

FIGURE 6.3 Eelgrass cover in Great Bay and its tributaries in 1996 and 2011

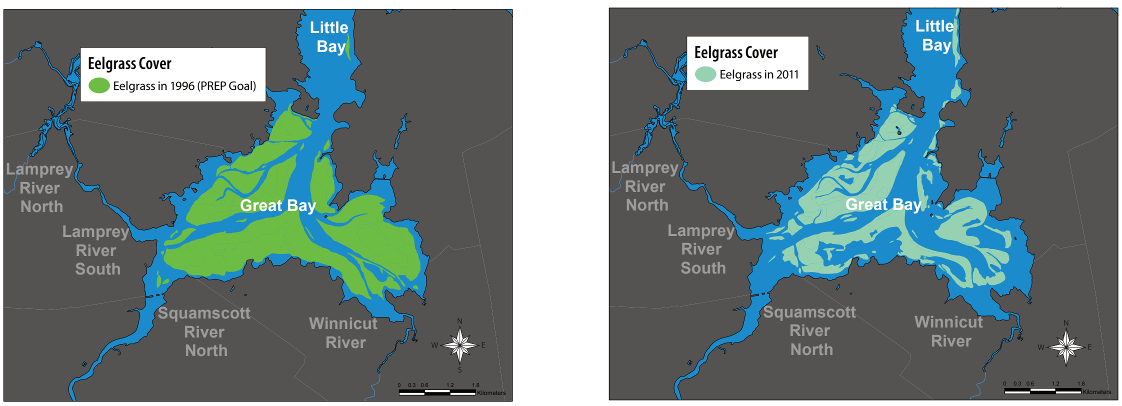


FIGURE 6.4 Eelgrass cover in Little Bay and its tributaries in 1996 and 2011

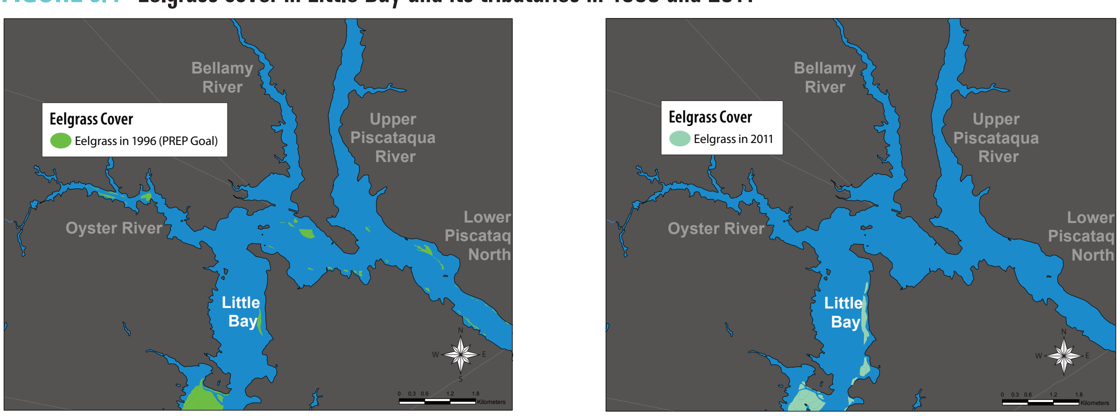
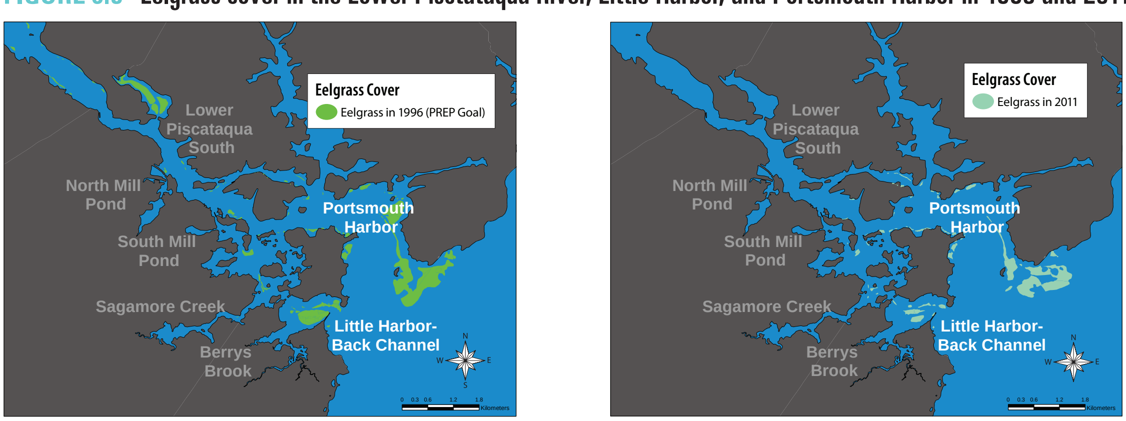


FIGURE 6.5 Eelgrass cover in the Lower Pisctataqua River, Little Harbor, and Portsmouth Harbor in 1996 and 2011



Data Source: UNH Seagrass Ecology Laboratory

EELGRASS

Sediment Concentrations

How has the amount of sediment in the water of the estuary changed over time?

Oyster River Reservoir, Durham, NH. Photo by D. Kellam

Suspended sediment concentrations at Adams Point in the Great Bay Estuary have increased significantly between 1976 and 2011.

EXPLANATION Suspended sediments have been measured at Adams Point in Great Bay since 1976. At this station, the concentrations of suspended sediment have increased by 122% between 1976 and 2011 (Figure 7.1).

Suspended sediment concentrations are important because a UNH study found that non-algal particles contributed significantly to light availability for the underwater eelgrass in the vicinity of the Great Bay Coastal Buoy in 2007.[16] Increased suspended sediments are expected in estuaries where eelgrass has been lost . Eelgrass stabilizes the sediments in the estuary. When this habitat is lost,[17] the sediments are more easily stirred up by wind and waves.

Why This Matters

Suspended sediments are soil and plant particles that hang in the water and cause the water to look cloudy. This cloudiness blocks sunlight from entering the water which can inhibit eelgrass growth and can also smother eelgrass and oysters. Soil and plant particles mostly get into the water from turbulent mixing that carries bay sediments up from the bottom into the water or rain and snow melt running off from developed land.

PREP GOAL **No increasing trends for suspended sediments.**

FIGURE 7.1 Suspended sediment trends at Adams Point in the Great Bay Estuary

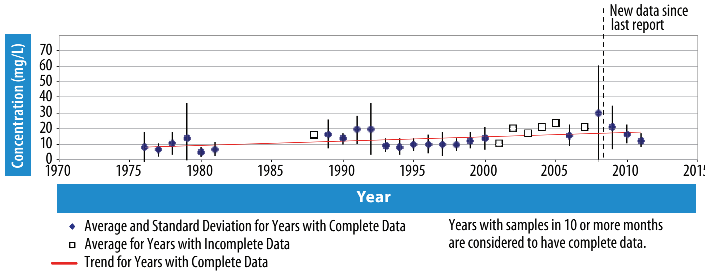
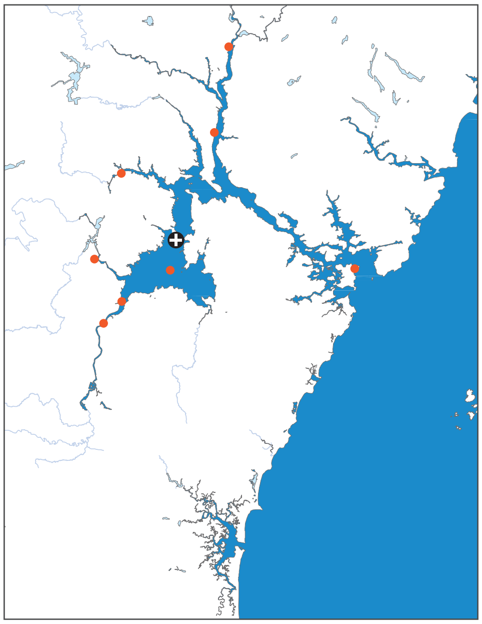
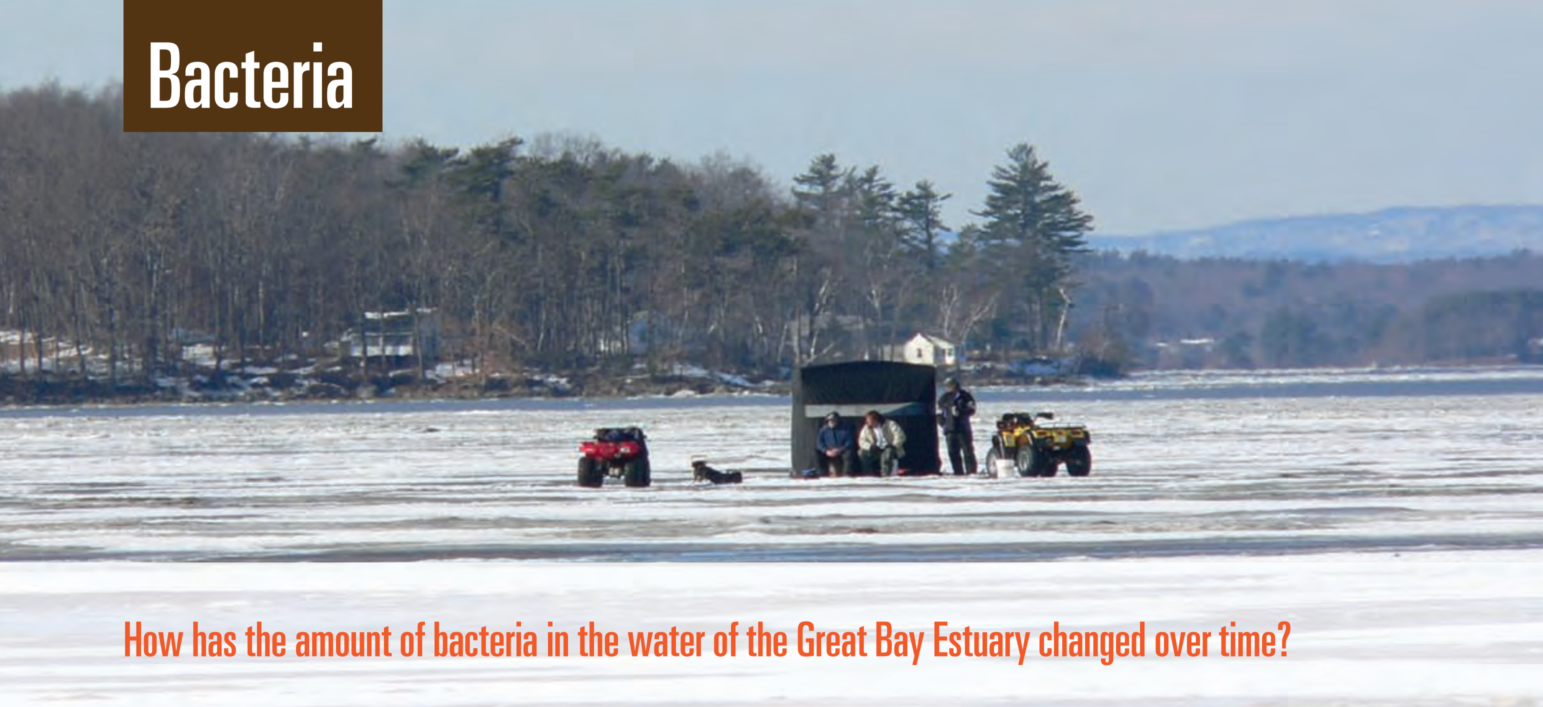


FIGURE 7.2 Monitoring site for sediment concentration is marked by a black dot with a white cross.



Bacteria



How has the amount of bacteria in the water of the Great Bay Estuary changed over time?

Smelt Fishing on Great Bay. Photo by D. Kellam

Between 1989 and 2011, dry weather bacteria concentrations in the Great Bay Estuary have typically fallen by 50 to 92% due to pollution control efforts in most, but not in all, areas.

EXPLANATION High amounts of fecal coliform bacteria, which is found in human and animal waste, is an indication of sewage pollution from leaking septic systems, overboard marine toilet discharges, sewer treatment plant overflows, cross connections between sewers and stormdrain systems, farm animals and wildlife waste, polluted mud on the estuary floor being stirred up, and polluted water running off from paved surfaces. PREP uses fecal coliform bacteria measurements from days without signficant rainfall for this indicator because storm runoff can cause large spikes of pollution. Data on this indicator is only available for the Great Bay Estuary.

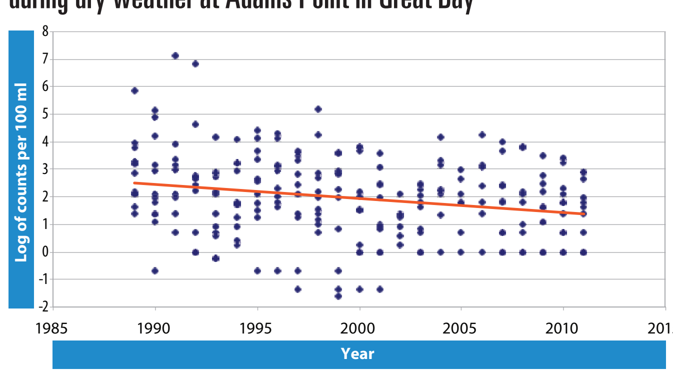
At all four long-term water pollution monitoring stations in the estuary, there has been a decrease in fecal coliform bacteria during dry weather over the past 23 years. For example, in the middle of Great Bay at Adams Point, fecal coliform bacteria decreased by 68 percent between 1989 and 2011 (Figure 8.1). Sewer treatment plant upgrades and removal of sewage flowing into cities' and towns' storm drain systems are likely major contributors to the long-term decreasing trend. In the most recent 10 years, bacteria levels have mostly remained the same. The observed trends may have been driven by large decreases in the late 1980s and early 1990s. Alternatively, continued population growth in the Piscataqua Region watershed may be counteracting the ongoing pollution control efforts. It should be noted that not all trends were decreasing. Concentrations of enterococcus, a different type of bacteria, increased in the Squamscott River but did not show any trends in other locations.

Why This Matters

Increased amounts of bacteria in bay waters often indicate the presence of pathogens due to sewage pollution or other sources. Pathogens, which are disease-causing microorganisms, pose a public health risk and are the primary reason why shellfish beds and public beaches can be closed.

PREP GOAL **No increasing trends for any bacteria species.**

FIGURE 8.1 Fecal coliform bacteria concentrations at low tide during dry weather at Adams Point in Great Bay



Source: UNH Jackson Estuarine Laboratory

Shellfish Harvest Opportunities

How much of our estuaries are open for shellfish harvesting and how has it changed over time?

NH Dept. of Environmental Services measuring shellfish size. Photo by PREP

Only 36% of estuarine waters are approved for shellfishing and, in these areas, periodic closures limited shellfish harvesting to only 42% of the possible acre-days in 2011. The harvest opportunities have not changed significantly in the last three years.

EXPLANATION There are still many closures of shellfish beds due to bacterial pollution, particularly after it rains. In 2011, the most recent year with data, 64% of the shellfish growing areas were closed to harvesting on a year-round basis (Figure 9.1). The major open areas are in Hampton-Seabrook Harbor, Great Bay, Little Bay, and Little Harbor (Figure 9.2). None of the Piscataqua Region estuary waters in Maine are open for harvesting. In 2000 and 2001, approximately 29 to 31% of the estuarine waters were classified as open for shellfishing by NH Department of Environmental Services and Maine Department of Environmental Protection shellfish programs. The percentage of waters in these open categories grew to 38% in 2003 and then remained relatively constant from 2004 to 2011, ranging from 35 to 36%. In the areas where harvesting was allowed, the shellfish beds were closed at least 50 percent of the time in 2011 due to water pollution after rain storms (Figure 9.3).

Why This Matters

Shellfish beds are closed to harvesting when there are high amounts of bacteria or other pollution in the water. The closures can be permanent or temporary. Therefore, the amount of time that shellfish beds are open for harvest is an indicator of how clean the water is in the estuary. Shellfishing aquaculture provides a living for some area fishermen and brings in money for the Seacoast region through retail sales.

PREP GOAL **100% of possible acre-days in estuarine waters open for harvesting.**

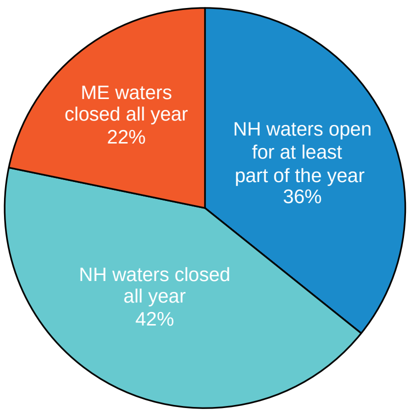
Success Story

Septic-sniffing dogs

FB Environmental Associates recently hired Environmental Canine Services LLC to help collect data on fecal bacteria sources in Kittery, ME. Hailing from Michigan, Environmental Canine Service (ECS) is a K-9 illicit discharge detection unit made up of animal handlers, scientists and two furry data collectors, Sable and Logan. By sniffing outflow pipes and areas where stormwater or wastewater discharges into rivers, estuaries, and beaches, they can tell if it's contaminated with harmful bacteria and then Kittery officials can work to identify and correct the sources.

In 2011, the most recent year with data, 64% of the shellfish growing areas were closed to harvesting on a year-round basis.

FIGURE 9.1 Shellfish harvest classifications for Piscataqua Region estuaries, 2011



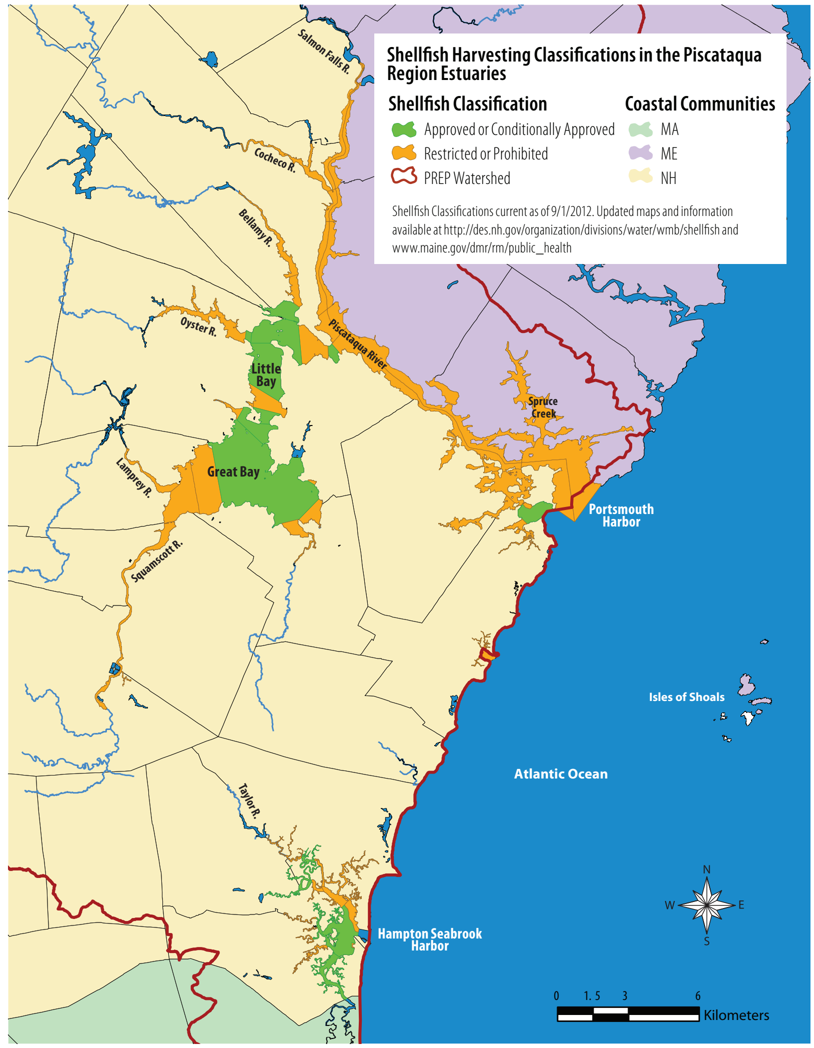
ME waters open for at least part of the year 0%

Data Source: NH Dept. of Environmental Services and Maine Dept. of Marine Resources

Success Story

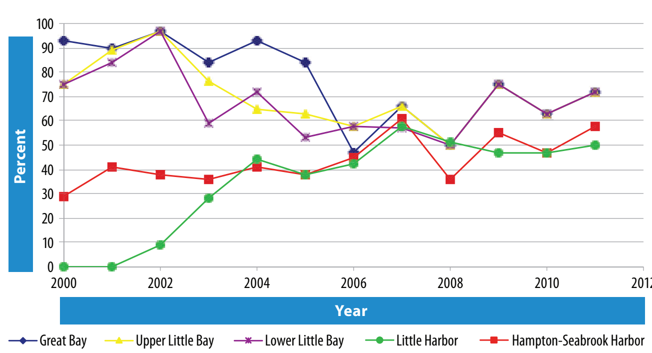
Will Carey of Little Bay Oyster Company Oysters are a model for the importance of a healthy ecosystem that in turn supports a healthy economy. Will Carey of The Little Bay Oyster Company grows oysters in his "underwater vineyard" off of Fox Point in Newington, NH. Enterprises like the Little Bay Oyster Co. represent an opportunity to reintroduce a natural resource as part of local business and stimulate the NH economy. Today Little Bay Oyster Company is now one of about six commercial growers and part of a growing movement of local economies based on a healthy ecosystem, valuable natural resources and clean water.

FIGURE 9.2 Shellfish Harvesting Classifications in the Piscataqua Region Estuaries



Data Source: NH Dept. of Environmental Services and Maine Dept. of Marine Resources

FIGURE 9.3 Shellfish harvesting opportunities in open areas as a percent of the maximum possible per year



Data Source: NH Dept. of Environmental Services

Beach Closures

How often are tidal bathing beaches closed due to bacteria pollution and how has it changed over time?

Hampton Beach on a crowded Summer day. Photo by C. Keeley

Poor water quality prompted advisories extremely rarely in 2011. There are no apparent trends.

EXPLANATION Tidal beaches in the Piscataqua Region are mostly located along the Atlantic coast, not in the estuaries (Figure 10.1). At these beaches, between 1 and 11 advisories have been issued per year between 2003 and 2011 (Figure 10.2). The advisories have resulted in very few beach closures as a percent of the total beach days in the summer. The greatest number of advisories occurred in 2009 (11 advisories affecting 6 beaches for a total of 23 days or 1.2% of the total beach-days for that summer). In 2011, there were four advisories affecting three beaches for a total of nine days (or 0.5% of total beach-days for that summer). Therefore, the PREP goal of having minimal (i.e., <1%) advisories at tidal beaches is currently being met. The beaches with the most advisories are the New Castle Town Beach (9), the North Hampton State Beach (7), and Fort Foster in Maine (5).

Jenness Beach, Rye, NH. Photo by J. Carroll

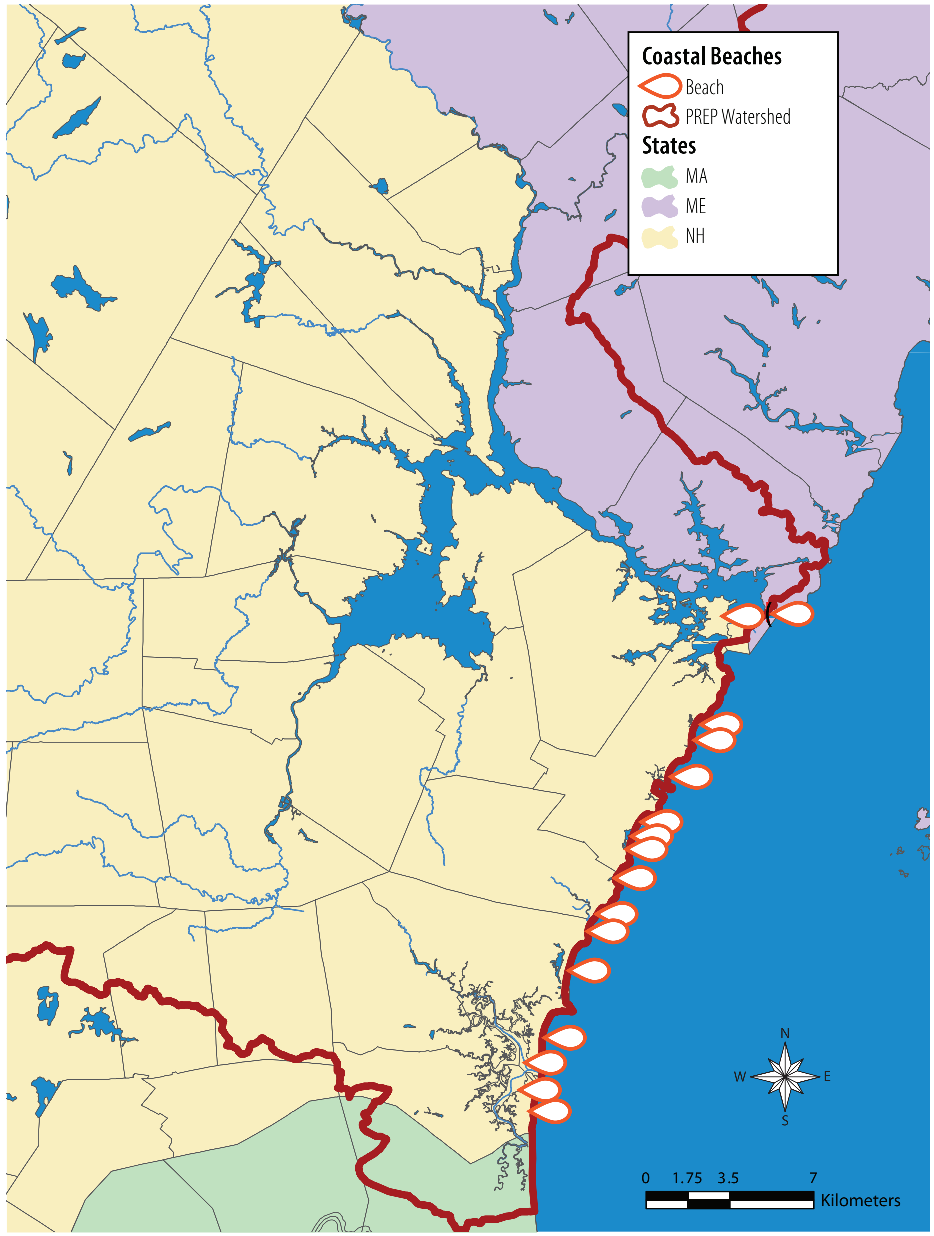
Why This Matters

If the concentrations of bacteria in the water at a beach do not meet state standards for swimming, the state agencies may recommend that an advisory be posted at the beach. Therefore, the number of postings at tidal beaches is a good indicator of bacteria pollution at important recreational areas. Recreational beach visitors supply tourist dollars for our region's economy giving local businesses like hotels, restaurants and beachfront shops a boost.

PREP GOAL **Less than 1% of summer beach days over the summer season affected by closures due to bacteria pollution.**

The beaches with the most advisories are the New Castle Town Beach, the North Hampton State Beach, and Fort Foster in Maine.

FIGURE 10.1 Coastal Beaches



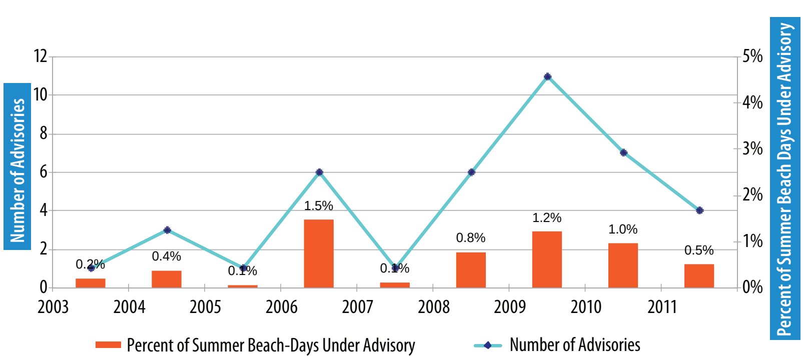
Data Source: NH Dept. of Environmental Services and Maine Dept. of Environmental Protection

Success Story

New Hampshire's 5 Star Beaches

The Natural Resource Defense Council publishes an annual guide to water quality for US beaches. Two of New Hampshire's beaches were once again rated as "5-Star," standing out from over 200 beaches rated from across the country. Hampton Beach State Park and Wallis Sands in Rye were recognized for exceptionally low violation rates and strong testing and safety practices.

FIGURE 10.2 Advisories at tidal beaches in the Piscataqua Region, 2003-2011



Data Source: NH Dept. of Environmental Services and Maine Dept. of Environmental Protection

Toxic Contaminants

How much toxic contamination is in shellfish tissue and how has it changed over time?

Wrack on the shore in New Castle, NH. Photo by D. Kellam

The vast majority of shellfish tissue samples do not contain toxic contaminant concentrations greater than FDA guidance values. The concentrations of contaminants are mostly declining or not changing.

EXPLANATION Shellfish collect toxic contaminants in their flesh when they feed by filtering water. The Gulf of Maine Council's Gulfwatch Program uses blue mussels (*Mytilus edulis*) for measuring the accumulation of toxic contaminants in their flesh. Between 1993 and 2011, 20 stations in the Great Bay Estuary and Hampton-Seabrook Harbor have been tested at least once for toxic contaminants in blue mussel tissue. The concentrations of toxic contaminants in mussel tissue have been less than U.S. Food and Drug Administration guidelines at all of the sites except for South Mill Pond in Portsmouth and shellfish harvesting is not permitted in this area. The acceptable levels of contaminants in these creatures suggest that the amount of toxic contaminants in estuarine waters are of minimal concern in most of the estuary.

Samples of mussel flesh from three locations (Portsmouth Harbor, Hampton-Seabrook Harbor, and Dover Point as shown in Figure 11.1) have been tested repeatedly between 1993 and 2011 to detect trends. The trends for toxic contaminants were decreasing (Figures 11.2, 11.3, 11.4) or remaining stable in these locations. These trends reflect that people are using less of the products containing these contaminants due to product bans and pollution prevention programs. While declining trends are a good sign, the amount of some toxic contaminants are still elevated. Research by Sunderland et. al. (2012) reported that the amount of mercury in the muddy bottom of the Piscataqua Region estuaries was similar to Boston Harbor and other estuaries located close to cities.

Why This Matters

Mussels, clams, and oysters accumulate toxic contaminants from polluted water in their flesh. In addition to being a public health risk, the contaminant level in shellfish flesh is a long-term indicator of how clean the water is in the estuaries. If toxic pollution does not appear in the flesh of the mussels, then the amount of toxic pollution in the water is likely very low.

PREP GOAL **Zero percent of sampling stations in the estuary to have mean shellfish tissue concentrations greater than FDA guidance values and no increasing trends for any contaminants.**

Frog photo by PREP

FIGURE 11.1 Gulfwatch Program Sampling Stations

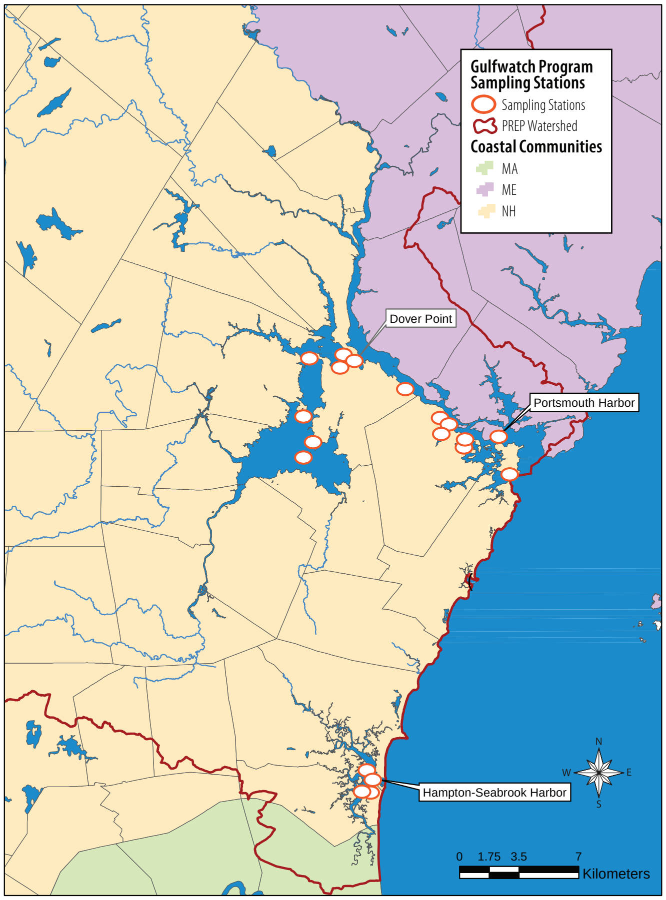
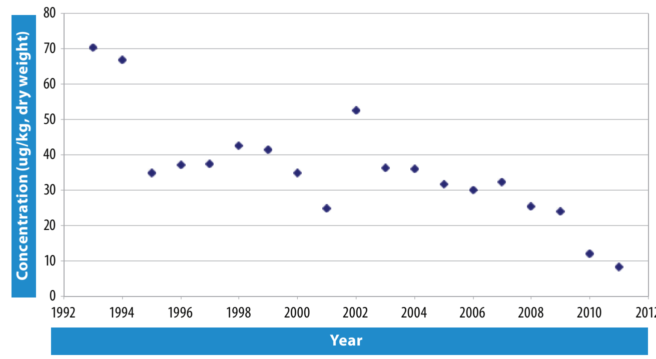
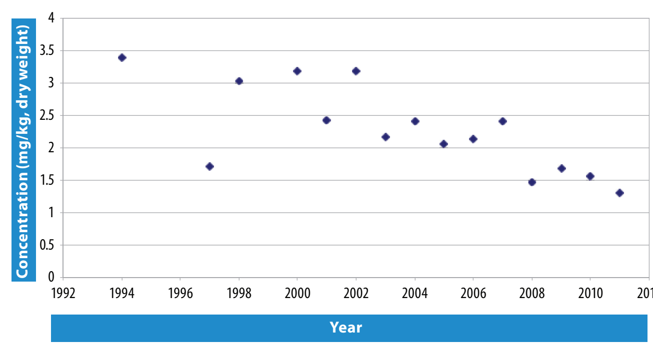


FIGURE 11.2 Total PCBs in Mussel Tissue in Portsmouth Harbor



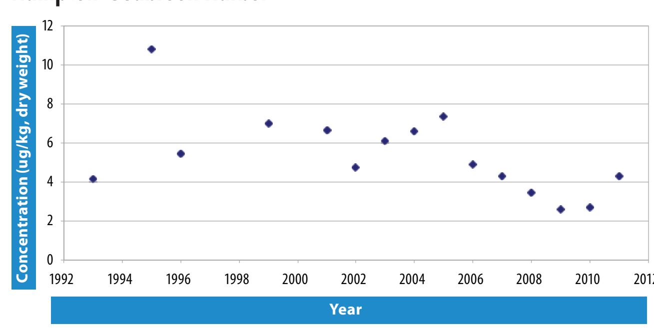
Data Source: NH Gulfwatch Program

FIGURE 11.3 Lead in Mussel Tissue at Dover Point



Data Source: NH Gulfwatch Program

FIGURE 11.4 Total DDT Pesticides in Mussel Tissue in Hampton-Seabrook Harbor



Data Source: NH Gulfwatch Program

Newt photo by NH Fish & Game

Digging Deeper

PCBs (Polychlorinated Biphenyls) belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned by the US EPA in 1979. They were used in hundreds of industrial and commercial applications. Since being banned in 1979 the presence of PCBs in the environment has dramatically dropped.

In 1972 after the publication of Rachel Carson's *Silent Spring* the use of the pesticide DDT (dichloro-diphenyl-trichloroethane) was also banned. Although it is no longer used or produced in the United States, we continue to find DDT in our environment. Other parts of the world continue to use DDT in agricultural practices and in disease-control programs. Therefore, atmospheric deposition is the current source of new DDT contamination in soils, fish & shellfish.

PAHs are Polycyclic Aromatic Hydrocarbons. PAHs are created when products like coal, oil, gas, and garbage are burned but the burning process is not complete.

Source: US EPA

Oysters

How many oysters are in the Great Bay Estuary and how has it changed over time?

Oyster spat, or seed, set on an oyster shell. Photo by R. Grizzle

The number of adult oysters decreased from over 25 million in 1993 to 1.2 million in 2000. The population has increased slowly since 2000 to 2.2 million adult oysters in 2011 (22% of goal).

EXPLANATION The New Hampshire Fish and Game Department monitors the oyster populations in the six major reefs in the Great Bay Estuary (Figure 12.1).

Data from 1993 to 2011 show that the oysters in Great Bay have been declining considerably (Figure 12.2). There was a steep fall from over 25 million adult oysters in 1993 to 1.2 million in 2000. The major cause of this decline is thought to be the diseases MSX and Dermo which have caused similar declines in oysters in the Chesapeake and other mid-Atlantic estuaries. Since 2000, the number of adult oysters has grown slightly to 2.2 million. The 2011 number of adult oysters is approximately 22% of the PREP goal of 10 million adult oysters. Biologists hoped for a large increase in oysters when the 2006 oyster seed, called spat, reached maturity in 2009. A small amount of mature oysters (>60 mm) did appear in 2009 but they did not grow to the typical adult size (>80 mm). Overall, the average amount of adult and mature oysters in the major beds is 58% and 45% lower than 1997 levels, respectively.

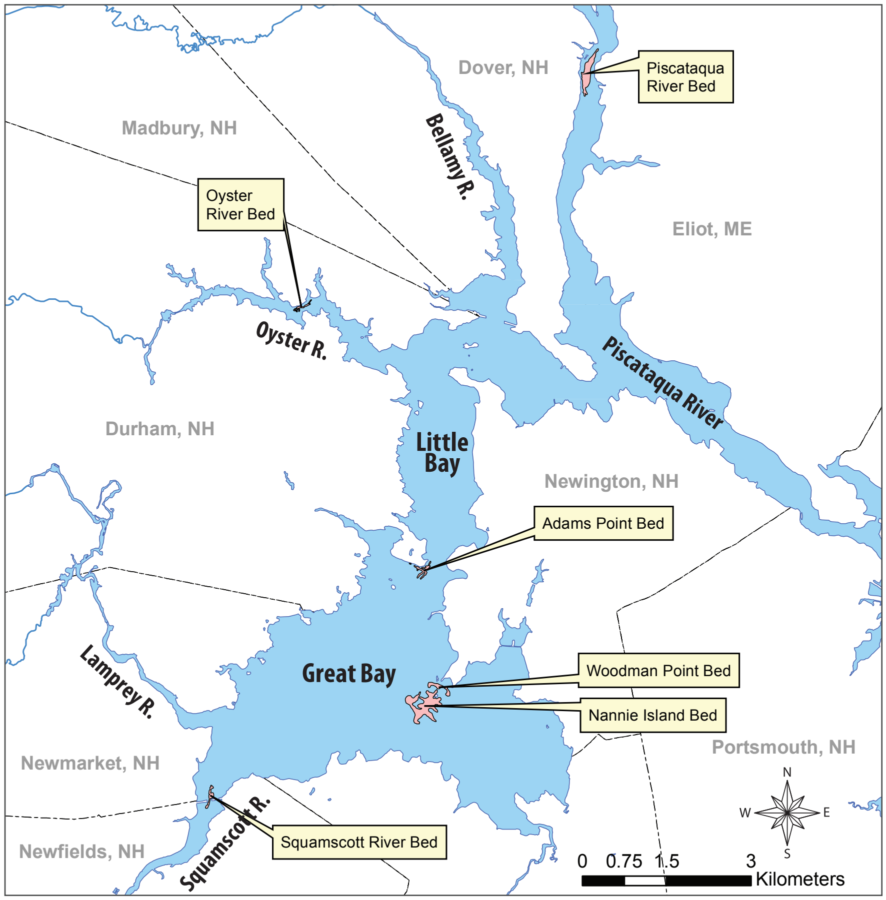
The New Hampshire Fish and Game Department has monitored the prevalence of the diseases MSX and Dermo in oysters from the Great Bay every year since 1995 (Figure 12.3). There has been no apparent trend in MSX infection rates since the disease was first detected. Approximately 21% of the oysters in Great Bay were infected with MSX at some level in 2011. However, starting in 2002, the prevalence of Dermo infections has increased from zero to greater than 90%. The increase in Dermo may be the result of warming water temperatures or adjustment of the parasite to local conditions. These two diseases, in combination with other factors, limit the survival of oysters into adult size. Recreational harvest of oysters has been declining for 30 years and is not thought to be affecting the size of the population.

Why This Matters

Oysters are filter feeders that take in the water around them, filter out some of the pollutants and sediment, and then release cleaner water. Harvesting and aquaculture farming of oysters provide economic benefits to local communities and businesses. Oyster shell reefs also create important habitat for other creatures in the estuary.

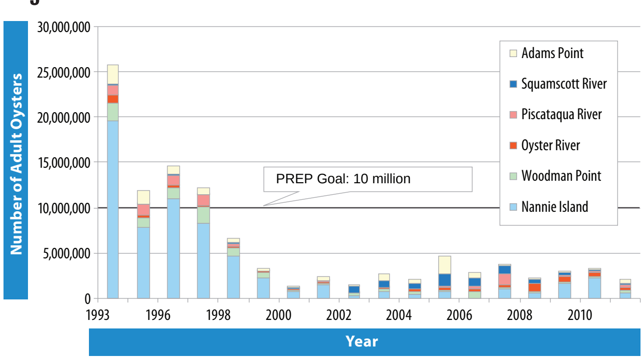
PREP GOAL **Increase the abundance of adult oysters at the six documented beds in the Great Bay Estuary to 10 million oysters by 2020.**

FIGURE 12.1 Major oyster beds in the Great Bay Estuary



Data Source: NH Dept. of Environmental Services

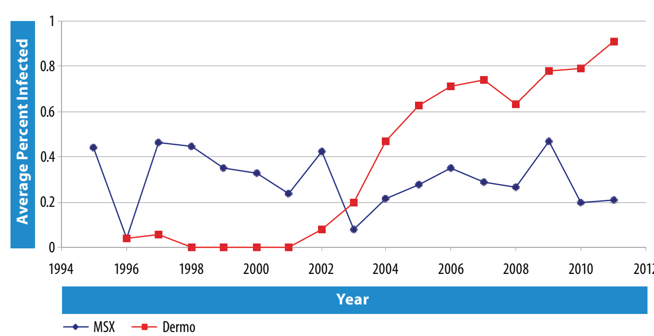
FIGURE 12.2 Number of adult oysters* in major Piscataqua Region beds



* Shell height greater than 80 mm

Data Source: NH Fish and Game Department

FIGURE 12.3 Average MSX and Dermo infection prevalence in Piscataqua Region oysters from all beds



Data Source: NH Fish and Game Department

Success Story

Oyster Conservationists Homeowners are helping Ray Konisky of the Nature Conservancy rebuild oyster reefs at the mouths of the tributary rivers of Great Bay. Through the Oyster Conservationist program, people with waterfront property can take care of baby oysters until they are ready to join the big oysters at the restoration sites around the Bay. In the 2011 season, 39 families helped grow oysters for restoration. More oyster parents are always needed, contact Kara McKeton (kmcketon@tnc.org) if you're ready to help raise baby oysters!

Clams

How many clams are in Hampton-Seabrook Harbor and how has it changed over time?

Digging for clams in Hampton Harbor. Photo by PREP

The number of clams in Hampton-Seabrook Harbor is 43% of the recent historical average. Large spat or seed sets may indicate increasing populations in the future.

EXPLANATION The largest clam flats in the Piscataqua Region estuaries are in Hampton-Seabrook Harbor (Figure 13.1). The number of adult clams in these flats has been monitored by NextEra Energy/Seabrook Station over the past 41 years (Figure 13.2). The number of adult clams has undergone several cycles of growth and decline. Peak clam numbers of approximately 18 million and 27 million occurred in 1983 and 1997, respectively. Between the peaks, there have been crashes in 1978 and 1987, with the number of adult clams totalling less than 1 million. From 1997 to 2004, the number of adult clams dropped to 1.9 million. By 2006 the population had rebounded to 5.1 million (93% of the goal). However, in the last five years, the population has declined to 2.4 million (43% of the goal).

"Clam spatfall" refers to the event when clam larvae fall out of the water and settle onto the muddy bottom. It is critical to have good spatfalls on a clam flat in order to recruit new clams which can then grow into adults. Figure 13.3 illustrates that clam spatfall in recent years has been higher than historical averages, which may mean more adult clams in the future.

Father and daughter clamming. Photo by PREP

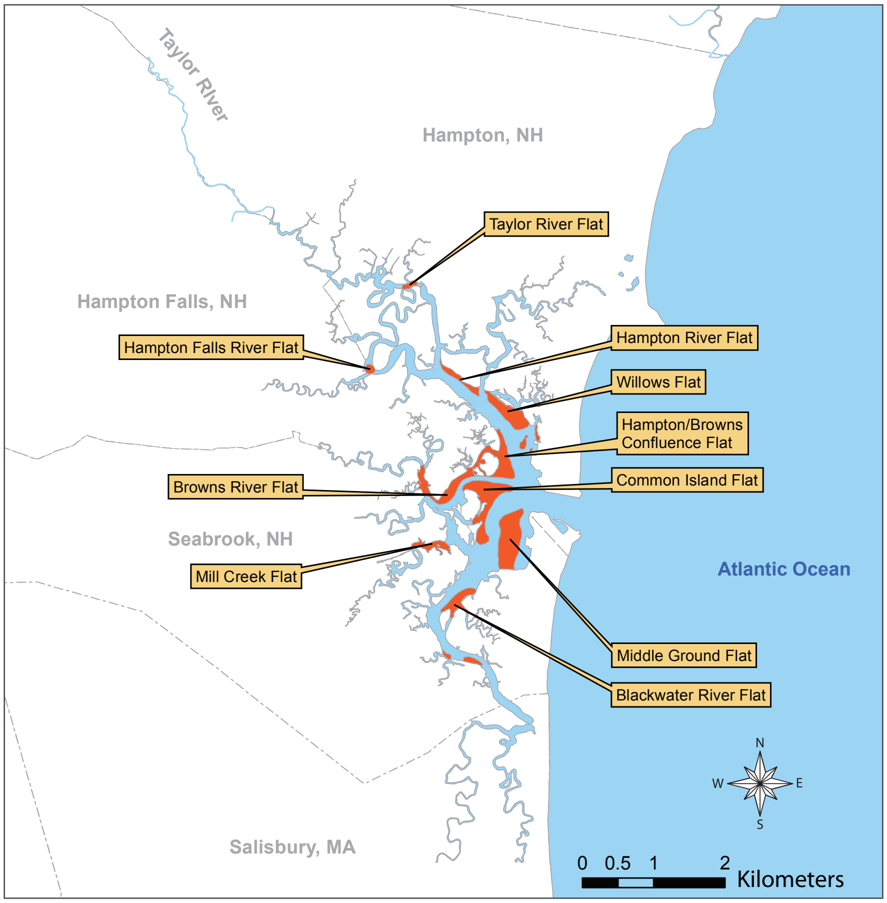
Why This Matters

Soft shell clams are an important economic, recreational, cultural, and natural resource for the Seacoast region. Recreational shellfishing in Hampton-Seabrook Harbor is estimated to contribute more than $3 million a year to the New Hampshire economy.

PREP GOAL **Increase the number of adult clams in the Hampton-Seabrook Estuary to 5.5 million clams by 2020.**

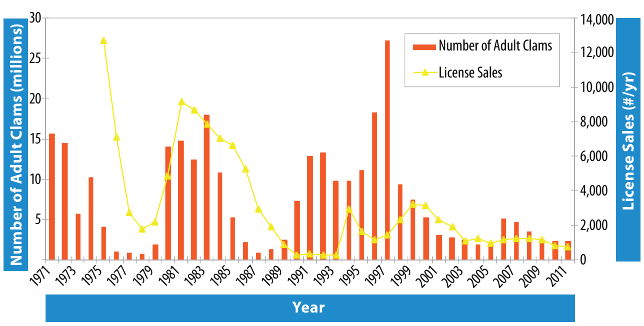
In the last five years, the population of clams has declined to 2.4 million (43% of the goal).

FIGURE 13.1 Major clam flats in the Hampton-Seabrook Estuary



Data Source: NH Dept. of Environmental Services

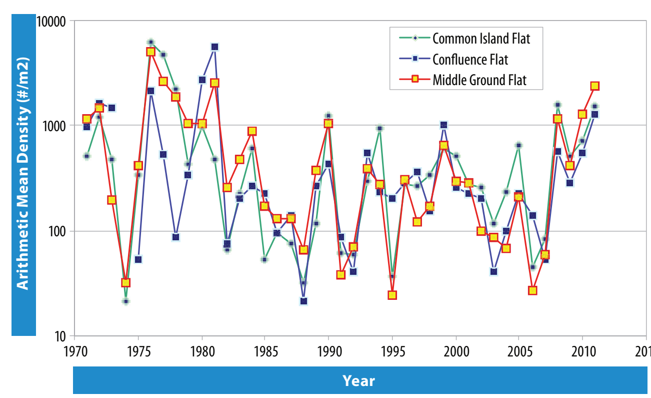
FIGURE 13.2 Number of adult clams* in Hampton-Seabrook Harbor and recreational clam harvest license sales



*Shell length greater than 50 mm

Data Source: NextEra Energy Seabrook Station and NH Fish and Game Department

FIGURE 13.3 Average clam spat* density in Hampton-Seabrook Harbor



*Young clams with shell length between 1-25mm

Data Source: NextEra Energy Seabrook Station

Success Story

The New Hampshire Shellfish Program

The New Hampshire Department of Environmental Services (NHDES) Shellfish Program ensures that shellfish harvested from the state's tidal waters are safe to eat. In order to provide this service, the program regularly monitors bacteria levels in seawater from over 75 locations in New Hampshire's tidal waters and evaluates weekly samples of mussels to ensure that shellfish are not contaminated with Paralytic Shellfish Poison (PSP) toxin from "red tide" events.

Migratory Fish

How have migratory fish returns to the Piscataqua Region changed over time?

Fish ladder on the Lamprey River, Newmarket, NH. Photo by PREP

Migratory river herring returns to the Great Bay Estuary generally increased during the 1970-1992 period, remained relatively stable in 1993-2004, and then decreased in recent years.

EXPLANATION Major rivers of the Piscataqua Region historically had very large populations of migratory fish including Atlantic salmon, river herring, American shad, and American eels. Today, only river herring and American eels still return regularly in substantial numbers to the rivers and are the focus of current migratory fish restoration efforts.

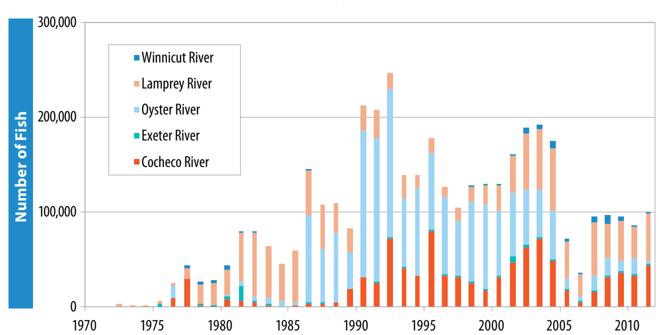
River herring returns to the major rivers of the Great Bay Estuary have been combined in Figure 14.1. This figure illustrates that river herring returns to the Great Bay estuary generally increased during the 1970-1992 period, remained relatively stable 1993-2004, then decreased in recent years. This decline is likely due to a combination of losses while the herring are in the sea-going portions of their lifecycle, limited freshwater habitat quantity/quality, difficulty getting up fish ladders that are installed over dams, safe downstream passage over dams, possible over-fishing in some river systems, water pollution, and flood events during upstream migrations. The Taylor River, in Hampton-Seabrook Harbor, has had the highest recorded returns of herring (Figure 14.2). However, this population has declined dramatically. The decline is most likely due to poor water quality in the Taylor River reservoir upstream of the dam.

Why This Matters

River herring are migratory fish, which means they travel from the ocean upstream to freshwater streams, marshes, and ponds to reproduce. Herring are eaten by other species and therefore sustain important commercial and recreational fisheries and other wildlife.

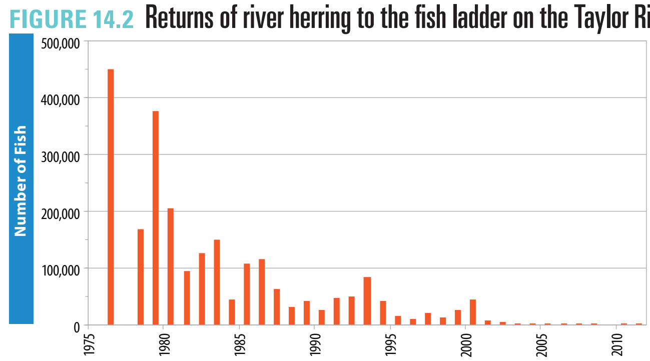
PREP GOAL No goal.

FIGURE 14.1 Returns of river herring to fish ladders in the Great Bay Estuary



Data Source: NH Fish and Game Department

FIGURE 14.2 Returns of river herring to the fish ladder on the Taylor River



Data Source: NH Fish and Game Department

Salt Marsh Restoration

How much salt marsh restoration has been done?

Pickering Brook, Greenland, NH. Photo by D. Kellam

280.5 acres of salt marsh have been restored since 2000 and 30.6 acres of salt marsh have been enhanced since 2009, which is moderate overall progress towards PREP's goals.

EXPLANATION Salt marshes are coastal wetlands connected to the ebb and flow of the tides. Salt marshes serve as a critical base of the food web in the estuary, provide essential breeding, feeding, and rearing places for birds, fish, and other wildlife, filter pollutants, and protect our communities from coastal flooding. Historically, many salt marshes were filled for development, blocked off from the tides for hay fields, or impacted with ditches to try to drain them. Restoration of salt marshes involves undoing these past harmful alterations, while enhancement usually involves removing invasive plants and re-establishing native plant communities.

PREP has two complementary goals for salt marsh restoration: to restore 300 acres of salt marsh and to enhance an additional 300 acres of salt marsh by 2020. Tracking of enhancement acres is a new indicator and began in 2009. There has been significant progress toward the goal of restoring 300 acres of salt marsh (Figure 15.1), with 280.5 acres restored (93% of goal).

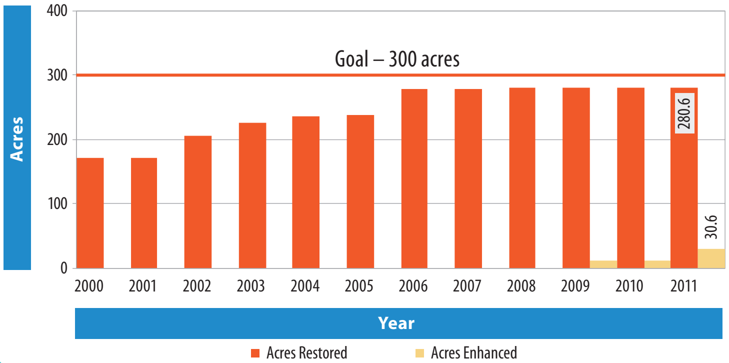
Limited progress has been made toward the goal of enhancing 300 acres of salt marsh. There has been 30.6 acres of marsh enhancement work completed since 2009, representing 10% of the goal.

Why This Matters

Salt marshes are among the most productive ecosystems in the world.[18] In the past few centuries, many of the salt marshes in the Piscataqua Region watershed have been degraded or lost over time. Restoration efforts attempt to restore the function of these critical habitats.

PREP GOAL **Restore 300 acres of salt marsh and enhance an additional 300 acres of salt marsh by 2020.**

FIGURE 15.1 **Cumulative acres of salt marsh restoration and enhancement projects, 2000-2011**



MIGRATORY FISH & SALT MARSH RESTORATION

Conservation Land (General)

How much of the Piscataqua Region is permanently conserved in its natural state?

Evans Mountain Overlooking Bow Lake, Strafford, NH. Photo by D. Sperduto

At the end of 2011, 88,747 acres in the Piscataqua Region watershed were conserved which amounted to 13.5% of the land area. At this pace, the goal of conserving 20% of the watershed by 2020 is likely to be reached.

EXPLANATION By the end of 2011 there were 88,747 acres of conserved, protected land in the watershed (Figure 16.1). This amount is equivalent to 13.5% of the land area, which is below the PREP goal of 20% by 2020. Eighty-six percent of the conservation lands have permanent protection status. The remaining lands are "unofficial" conservation lands, water supply lands, or recreational parks and fields. The rate of growth of conservation lands in the Piscataqua Region Watershed has been approximately 7,000 acres per year. If this pace is maintained, the PREP goal to conserve 20% of the entire Piscataqua Region watershed by 2020 will be achieved.

The percentage of land area that is protected in each town is shown in Figure 16.2. This map illustrates that significant progress has been made in the towns around Great Bay, near the coast, in the vicinity of the Bear Brook and Pawtuckaway State Parks, and in the Mt. Agamenticus to the Sea area. In contrast, there is a lower percentage of protected land in the Salmon Falls River and Cocheco River watershed areas.

Photo by C. Keeley

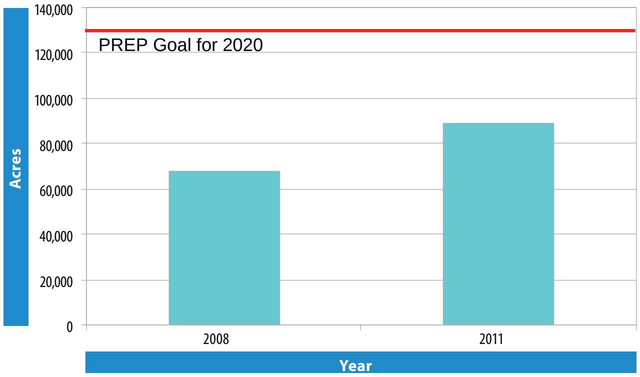
Why This Matters

Our region is under pressure from rapid population growth and land development. Conserving a network of undeveloped natural lands in our region is critical in order to maintain clean water, support healthy wildlife populations, minimize flood damages, and provide quality recreational opportunities.

PREP GOAL **Conserve 20% of the watershed by 2020.**

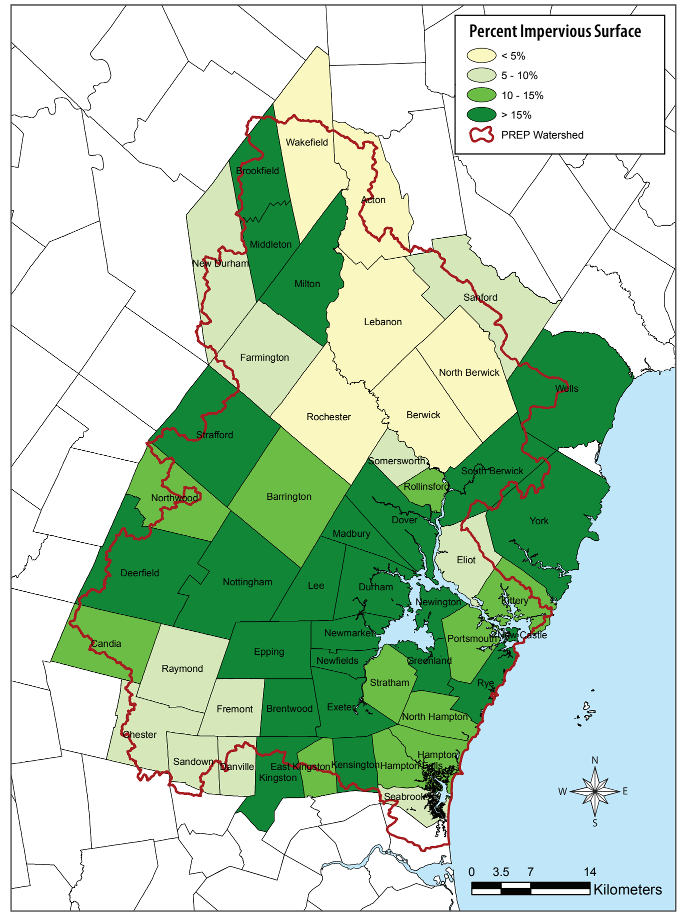
By the end of 2011 there were 88,747 acres conserved that is 13.5% of the land area of the Piscataqua Region.

FIGURE 16.1 Conservation lands in the Piscataqua Region watershed



Data Source NH GRANIT & Wells National Estuarine Research Reserve

FIGURE 16.2 Percent Conservation Lands

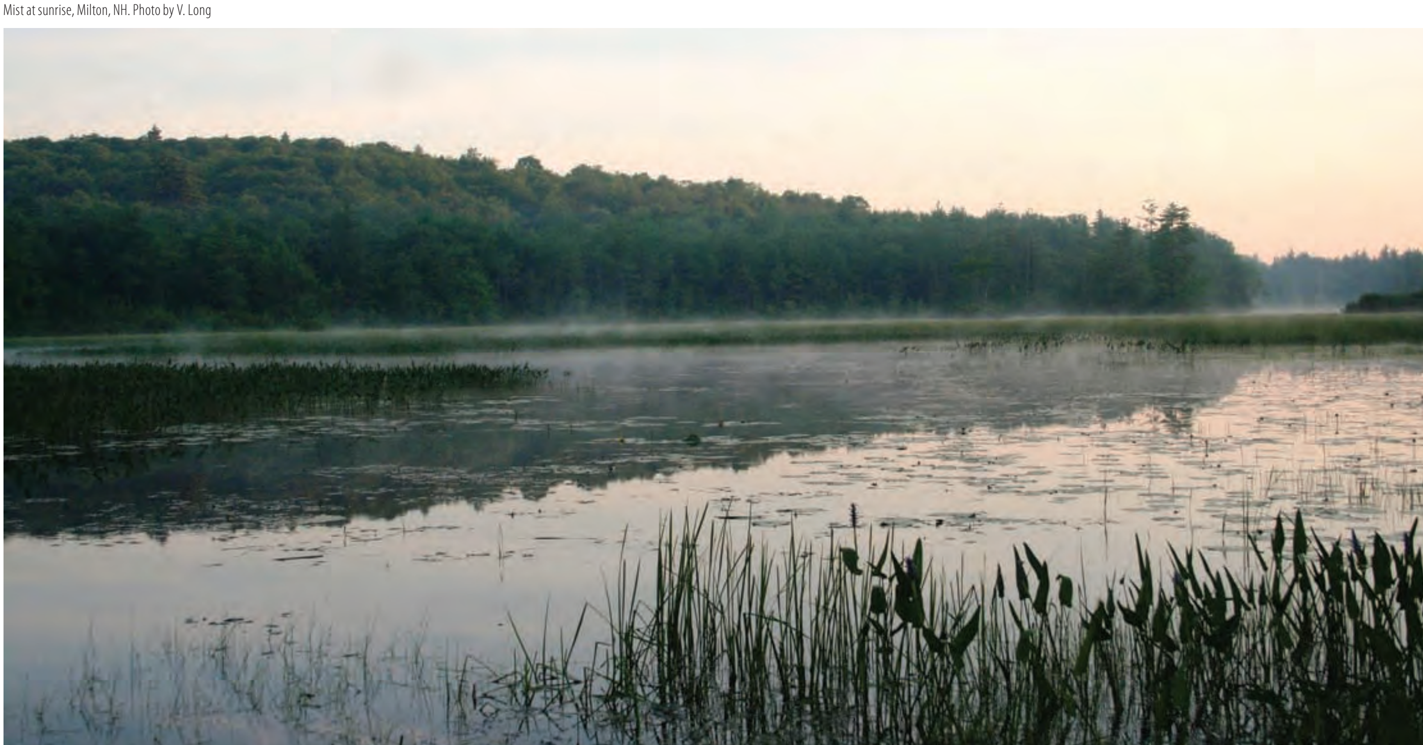


Data Source NH GRANIT & Wells National Estuarine Research Reserve

Success Story

Protecting A Mountain Where A Coastal River Begins In 2011, the local land trust Bear-Paw Regional Greenways permanently protected 1,015 acres on Evans Mountain, an area in the Town of Strafford from which the Isinglass and Cocheco Rivers begin their journey to the Great Bay Estuary. This project conserves clean streams, highest quality wildlife habitats, and large forestlands perfect for outdoor recreation and educational opportunities such as hiking, hunting, and snowmobiling.

Mist at sunrise, Milton, NH. Photo by V. Long



Conservation Land (Priority)

How much of the top priority areas in the Piscataqua Region are permanently conserved in their natural state?

Spruce Swamp, a Conservation Focus Area in Fremont, NH. From the Fremont Prime Wetland Designation Study by West Environmental

In 2011, 28% of the core priority areas in New Hampshire and Maine were conserved. At this pace, the goal of conserving 75% of these lands by 2025 is unlikely to be reached.

EXPLANATION *The Land Conservation Plan for New Hampshire's Coastal Watersheds* and *The Land Conservation Plan For Maine's Piscataqua Region Watershed*s are two key science-based regional conservation plans that identified 90 Conservation Focus Areas in the Piscataqua Region watershed. These areas represent the highest priority lands to conserve in order to protect clean water and highest quality wildlife habitat. PREP has established a goal of permanently protecting 75% of the lands in these focus areas by 2025. Of the 88,747 acres of existing conservation lands, more than half (45,869 acres) fall within the high-priority conservation focus areas. Overall, 28% of the focus areas have been conserved. This statistic demonstrates that the conservation focus areas have been a priority for land protection efforts but that the majority of these areas are still unprotected.

In recent years, less than one-in-five of the new conservation lands have been in high priority focus areas. The goal to conserve 75% of the focus areas will not be met unless the pace of conservation in these special areas increases.

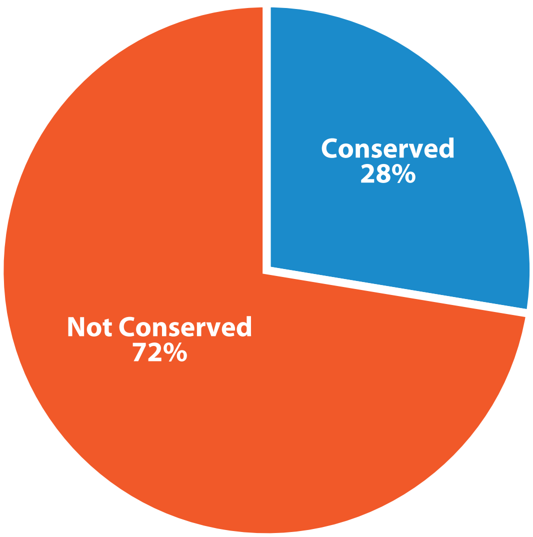
Why This Matters

Our region still contains exceptional unfragmented natural areas that support critical wildlife populations and maintain high water quality. There is a small window of time to protect these areas in order to ensure these benefits remain for future generations.

PREP GOAL **Conserve 75% of lands identified as Conservation Focus Areas by 2025.**

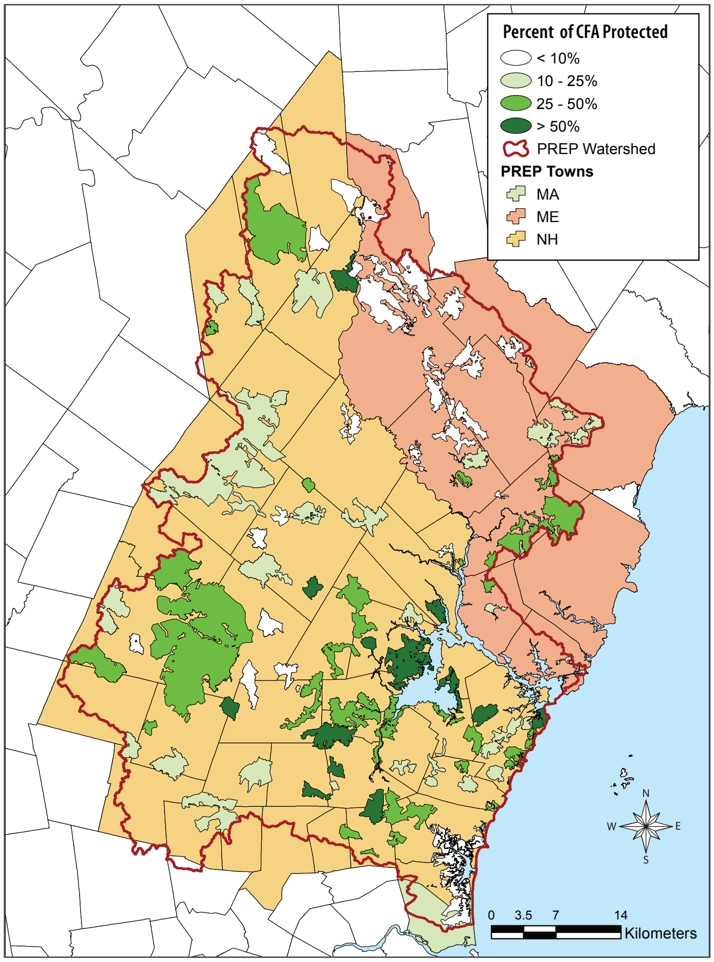
Goose in Marsh. Photo by C. Keeley

FIGURE 17.1 Percent of core priority areas in the Piscataqua Region that are conserved in their natural state



Data Source: NH GRANIT and Wells National Estuarine Research Reserve

FIGURE 17.2 Percent of each Core Priority Area in the Piscataqua Region that is conserved in its natural state



NH GRANIT & Wells National Estuarine Research Reserve

Isinglass River, Strafford, NH. Photo by D. Sowers

Success Story

Conserving Top Priority Conservation Land and Building a Town Forest The Town of Fremont, NH is working to add 76 more precious acres to their existing 313 acre Glen Oakes Town Forest while permanently protecting the Spruce Swamp Conservation Focus Area. This area contains highest quality wildlife habitat in the state and exceptional trails for public access. Protection of this special natural area will ensure that the wetlands there continue to provide clean water to both the Lamprey and Exeter Rivers that flow to the Great Bay Estuary.

Oyster Restoration

How much oyster restoration has been done?

Imported clam shell is deposited to settle on the bottom and make a reef for new oysters to grow on at the mouth of the Oyster River. Photo by D. Kellam

A total of 12.3 acres of oyster beds have been created in the Great Bay Estuary, which is 61% of the goal. Mortality due to oyster diseases is a major impediment to oyster restoration.

EXPLANATION Nine oyster restoration projects have been completed in the Piscataqua Region watershed since January 1, 2000. As a result of these projects, a total of 12.3 acres of oyster bed has been restored, representing 61% of the goal of 20 acres (Figure 18.1). Restoration projects start by the setting of disease-resistant oyster seed called spat then planting the settled spat to an artificial reef on the estuary floor. High mortality was reported for some of the restoration sites. However, the restoration work still created an oyster reef structure by installing cultch or other materials on which spat could settle. Additional information about oyster restoration in New Hampshire is available from www.oyster.unh.edu. A major impediment to oyster restoration efforts in the Great Bay Estuary is the ongoing oyster mortality due to MSX and Dermo infections in native oysters. Inconsistent year spatfall is another limiting factor.

This indicator tracks restoration effort in terms of acres for which restoration was attempted. The area of successful, functioning habitat created by restoration projects may be lower.

Why This Matters

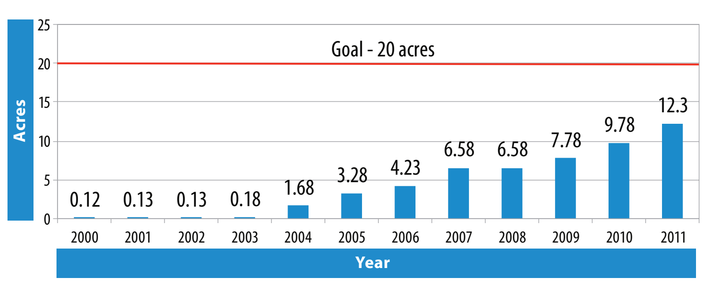
Oysters grow in concentrated groups, called beds, in areas with hard bottom. Historic data has documented that the amount and size of oyster beds in the Piscataqua Region watershed have been decreasing or lost over time. Restoration efforts attempt to restore the abundance and function of these critical habitats.

PREP GOAL Restore 20 acres of oyster reef habitat by 2020.

Success Story

Oyster Shell Recycling The Coastal Conservation Association of NH works with eight area restaurants to help restore oysters to Great Bay. Weekly, CCA volunteers pickup discarded oyster shells after they've been happily slurped by customers. Shells are then recycled back to the bottom of Great Bay to give growing oyster spat or seed a place to grow at restoration sites.

FIGURE 18.1 Cumulative acres of oyster restoration projects, 2000-2011



Eelgrass Restoration

How much eelgrass restoration has been done?

Measuring eelgrass height at a restoration site in Great Bay. Photo by J. Carroll

A total of 8.5 acres of eelgrass beds have been restored which is only 17% of the goal. Poor water quality is often the limiting factor for eelgrass transplant survival.

EXPLANATION Several eelgrass planting projects have been completed since January 1, 2000. A small, community-based project was attempted in North Mill Pond in 2000. Eelgrass was transplanted in over twenty wooden planting frames. The total area covered by the project was 0.5 acres. None of the transplants survived due to the water not being clean enough. In 2001, an eelgrass replacement project for the US Army Corps of Engineers was completed in Little Harbor. Eelgrass was transplanted and covered 5.5 acres. The restoration was monitored for one year following the transplant and found to be successful. However, because the purpose of this project was to replace eelgrass beds that were destroyed, it was not counted toward the PREP goal. In 2005, eelgrass was transplanted to locations in the Bellamy River (1 ac.) and Portsmouth Harbor (0.25 ac.). In 2006-2008, a total of 6.8 acres of eelgrass was restored in the Bellamy River. The project was funded by the Natural Resource Conservation Service. Therefore, since 2000, 8.5 acres of eelgrass restoration projects have been completed (16% of the goal) (Figure 19.1). Prior to 2005, no state or federal money was available for eelgrass restoration.

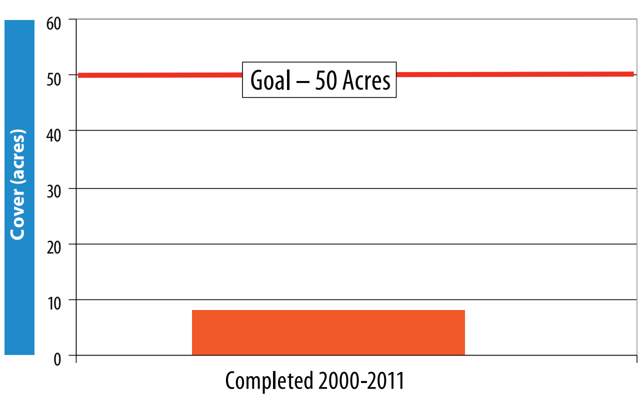
This indicator tracks restoration effort in terms of acres for which restoration was attempted. The area of successful, functioning habitat created by restoration projects may be lower.

Why This Matters

Eelgrass grows in meadows on the floor of the estuary and provides important habitat for young fish, lobsters and mussels. Historic data suggests that eelgrass meadows in the Piscataqua Region watershed have been thinning or lost over time. Restoration efforts attempt to restore the coverage and function of this critical habitat.

PREP GOAL **Restore 50 acres of eelgrass habitat by 2020.**

FIGURE 19.1 **Cumulative acres of eelgrass restoration 2000-2011**



Migratory Fish Restoration

How much river restoration for migratory fish has been done?

Alewife photo by: B. Gratwicke www.dcnature.com

River herring access has been restored to 42% of their historical distribution within the mainstems of the major rivers in the Piscataqua Region. This represents substantial progress in meeting PREP's goal of restoring 50% of the historical distribution of river herring by 2020.

EXPLANATION Major efforts are underway to restore river herring access to their historical freshwater streams and ponds in order to support recovery of their populations. Figure 20.1 shows the miles of freshwater in the main branch of each major river that was historically accessible to herring, and how many miles of that habitat are currently accessible. There is 100% access to main-stem sections of the Winnicut, Exeter, and Cocheco Rivers but less than 30% access in all other rivers. Overall, river herring access has been restored to 42% of their historical distribution within the main stems of the region's major rivers (Figure 20.2). This represents substantial progress in meeting PREP's goal of restoring 50% of the historical distribution of river herring by 2020.

Winnicut River Fish Passage, Greenland, NH. Photo by: C. Lentz.

Why This Matters

Dams and road crossings of streams often block migratory fish from swimming upstream to reproduce and safely downstream to grow in the estuary and ocean, limiting their populations.

PREP GOAL **Restore native diadromous fish access to 50 percent of their historical mainstem river distribution range by 2020.**

FIGURE 20.1 Mainstem stream miles accessible to river herring in major rivers of the Piscataqua Region

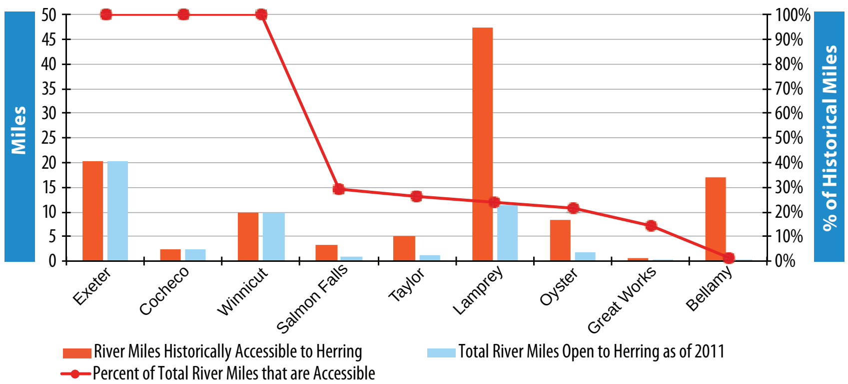
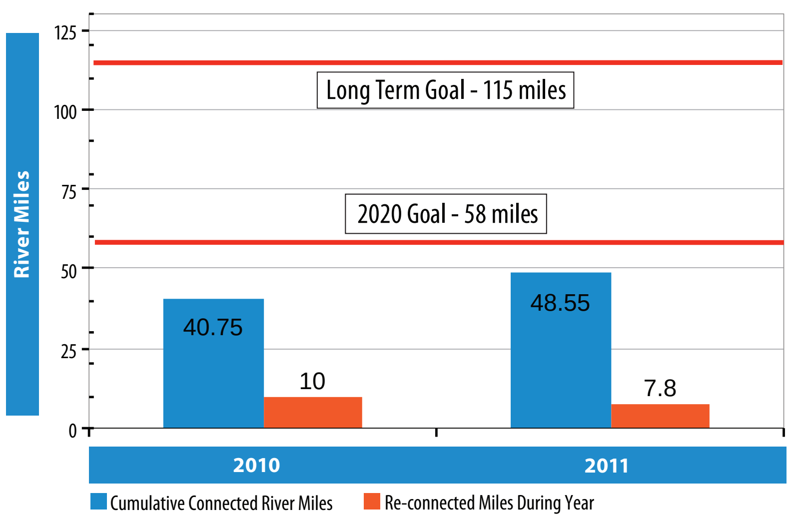


FIGURE 20.2 Upstream river miles re-connected for migratory herring on the mainstems of major rivers



Newly installed Wiswall Fish Ladder on the Lamprey River, Durham, NH. Photo by D. Cedarholm

Success Story

Returning Fish after 200 Years

Thanks to leadership from the Town of Durham, the USDA Natural Resource Conservation Service, and the New Hampshire Fish and Game Department, migratory fish from the Great Bay Estuary are now swimming upstream to habitat in the Lamprey River that they have been blocked from reaching for over 200 years. Access to at least 7.8 miles of the Lamprey River was restored by constructing a fish passage ladder over the Wiswall Dam in Durham, with initial estimates of 14,000-26,000 fish getting past the ladder in the first year.

EMERGING ISSUES & CHANGING CONDITIONS

Estuaries are complex and responsive to factors both within, and outside of, our control. By definition, an environmental indicators report is not intended to determine cause and effect. The causes of some environmental changes can be numerous, and directed research is sometimes required to better understand how the estuaries respond to stresses like pollution and losses of key habitats.

This report provides a summary of results from an extensive suite of environmental monitoring data collected and analyzed by PREP and its partner organizations. However, PREP also recognizes that there are emerging issues not fully described in this report or reflected in our current indicators that are likely to impose additional challenges to the health of our estuaries. This section of the report acknowledges some of these pressing emerging issues that are likely to need more research, monitoring, and analysis attention in the near future.

Autumn Marsh. Photo by C. Keeley

Weather and Climate

The most influential emerging issue is the fact that New England's climate is changing, and the best available scientific information indicates that climate change impacts such as sea level rise, temperature increases, and more frequent severe storm events are highly likely to continue to increase throughout the next century. These major changes to climate and weather events will substantially affect water quality, wildlife habitat, and human communities in unprecedented ways. One of the implications is that more erratic and extreme weather is to be expected and that assessing the health of our estuaries based on assumptions of historical weather and climate patterns can be misleading. Climate change impacts are likely to contribute additional stress to coastal habitats that we are working to conserve and restore. For instance, increased rainfall can transport additional contaminants such as sediments and nutrients into our estuaries. Climate change is also likely to substantially change the temperature, saltiness, and acidity in our estuaries and thereby modify many of the natural chemical and biological processes in the bays. Exactly how these changes will affect coastal habitats, shellfish, water quality, and human health is uncertain – but it is certain that they will have an important influence over the future State of Our Estuaries. To learn more about these issues refer to the 2011 report "Climate Change in the Piscataqua/Great Bay Region: Past, Present, and Future" (www.carbonsolutionsne.org).

Macroalgae

Recent major research efforts have been completed to inventory the types of macroalgae present in the Great Bay estuary, assess their abundance, and map their coverage in the bay. These efforts have led to recognition that a substantial increase in the abundance of nuisance macroalgae is an emerging problem for the bay and that increased monitoring and research effort is needed to better understand this issue.

Aquaculture

There is substantial interest in the region about the potential to responsibly develop shellfish and algae aquaculture within or adjacent to our estuaries as a way to help remove excess nutrients from the water column while also producing valuable commodities. The environmental, social, and economic costs and benefits of aquaculture scenarios is a topic of current and ongoing research interest.

Pharmaceuticals and Personal Care Products

Thousands of chemicals from pharmaceuticals and personal care products used by humans (such as prescription drugs and cosmetics) end up in sewage waste, are insufficiently removed by conventional treatment systems, and inevitably enter our nation's waterways. These chemicals have been documented in many waterways that have been studied, and some research suggests that certain chemicals may cause ecological harm. Potential negative impacts on our region's waterways are largely unknown at this time.

Did You Know

The US Drug Enforcement Administration has hosted five successful National Drug Take-Back Days over the last two years. The most recent event in September 2012 resulted in 244 tons of prescription medication being safely disposed. Citizens are able to return unused or expired prescription drugs to their local police station or other location to be sure they are disposed of properly keeping them out of our environment.

Visit www.deadiversion.usdoj.gov/drug_disposal/takeback to find out when the next take-back day is scheduled.

LOOKING AHEAD: DATA, MONITORING, AND RESEARCH NEEDS

Both prior to and during the development of this report, one theme that emerged was the critical need for more data collection and research on critical topics. As we work closely with our municipal, state, private, and university partners on collecting and analyzing data, it is well understood that more data is needed to help inform some of the critical questions that are being asked about our estuaries today. PREP has worked hard since the program began in 1995 to develop and implement a diverse Monitoring Plan that synthesizes and analyzes data about our estuaries. PREP is committed to working with our partners on securing resources to address data and research gaps in an effort to provide researchers, managers and the public with accurate scientific information needed to make management decisions pertaining to the health of our estuaries.

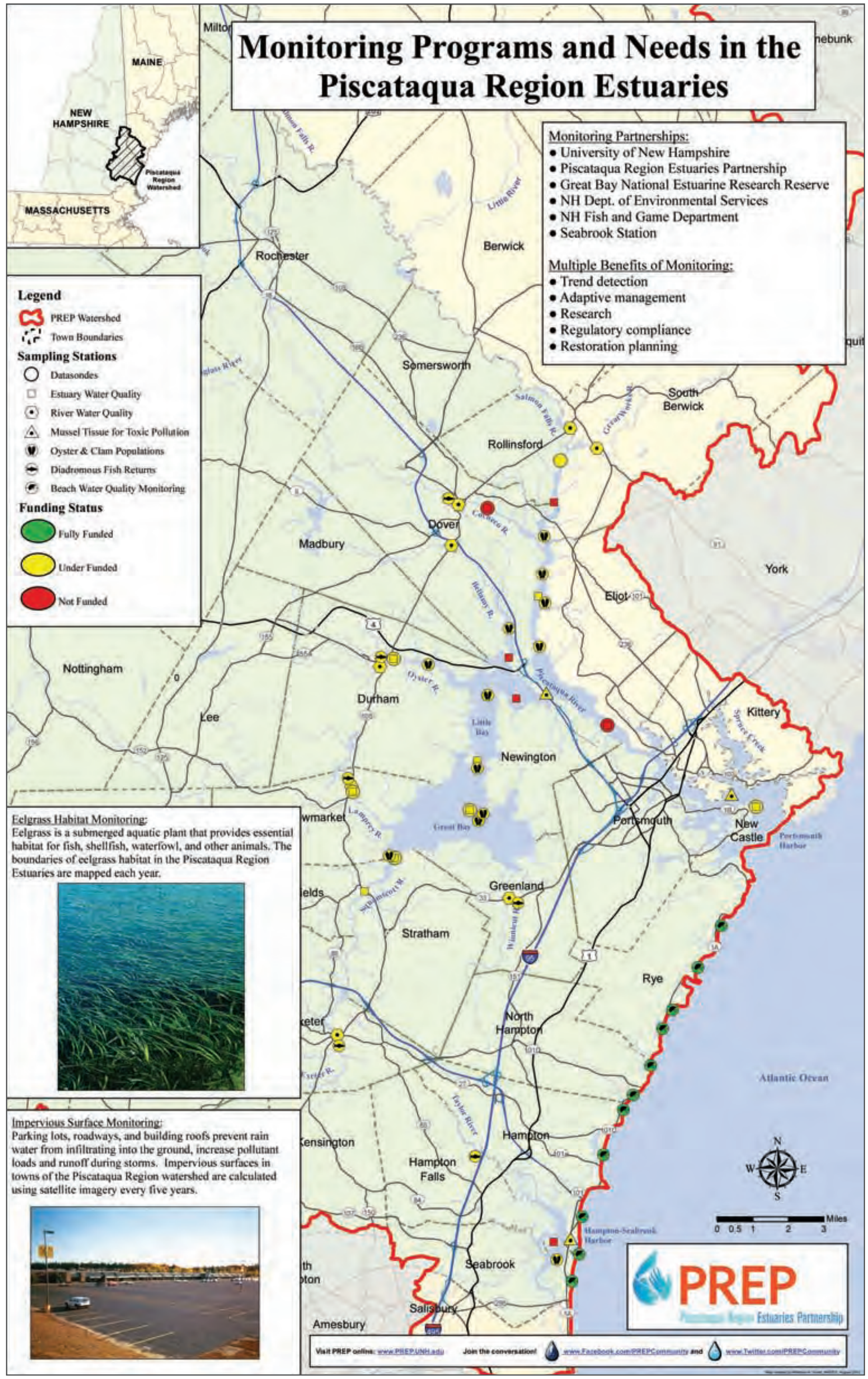
Monitoring Needs (Data Collection)

The Piscataqua Region estuaries have been monitored by the University of New Hampshire researchers, government programs, and volunteers for decades. However, at this crucial juncture the programs that monitor the health of the estuaries need to be upgraded to answer new questions and help inform management decisions. The current system of monitoring is a mosaic of programs with shrinking funds from different federal and state sources. There is an immediate need to add stations in a number of areas throughout the system.

Research Priority Themes

Over the next three to seven years there are a number of high priority research areas needing additional work. Given how a number of indicators interrelate with one another, themes that have been identified as priority include:

- **Oyster restoration and other economically beneficial, nutrient extractive technologies**
- **Integration and expansion of stormwater management strategies**
- **Macroalgae, including its extent, new invasive species, and relationship to nutrient-uptake**
- **Nutrient and other pollutant loads and concentration variations throughout the system**
- **Changes in climatic conditions and storm events, and their impact on pollutant loading, species shifts, marsh migration, coastal resiliency, and flooding**
- **Impacts of dams and other factors on anadromous fish**
- **Sediment concentrations, sources, transport and resuspension, and ecosystem impacts**
- **Ecosystem services within and surrounding the estuaries**
- **Emerging bacterial pathogens and toxin-producing microorganisms**



A commitment to, and the required support for, increased data collection and focused research will be critical to our collective success in answering important questions about the challenges in our estuaries.

CREDITS & ACKNOWLEDGEMENTS

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END NOTES

1. See CBP (2000), Cloern (2001), Bricker et al. (2007), Burkholder et al. (2007), and CENR (2010)
2. See Bricker et al. (2007) and Diaz and Rosenberg (2008)
3. See Bricker et al. (2007), Diaz and Rosenberg (2008), and Nixon et al. (2005)
4. See Cloern (2001), Bricker et al. (2007), CERN (2010), Mathieson (2012), Valiela et al. (1997), Hauxwell et al. (2001), and McGlathery (2001)
5. See Fox et al. (2008) and Pedersen and Borum (1996)
6. See Chock and Mathieson (1983) and Hardwick-Witman and Mathieson (1983)
7. See Nettleton et al. (2011)
8. See Nettleton et al. (2011), page 82
9. See Pe'eri et al (2008)
10. See NRC (2000), Cloern (2001), Bricker et al. (2007), EPA (2001), Diaz and Rosenberg (2008)
11. See Diaz and Rosenberg (2008), Cloern (2001), and Bricker et al. (2007)
12. See Pennock (2005)
13. See HydroQual (2012)
14. See Short and Short (1984)
15. See Duarte (2001) and Heck et al. (2003)
16. See Morrison et al. (2008)
17. See Burkholder et al. (2007)

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A short guide for municipal leaders and legislators that provides a short list of priority policy options for consideration and model efforts from our own communities.

A short guide for citizens that has examples and tips on simple things everyone can do to help prevent pollution and protect the places we love.

Attachment C

TS 3-5 Once it is completed, provide Mr. Raphael's analysis of the visual impact of the concrete mats in Little Bay at low tide.

Response: The Applicant is in the process of reviewing potential impacts associated with the concrete mattresses in Little Bay at low tide and will provide the results when complete. The Applicants anticipate that such an analysis will be completed and submitted to the Site Evaluation Committee and SEC Distribution List around July 17, 2017.

Visual Assessment of the Proposed Concrete Mattresses for the Submarine Transmission Cable across Little Bay

The Visual Assessment (VA) for the Seacoast Reliability Project ("Project") dated April 2016 concluded that the overall visual sensitivity to change for Little Bay was moderate. This conclusion was based on the methodology employed in the Visual Assessment (set forth on pages 5 through 31 of the VA) and remains unchanged. This methodology identified scenic resources with potential Project visibility and those resources included Little Bay and Little Bay Channel. On page 53 of the Visual Assessment all scenic resources with potential visibility were analyzed for their "Cultural Designation" and "Scenic Quality". In both these categories, the determination was that there was moderate sensitivity with regard to cultural and scenic values. Resources with moderate sensitivity are not analyzed further—only those with moderate to high or high sensitivity are analyzed in the next step of the methodology, which assesses visual effect and viewer effect. Given that the analysis concluded that the Little Bay resource had only moderate sensitivity, LandWorks determined that the proposed elements described herein and associated with the Project did not rise to a level of concern where the Project would result in an unreasonable adverse effect on aesthetics in the Project area. Nonetheless, LandWorks prepared a narrative as well as photographs and visual simulations that support the review of Project effects on Little Bay and users of that water resource. The LandWorks review concludes that the Project as proposed would be acceptable due to the presence of existing development, the lack of outstanding or unique characteristics associated with the channel, and the fact that the transmission facility was already established across the channel. These factors contributed to the finding that the change associated with the transmission upgrade would not be dramatic and would not substantively affect any users and their boating and recreational activities along this portion of Little Bay. This analysis and its conclusions are set forth on pp. 97 through 101 of the Landworks VA.

This current assessment reviews the Applicant's proposal to install concrete "mattresses" to protect the cables in nearshore areas where ledge precludes burial to full depth. This proposed component of the Project was not included in the initial analysis, because use of concrete mattresses had not yet been determined to be an essential element of the Project. Based on this current analysis of the proposed concrete mattress installations, it has been determined that the conclusion forwarded in the initial assessment is still valid, and that the concrete mattress installation as designed will not result in an unreasonable effect on aesthetics or scenic beauty of the Project area.

Description of the Specific Project Elements

As part of the installation of the underwater cable for the Seacoast Reliability Project, protective elements referred to as "concrete mattresses" may be installed on either side of Little Bay at that point at which the cables transition from the shoreline to the underwater installation. In the shallow areas of the Bay edges, typically referred to as Tidal Flats, these concrete elements will be placed to protect the cables where they are very shallow in the seafloor in this transition zone. The concrete mattresses are typically mats of interconnected individual precast concrete forms that conform to the bottom contours of the seafloor. Individual mattresses are typically 8' x 20' and 4.5-9" thick. On the Durham side the starting width is 24 feet (3 mattresses wide) and it widens to about 30 feet over a distance of approximately 102', which will take 5 mattresses end to end for each of the 3 sections. On the Newington side, the configuration is also 3 mattresses in width to start, overlapping at the start point along the shore to have a 16' width and ending at 34' in width over a distance of approximately 214 feet.

It is our understanding that the Applicants are in the process of finalizing the details and extent of the concrete mattress installation; the information relied on for this assessment may change slightly. At each shoreline there will be a short section of concrete mattress installation that will be placed on the slope of the bay floor before the seabed flattens out, resulting in potential visibility of about 34 feet of the installation on the Durham side, and 50 feet on the Newington side of the Bay. The location for the mattresses and their lengths and widths, as well as how they will relate to seabed contours have been based on discussions with the Project team and contractors, as well as on plans provided in the "Seacoast Reliability Project Amended Environmental Maps" developed by Normandeau

Associates and dated 3-8-17.

Analysis of Proposed Installation

LandWorks conducted a site visit on June 29, 2017 to the Project Area for the expressed purpose of reviewing the locations for the concrete mats and to assess their potential visibility and the effects of that visibility. The site visit was conducted at low tide, and observations made from the Durham shore, just off shore, from the mudflats beyond the shore, and from the navigable channel at low tide. Observations of the Newington transition area and concrete mat location were conducted from the channel. This site visit was also informed by previous visits to this portion of the Project area.

A number of distinct observations and conclusions emerged from both the on-site study and a review of plans, profiles and aerial and site photographs of these 2 areas and they include:

1) Visibility and Viewing Distances at Low Tide.

The visible area of the concrete mattresses will be primarily just off the shoreline at the point where the mattresses begin and for the distance that mattresses are located on the initial slope coming off the shore. Each shoreline has a short distance of sloping seabed and then a more level expanse of seabed and tidal flats stretching out into the Bay. The sloped area will be where the mattresses will be most visible. On the Durham side, the actual area of visible mats will be limited to an expanse of approximately 24-28' wide and 34 feet long. Beyond the 34' sloping section the mats will be located along a more gradual, almost level expanse of the tidal flat. At that size and with the typical viewing distance in the middle of the channel at almost 2/3 of a mile (3315' from the shoreline) during low tide, these mats will be an unobtrusive element and even difficult to pick out. The closest view at low tide is at just under a 1/2 mile (2055') from the shore due to the presence of very shallow tide flats which stretch out that distance from the shore—so shallow that even kayaks would be unlikely to paddle to close to shore at low tide. At that vantage point of about ½ mile the mattresses will be difficult to even pick out and/or focus on.

On the Newington side, the area of visible mattresses will be approximately 16-18' by 60 feet in length before the mattresses lie flat on the seabed/tidal flat area, and below the water level at low tide. The center of the channel, where most boat traffic occurs at low tide, is just under ½ mile from shore at 2060'. As with the Durham side, the view of the mats from this distance will not result in an intrusion or visible element that will necessarily draw the eye and be prominent at all within that view.

Overall, in periods of low tide, paddlers on either side will not be drawn to the locations of the transmission corridor's transition to the underwater design. On both sides, there are areas of very shallow water which, even if navigable for kayaks or canoes would be difficult for paddling as the paddles will inevitably hit the bottom during the periods of lower tide. The navigable channel is closer to the Newington side, and yet not an ideal location for non-motorized watercraft to linger. Based on boating enthusiast's typical behaviors and observations on site and in the water, it was readily concluded that motorized and non-motorized watercraft will typically be too far away to be affected by the view of this relatively small scale element near to the shoreline. Additionally, motorized boat traffic is moving faster and in a direction that does not focus on or put the transition areas in the primary angle of view or cone of vision. The visual context, as described in the next section of this narrative, further diminishes the potential for negative effects on the visual quality or viewer's experience.

2) Characteristics of the View

As stated, the typical viewing distances at low tide will reduce the prominence and presence of the concrete mattresses in the view and reduce their visual effect. Other factors also contribute to the conclusion that the proposed concrete mattress installation will not be obtrusive or have any real negative effect to the viewscape of the Little Bay Channel. These factors include the nature of the view and the context of the view. The views of the two sites are to the side of the channel as opposed to being in the foreground or direct view of boaters and paddlers. Observations on several site visits indicated primarily north south traffic and the eye and the experience tend to be focused on points to the north and south rather than directly at the shorelines perpendicular to the view.

Additionally the context for the view is one of a developed and residential appearing shoreline, with larger homes, extensive clearings and numerous docks and shoreline elements such as outdoor furniture (See Exhibits 21A and 22A which accompany this review). This is not a pristine shore on either side. There are no distinctive landscapes or scenic elements that are unique or constitute a draw for boaters (and most of the land in this section appears to be privately owned on both shores – Adams Point and Great Bay National Wildlife Refuges are located to the south of this section of Little Bay). When directly opposite the Project ROW along the Durham shore, the view takes in the presence of the transmission infrastructure that has been well established, with the Cable House and existing transition structure readily visible. These existing elements and the aforementioned docks, shoreline rocks and bedrock, and other objects such as boats, lounge chairs and landscape components provide a visual pattern which can readily accommodate the proposed mattresses and their limited visibility.

3) Viewer Effect

The foregoing narrative highlights how the visibility of the concrete mattresses will be limited, and how the small scale of and minimal presence of the visible portion of the mattresses, when viewed from the water, will limit the visual effects. These factors translate directly into a limited effect on the viewer as well—one that will not undermine the viewer's enjoyment to any great extent, and one that will not discourage people from boating in this portion of Little Bay. Given the long established presence of the underwater transmission cables and the associated structures and Cable Houses on the shore, there already is an established expectation related to the infrastructure, and this new element is not a substantive change nor would it be a surprise to see another small scale element that is part of it.

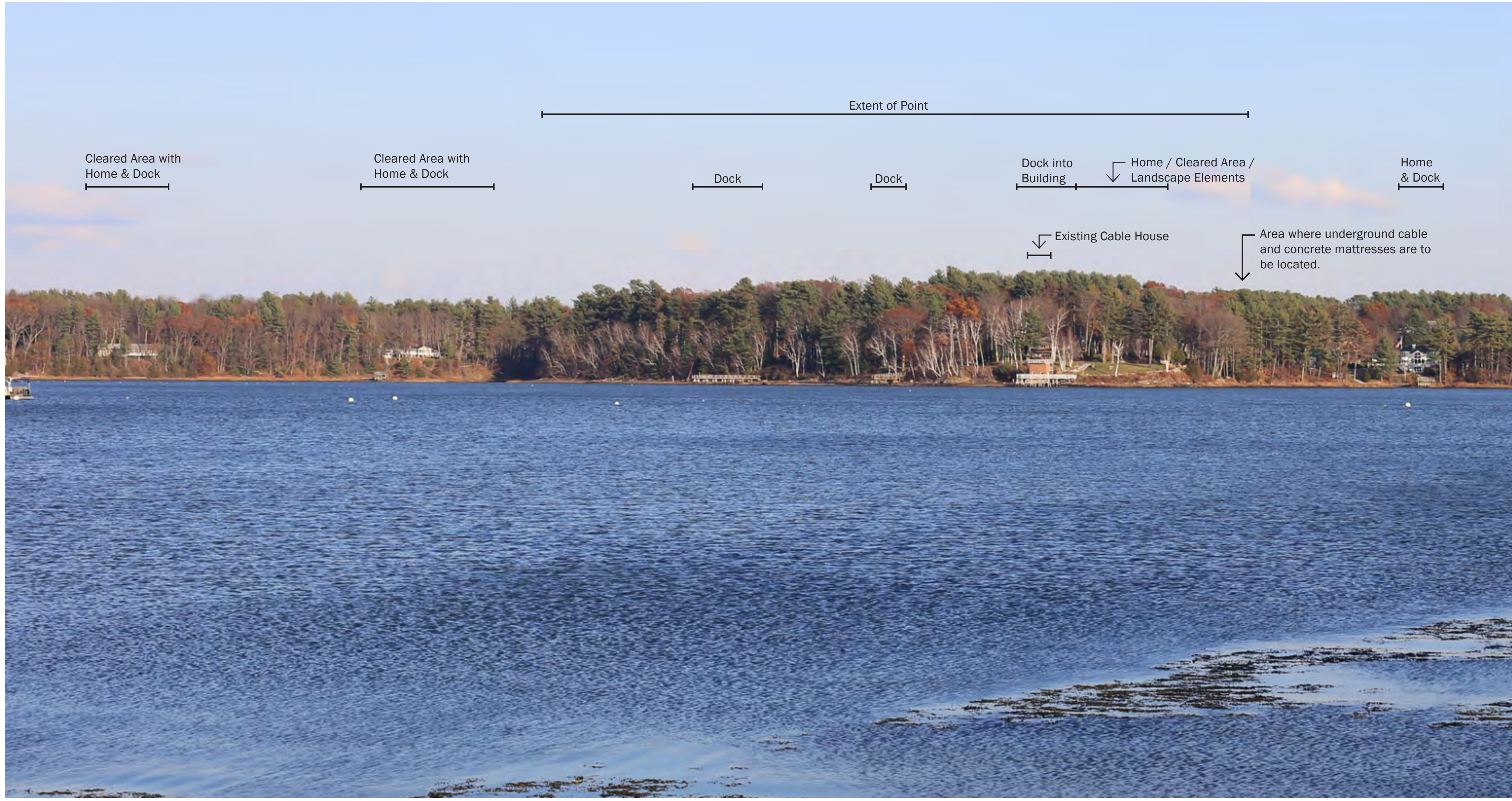
View duration is limited due to the fact that most boating activity in this portion of Little Bay tends to be moving north or south between the larger water body of Great Bay to the south and the variety of water destinations to the north, including Little Bay proper, the Piscataqua and Oyster Rivers and Royall's Cove. Given the north-south orientation of the channel there will be limited direct views of the installation. When heading south through the channel from Little Bay proper the Newington installation will not be visible due to the shoreline configuration – a point of land just to the north, where the old Cable House is located, obscures the new location for the land to water transition of the transmission lines. It will not be visible until boaters are to the south of it. The configuration on the Durham side may also limit visibility for those boating or paddling from the north and the south, until one is more directly opposite the installation.

4) Mitigation

The concrete mattresses will also include some inherent mitigating factors. It is likely the mats will sink into the muck of the tidal flats which is an elastic material that has a "quicksand-like" effect if walked upon, or when objects are placed on it when the mud is exposed. Additionally, the color of the concrete surfacing is expected to fade and become grey over time due to the natural weathering process, the deposition of sediments and the action of the salt water tides. Limiting the size and scale of the mattress installation represents another mitigating factor.

Overall Conclusion

The concrete mattresses will not draw the eye to any great extent, and they will not be a substantive intrusion into the visual landscape. Due to their limited size, their minimal visual presence and the fact that they will readily fade into and become part of the surrounding shoreline and waterscape, the concrete mattresses will be a very minor feature of the landscape and will only minimally affect the viewer's experience of the water, the bay, and the views to the shoreline. The conclusions reached initially in the VA, which determined that Little Bay has moderate sensitivity as a scenic resource, remain unchanged. The addition of this element along the shoreline in Durham and Newington will not result in a substantive visual effect or negative impact on the viewer's experience and enjoyment, or ongoing and future use of this resource. **Thus the proposed placement of the concrete mattresses will not result in an unreasonable adverse effect on aesthetics of the Project area.**

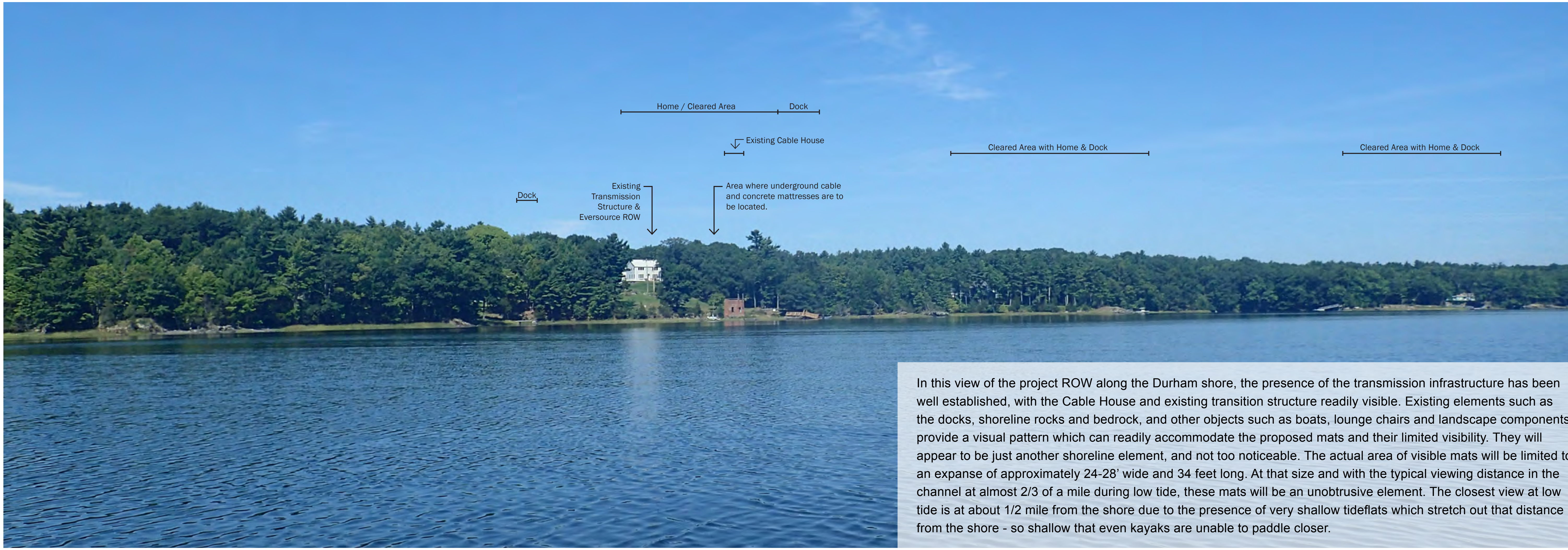


The purpose of this exhibit is to demonstrate that the existing development and specific structures along and near to the shoreline create a visual pattern that will not be undermined or altered by the visibility of a short section of concrete matting as proposed in this location. There are an extensive number of human elements, light colored structures and even buoys and moorings that provide a context within which the proposed concrete mats can be visually accommodated without drawing attention to them, or creating an unacceptable visual change in this landscape.

Aerial Context Map with approximate ROW location

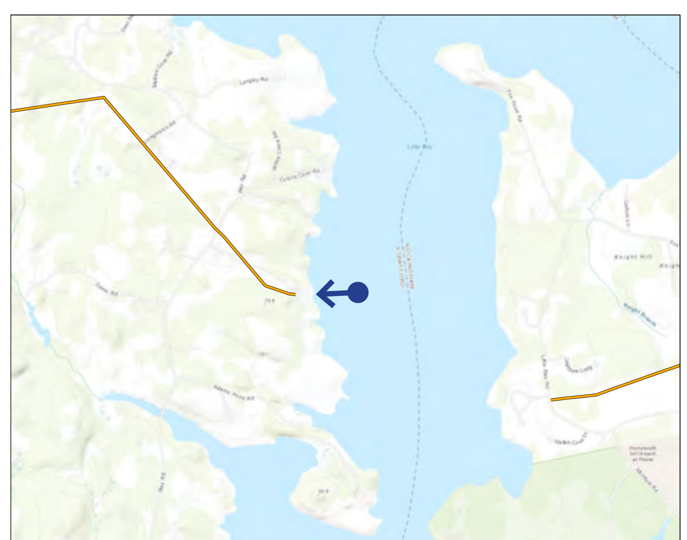
View Location Map

Prepared by **LandWorks**, Middlebury, VT
Prepared for Eversource



In this view of the project ROW along the Durham shore, the presence of the transmission infrastructure has been well established, with the Cable House and existing transition structure readily visible. Existing elements such as the docks, shoreline rocks and bedrock, and other objects such as boats, lounge chairs and landscape components provide a visual pattern which can readily accommodate the proposed mats and their limited visibility. They will appear to be just another shoreline element, and not too noticeable. The actual area of visible mats will be limited to an expanse of approximately 24-28' wide and 34 feet long. At that size and with the typical viewing distance in the channel at almost 2/3 of a mile during low tide, these mats will be an unobtrusive element. The closest view at low tide is at about 1/2 mile from the shore due to the presence of very shallow tideflats which stretch out that distance from the shore - so shallow that even kayaks are unable to paddle closer.

Aerial Context Map with approximate ROW location



View Location Map

EXHIBIT 22A: LITTLE BAY, DURHAM (SHEET 1 OF 3)

View Location Map

0' 750' 1500'

Simulation Information

Base Photograph
Date: 6/29/17
Time: 1:27 pm
Weather conditions: Overcast
Image Size: 5472 x 3648 pixels

Camera Properties
Camera Make/Model: Canon EOS 6D
Sensor Dimensions: 35.8mm x 23.9mm
Lens Make/Model: Canon EF 50mm
Lens Focal Length: 50mm
Focal Length (35mm Equivalent): 52mm
Approx. Angle of View: 40° horizontal, 27° vertical
Camera Height: 3 ft (0.914 meters)

View Location Information
View Location Name: Exhibit 22A
Location: Little Bay, Durham, NH
Classification: Resource
Orientation: West/Northwest
Latitude/Longitude: 43.105557°, -70.866763°
Camera elevation above sea level: 3.00' (0.91 m)
Simulation viewing distance: 21.3 in (54.102 cm)
Distance to nearest visible structure: 0.25 miles (0.40 km)
Distance to furthest visible structure: 0.28 miles (0.45 km)

Proposed Structure Information
Visible structure type: Weathering steel monopole, 3-pole
Visible structure numbers: F107-100, F107-101
Height range of proposed transmission structures (visible): 70' (21.3 m)
Height range of existing transmission structures (visible): N/A
Visible area of concrete mattresses at Low Tide: Approx. 28'x34'
Right of way width: 100'

Visual Simulation Notes:
1. Visual simulation is based on GIS data available at the time from USGS National Elevation Data Set, Eversource and NH GRANIT. Data is only as accurate as the original source and is not guaranteed by LandWorks.
2. This simulation depicts structures, conductors, and technical equipment as well as visibility of any associated clearing.

Technical Information
Software: Nemetschek VectorWorks 2015; SketchUp Pro 8; Adobe Photoshop CS5
Digital elevation data source: USGS National Elevation Dataset (NED) 1/3 arc-second

Aerial Context Map

0' 200' 400'

Prepared by **LandWorks**, Middlebury, VT
Prepared for Eversource

EXHIBIT 22A: EXISTING CONDITIONS AT LITTLE BAY, DURHAM (SHEET 2 OF 3)

EXHIBIT 22A: VISUAL SIMULATION OF PROPOSED CONDITIONS AT LITTLE BAY, DURHAM (SHEET 3 OF 3)

Durham 1-8 When it was developing this Project did PNSH take into account the possibility of directional boring under Little Bay? If it did not, please explain why not. If it did, please explain why it rejected this option.

Response: The Project investigated the use of horizontal directional drilling ("HDD") as a means to cross Little Bay and retained firms familiar with large scale HDD to analyze the crossing of Little Bay. The use of HDD to cross Little Bay would have required drilling through quartzite rock with a bore diameter of over 40 inches exceeding 6,000 feet in length.

The quartzite rock under the bay is classified as portions of the Kittery and Eliot formations that contain quartzite rock with known compressive strengths up to 30,000 pounds per square inch ("psi"). The drilling process would have required drill units be placed on the east and west shores, drilling 24 hours a day for a period of three to six months to complete the drill. An HDD drill for electric cable requires the bore be sleeved with a plastic pipe. This pipe must be constructed outside the bore and pulled through as a solid piece. Assembly of the PVC sleeve would have required a setup area over 6,000 feet long. As an example, if this setup were done on the Durham side using the existing ROW, the PVC sleeve would have extended from the shore of Little Bay across Durham Point Road and across Longmarsh Road. Moreover, HDD would have required large set-up areas on both sides of the bay for puling and staging cable reels, typical setup areas are approximately 100 feet by 250 feet. This would have been a significant disturbance to project abutters.

Use of HDD also requires large quantities of a bentonite (clay) slurry which is used to coat and lubricate the drilled shaft. While the material is inert, containment procedures are required to prevent its spilling into the surrounding environment. The containment would have required large pools be established on both sides of the bay during the drill. A review of the geologic structure indicated the potential for fault lines in the bed rock under the bay. Drilling through the fault lines increases the possibility of the bore "fracking out," which could release the bentonite slurry across the bottom of the bay coating the sea floor.

Based on technical, environmental and abutter impacts identified during the bore analysis, PSNH did not select HDD as the method to cross Little Bay. Please also refer to the Pre-filed testimony of James Jiottis at pages 20 to 21 for a complete description of the methods considered for crossing Little Bay.

Witnesses Available for Cross Examination include: Jim Jiottis

CLF 1-16 Please describe, and produce all documents, information and communications related to, any alternatives to the proposed Little Bay crossing analyzed by Eversource, including but not limited to alternative routes in or around Little Bay, non-transmission alternatives, and alternative construction techniques, including but not limited to horizontal directional drilling.

Response: The Applicant objects to this question as it seeks information not relevant to the proceeding and therefore is not reasonably calculated to lead to the discovery of admissible evidence. RSA 162-H:7, V(b) requires the Applicant to "identify both the applicant's preferred choice and other alternatives it considers available for the site and configuration of each major part of the proposed facility and the reasons for the applicant's preferred choice." The Applicant has done that. See Application Section 301.03(h)(2) . Other hypothetical alternatives, or alternative projects, are not subject to consideration under RSA 162-H:7 (application requirements for a certificate) or 162-H:16 (findings required for issuance of a certificate) and therefore are not relevant. See also *Decision Granting Certificate of Site and Facility with Conditions*, Application of Laidlaw Berlin BioPower, LLC, NH SEC Docket 2009-02 (Nov.8, 2010) at 36–40 (finding that RSA 162-H does not require the subcommittee to review all "available alternatives" and does not require consideration of every possible alternative). Notwithstanding the objection, the Applicant responds as follows:

The review of a non-transmission alternative was performed as part of the ISO-NE process to select a solution. The Project was approved through the ISO-NE Transmission Planning Process. Please refer to the Pre-Filed Testimony of Robert D. Andrew. The Pre-Filed Testimony of Mr. Andrew references several studies, including the 2010 New Hampshire/Vermont Needs Assessment and ISO-NE Load Forecasts (CELT) report. Each study discusses the need and methodology for the study. Most of the data in these reports are Critical Energy Infrastructure Information ("CEII") and not available publicly. Please refer to Appendix 22A, New Hampshire 10 Year Reliability Project for a publicly available summary of the NH/VT Needs report which contains a discussion of load forecasts and demand response treatment. Additional detail of the ISO-NE Planning process can be found at https://www.iso-ne.com/system-planning/system-plans-studies.

As part of the ISO-NE study process alternative transmission projects were considered. In the case of the Seacoast Reliability Project, an alternative suite of solutions, which included a new autotransformer and substation in Newington, was thoroughly reviewed. Ultimately, the suite of projects including the new line from Madbury to Portsmouth was selected. Please refer to Mr. Andrew's Pre-Filed Testimony at page 5, which discusses alternative projects for the Seacoast NH Solutions. Much of the detail behind the project selection is CEII and not publically available. A redacted version of the January 18, 2012 ISO-NE PAC meeting discussing alternative projects is attached. Moreover, alternative proposals or non-transmission alternatives were included as part of the ISO-NE studies.

The ISO-NE Planning Advisory Committee (PAC) is charged with introducing project alternatives, including, transmission and non-transmission solutions, see Planning Advisory Committee (PAC) Process https://www.iso-ne.com/committees/planning/planning-advisory No non-transmission alternatives were proposed by any PAC member to address the Seacoast

Area identified problems.

Three route alternatives were also studied for the Project. These included a northern, middle and southern route along with variations of the selected middle route. Please see the Pre-Filed Testimony of James Jiottis beginning on page 4 which discussed the alternative routes and the process for their selection.

Alternative measures to cross Little Bay were considered. These included an overhead crossing, uses of a jet plow and use of horizontal directional drilling (HDD). Please see the prefiled testimony of James Jiottis, starting on page 20 for discussion of the design to cross Little Bay and the response to Durham question 8.

Witnesses Available for Cross Examination include: Robert Andrew and James Jiottis

TS 2-5 Please provide a complete copy of all presentations and documents from your subcontractors, Mears and W.A. Chester, pertaining to the feasibility of Horizontal Directional Drilling (HDD) under Little Bay.

Response: The Applicant objects to the question as it seeks information not relevant to the proceeding and therefore is not reasonably calculated to lead to the discovery of admissible evidence. The Applicant further objects as the question is vague and ambiguous. The Applicant also objects to this question to the extent it seeks information that is protected by the attorney client privilege and/or attorney work-product privilege. *See* RSA 541-A:33, II ("Agencies shall give effect to the rules of privilege recognized by law."). *See also* N.H. R. Evid. 502 (Lawyer-Client Privilege); N.H. R. Prof. Conduct 1.6 (Confidentiality of Information). To the extent this data or document request seeks to obtain prior drafts, notes, or edits of any expert or consultant report, drawings, diagrams, photosimulations, or any other information contained in the Application, pre-filed testimony, and attached appendices, the Applicants object as the request is unduly burdensome, duplicative, irrelevant and not likely to lead to admissible evidence, and is protected as work-product pursuant to state and federal law. *See* RSA 541-A:33 (stating that the "presiding officer may exclude irrelevant, immaterial or unduly repetitious evidence" and providing that "[a]gencies shall give effect to the rules of privilege recognized by law"); RSA 516:29-b (requiring a witness retained or specifically employed to provide expert testimony to only disclose "the facts or data considered by the witness in forming the opinions"), which was recently amended to remove the requirement that an expert disclose such "other information" and to make the New Hampshire expert disclosure law consistent with recent amendments to Fed. R. Civ. Pro. 26, which explicitly protects prior draft reports from experts). *See also* Fed. R. Civ. Pro. Rule 26(b)(4)(B) (protecting drafts of any report or disclosure required under the general witness disclosure rules regardless of the form in which the draft is recorded).

Notwithstanding the objections, please see the attached documents.

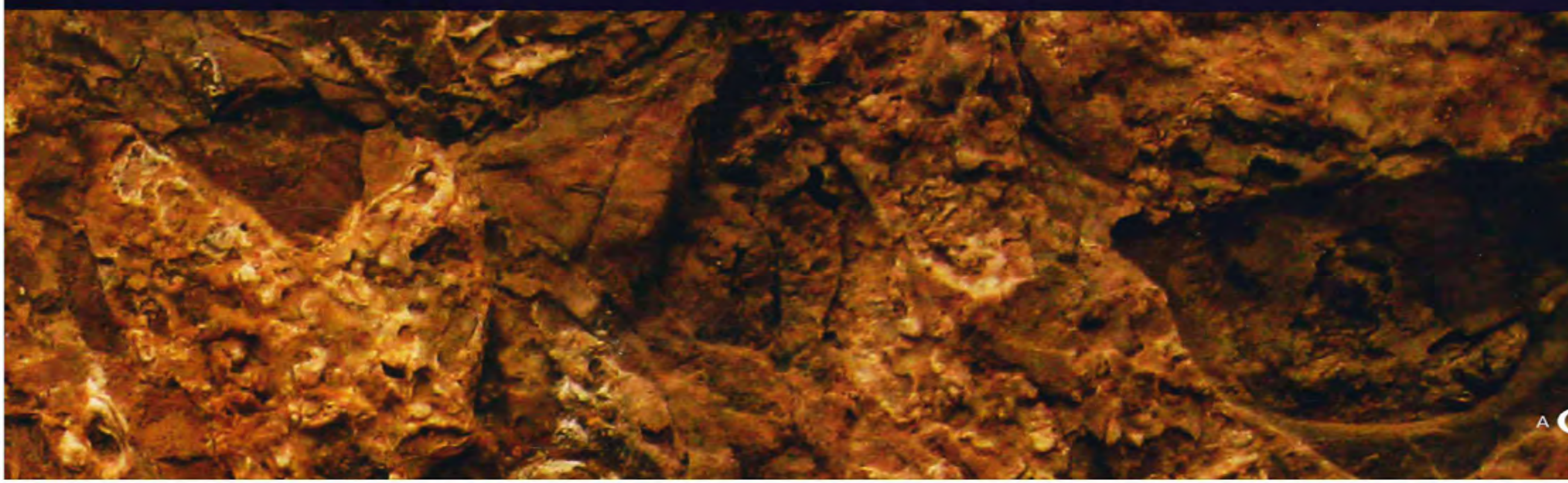
1. Mears HDD Model
2. Mears HDD Presentation for Northeast Utilities
3. Mears HDD Hand-out
4. WA Chester HDD Presentation

TS 2-6 Please provide all Eversource/PSNH Internal documents regarding the feasibility of HDD under Little Bay.

Response: The Applicant objects to the question as it seeks information not relevant to the proceeding and therefore is not reasonably calculated to lead to the discovery of admissible evidence. The Applicant further objects as the question is vague and ambiguous. The Applicant also objects to this question to the extent it seeks information that is protected by the attorney client privilege and/or attorney work-product privilege. *See* RSA 541-A:33, II ("Agencies shall give effect to the rules of privilege recognized by law."). *See also* N.H. R. Evid. 502 (Lawyer-Client Privilege); N.H. R. Prof. Conduct 1.6 (Confidentiality of Information). To the extent this data or document request seeks to obtain prior drafts, notes, or edits of any expert or consultant report, drawings, diagrams, photosimulations, or any other information contained in the Application, pre-filed testimony, and attached appendices, the Applicants object as the request is unduly burdensome, duplicative, irrelevant and not likely to lead to admissible evidence, and is protected as work-product pursuant to state and federal law. *See* RSA 541-A:33 (stating that the "presiding officer may exclude irrelevant, immaterial or unduly repetitious evidence" and providing that "[a]gencies shall give effect to the rules of privilege recognized by law"); RSA 516:29-b (requiring a witness retained or specifically employed to provide expert testimony to only disclose "the facts or data considered by the witness in forming the opinions"), which was recently amended to remove the requirement that an expert disclose such "other information" and to make the New Hampshire expert disclosure law consistent with recent amendments to Fed. R. Civ. Pro. 26, which explicitly protects prior draft reports from experts). *See also* Fed. R. Civ. Pro. Rule 26(b)(4)(B) (protecting drafts of any report or disclosure required under the general witness disclosure rules regardless of the form in which the draft is recorded).

Notwithstanding the objections, please see the Applicant's response to number 2-5 above.

HORIZONTAL DIRECTIONAL DRILLING



mears

A QUANTA SERVICES CO


CAT

WE DO MORE THAN JUST DRILL

The Mears reputation as a leading horizontal directional drilling (HDD) company has been earned by working hard and smart for our customers, gaining their confidence in our capabilities by completing complex and innovative projects. Our professional construction and engineering teams have experience, expertise and ingenuity that is well-known to the oil and gas, electrical and water/wastewater industries.

Mears is part of a professional network of companies under Quanta Services, Inc. (a Fortune 500 Company). As part of this network, Mears is able to provide customers with the nation's largest pool of skilled workers, equipment and specialized services to deliver infrastructure solutions to the power and pipeline industries all across the world.

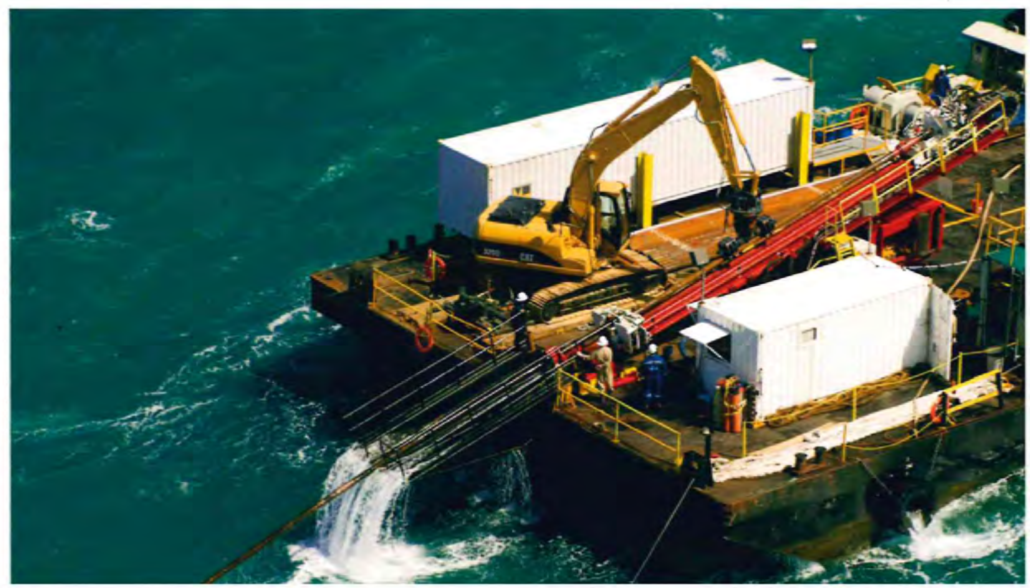
HORIZONTAL DIRECTIONAL DRILLING

Changing regulations, safety and quality standards and environmental concerns are an ever-present challenge to pipeline, power and utility companies responsible for installing and maintaining pipelines, cables and conduits. Led by a team of in-house engineers, project managers, steering technicians, international logistics and field personnel, Mears navigates the concerns of our customers through even the most complex projects.

With support from our Certified Equipment Managers, our fleet of horizontal directional drilling rigs and support equipment can complete projects with pipe diameter up to 60-inches, and our drilling capabilities include continuous lengths of over 11,000 feet.

Our experience also includes:

- Conventional HDD Crossings
- Marine Crossings (Water-to-Water and Shore Approaches)
- Hard Rock Drilling
- Design/Build
- Engineering, Procurement and Construction



MEARS' COMMITMENT TO SAFETY, QUALITY & ENVIRONMENT

Our **Safety Management System (SMS)** has allowed Mears to maintain the highest standards in health and safety, and it is our company policy to provide and maintain safe and healthy conditions for all employees, customers and the public. Our commitment to safety is at the core of our company values and forms a foundation for operational excellence. The **OHSAS 18001:2007** standard has elevated our safety practices to an even higher level for our employees and customers.

Mears' **Quality Management System (QMS)** is thoroughly designed and implemented to ensure client expectations and needs are exceeded. Guided by the **ISO 9001:2008** standard, Mears Group monitors and documents quality performance, effectiveness and compliance.

Additionally, our maintenance program, run by AEMP Certified Managers (CEMs), helps reduce downtime on projects and increases overall productivity by keeping equipment in optimum running condition.

The **Environmental Management System (EMS)** was established to strengthen Mears' commitment to protecting the environment by conducting our business operations in an environmentally responsible and sustainable manner. We recognize that by reducing and, when possible, eliminating waste, the environmental impact of our activities is significantly decreased.

To further our commitment to protecting the environment, Mears attained the **ISO 14001:2004** certification, and continues to place the value of environmental management as central to our corporate success.

DESIGN/BUILD

At Mears, we offer our clients the opportunity to have their project designed and built as one turnkey operation. Benefits of design/build project delivery include:

- Reduced owner risk
- Shortened project schedules
- Single point of contact
- Increased cooperation
- Reduced owner resources
- An environment of design and construction innovation

ENGINEERING, PROCUREMENT & CONSTRUCTION

Mears' engineering, procurement and construction (EPC) services provide a single source of contact and responsibility to our clients, saving them time and money. Through our EPC process, Mears' engineers, construction teams and subcontractors can communicate clearly and consistently with each other, ensuring that informative and collaborative decisions are made throughout the project. Additionally, having a single source of responsibility on a job enhances the safety and productivity of the project.

mears

A QUANTA SERVICES COMPANY

MEARS GROUP, INC. - HORIZONTAL DIRECTIONAL DRILLING

2800 Post Oak Blvd., Ste. 3010
Houston, TX 77056
281-448-2488
www.mears.net

Certified in Safety, Quality, and Environmental: OHSAS 18001:2007, ISO 9001:2008 and ISO 14001:2004

mears
Mears Group, Inc.
A QUANTA SERVICES COMPANY

Gregory J. Bosch
HDD Division

2800 Post Oak Blvd., Suite 3010
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U.S.A.

281 448-2488 **phone**
281 448-2523 **fax**
630 432-3193 **cell**

greg.bosch@mears.net **email**
www.mears.net **website**

ISO 9001:2008 Certified Company

NYSE – PWR

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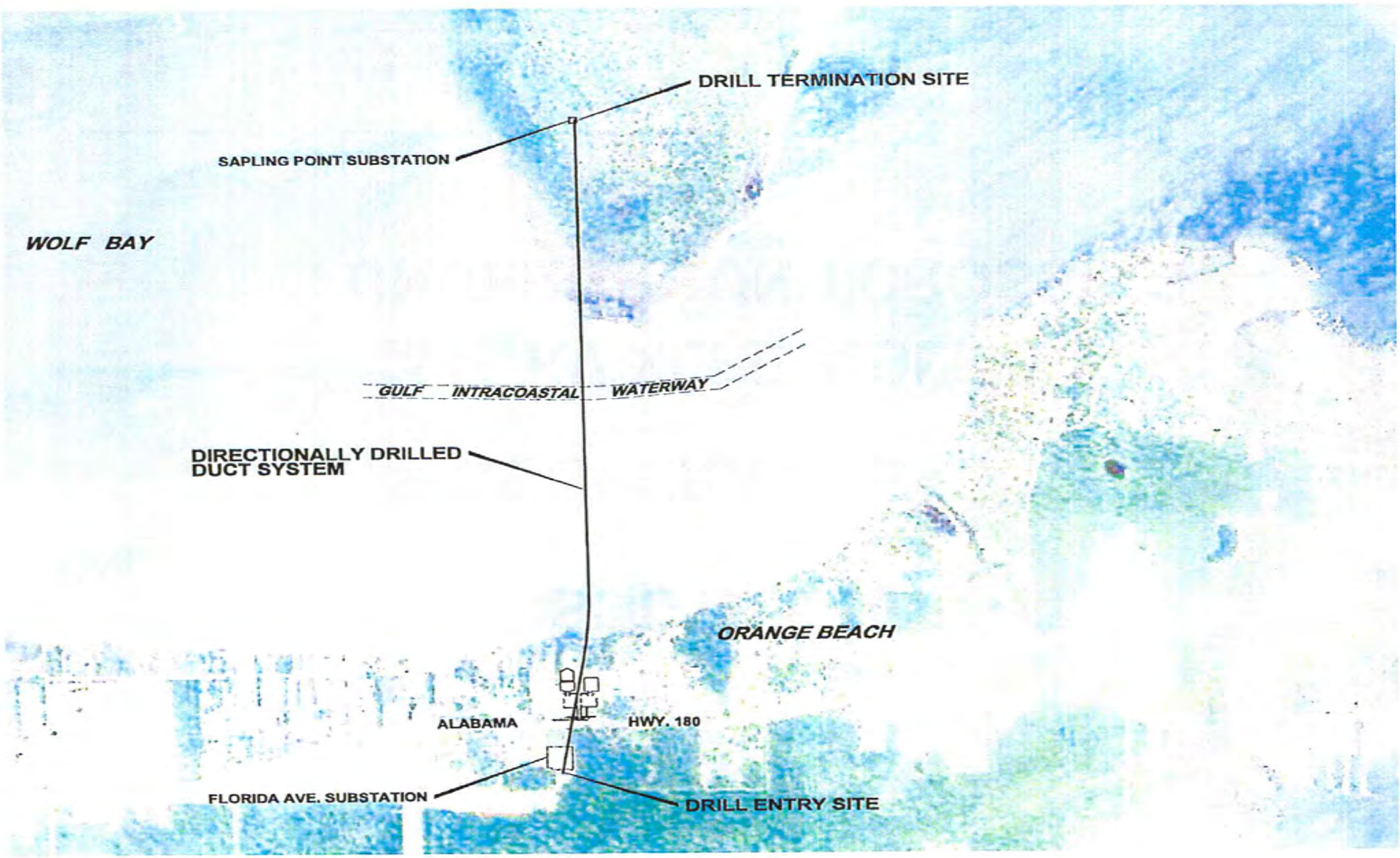
POWERSOUTH ENERGY

COOPERATIVE

115 KV XLPE WOLF BAY UNDERGROUND CROSSING

W.A. CHESTER, L.L.C.

Map of Installation



Other Sites of Sapling Point

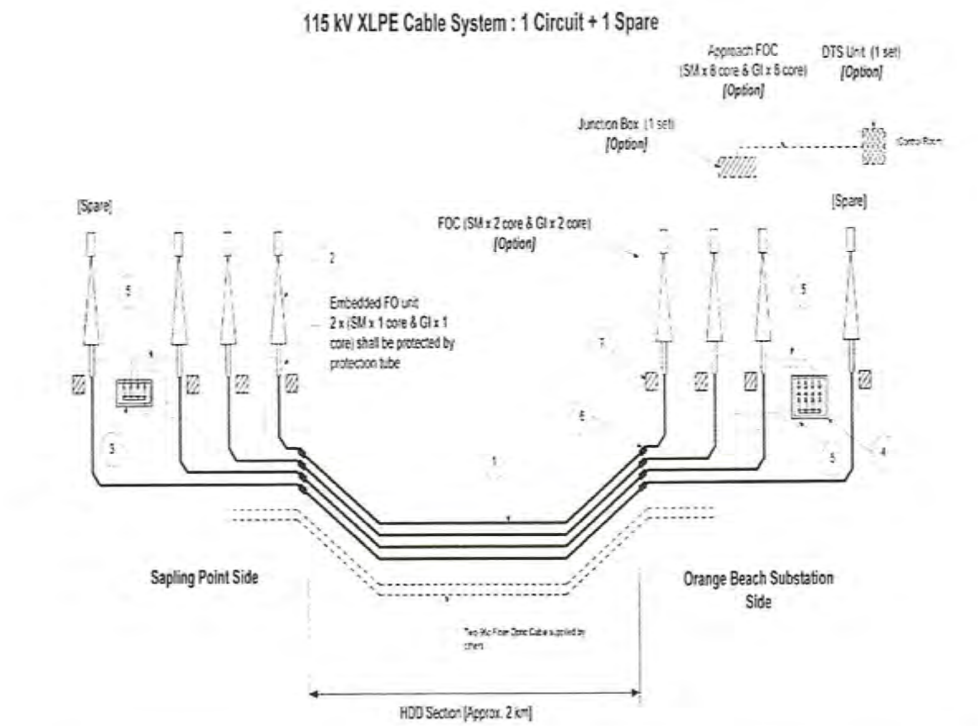
Project Team

- Owner – PowerSouth Energy Cooperative
- Engineer - Waldemar S. Nelson and Co., Inc.
- HDD – Southeast HDD
- Cable Installation - W. A. Chester LLC
  - Cable Manufacturer – J-Power Systems
  - Heavy Rigging – Barnhart
  - Steel Structures - DisTran

Key System Requirements

- Steel casing for 6,131 ft. HDD crossing
- HDPE Conduits (6) grouted in casing
- XLPE Cable (3 phases plus 1 spare)
- Fiber optic temperature monitoring
- Fiber optic communications
- Hurricane protection
    - 145 MPH Winds
    - Storm surge protection

115kV XLPE Cable System



[Note] *1)

Cable Specification

	Base Offer	Option 1	Option 2	Option 3	Alternative Offer
Conductor Size	2500	2500	2500	2500	2000
Conductor Type	Normal	Normal	Insulated	Insulated	Insulated
Material of Metal Sheath	Stainless Steel	Aluminum	Stainless Steel	Aluminum	Stainless Steel

7	Terminal Box for DTS Cable	IP68, SUS 316	6	2	sets
8	Cable Clamping Device	SUS 316	3		sets
5	Single Core Bonding Lead	240sqmm HDPE insulated	100		m
4	Link Box with Cabled Arrester (4 way)	Waterproof, SUS 316	1		sets
3	Link Box for Earthing (4 way)	Waterproof, SUS 316	1		sets
2	Outdoor Termination	With terminal pad, porcelain bushing	6	2	sets
1	115 kV Single Core XLPE Cable (*1)	[illegible]	6065		m
	Name of Part	Material	[illegible]	[illegible]	Qty

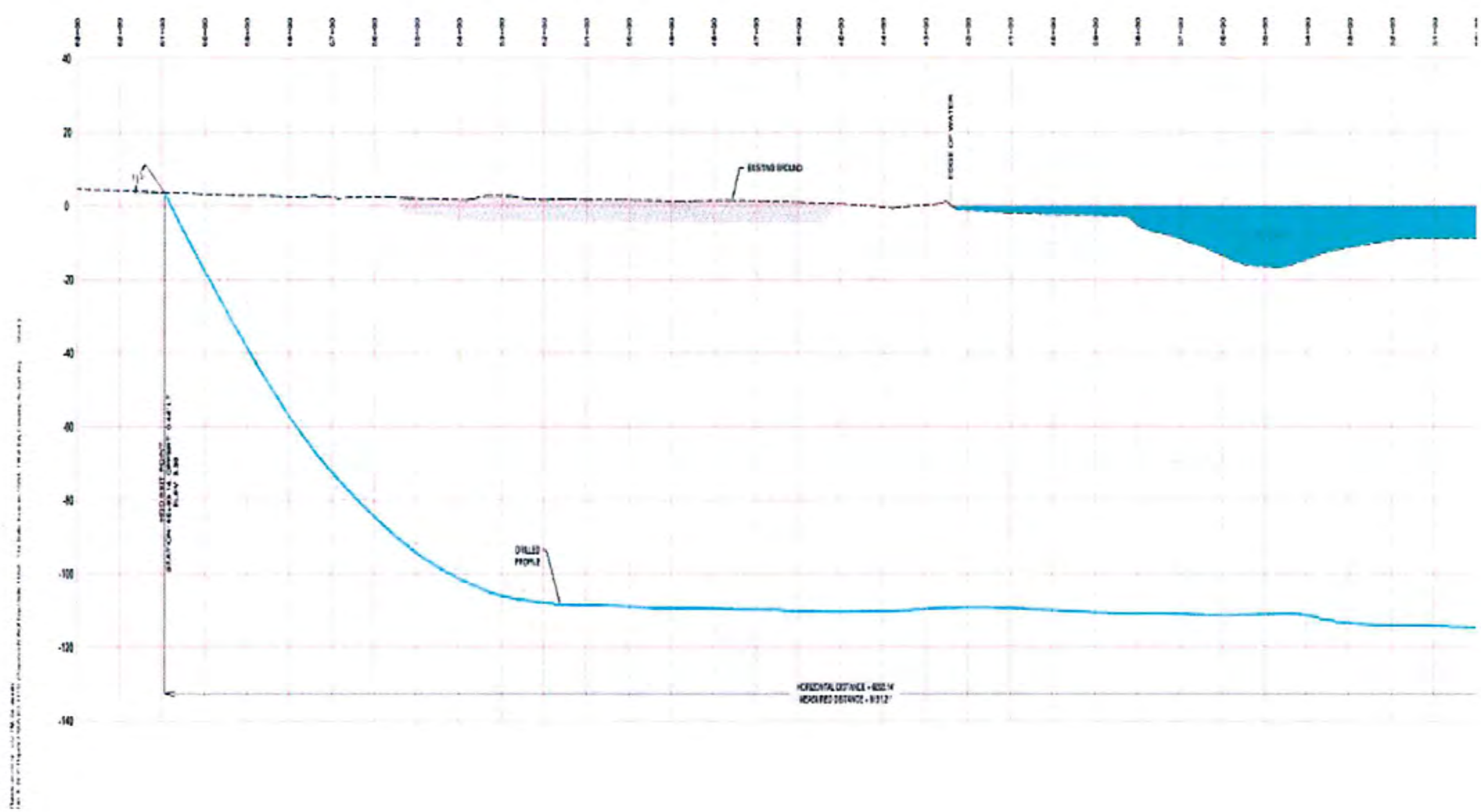
SCHEMATIC DIAGRAM FOR
115 KV XLPE CABLE CIRCUIT

MIFLIN SWITCH to FLORIDA AVENUE
WOLF BAY UNDERGROUND CROSSING PROJECT

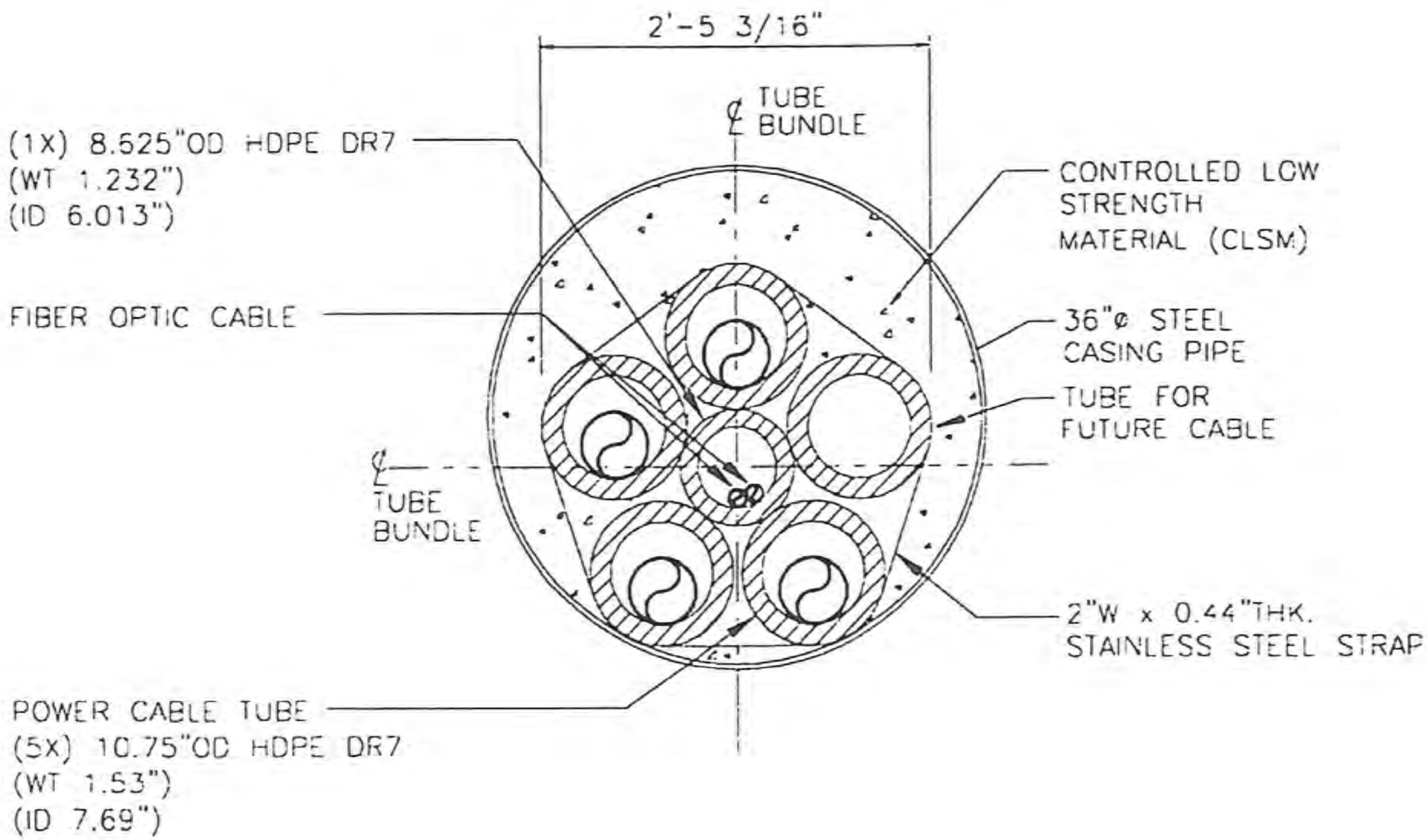
SCALE	NOT TO SCALE	DATE	November 2011
DESIGNER	[illegible]	CHECK	
DRAWING No.	JSP23-SCX0684		

J-Power Systems Corporation

Plan and Profile of Crossing



Steel Casing & Duct Arrangement



Sleeve Installation at Florida Ave. Sub.

Casing & HDPE Conduit Fabrication

HDPE Pull

HDPE Bundle Entering Casing

Grouting of Casing

Conduits at Exit of Bore Sleeve

XLPE Cable Design

- Conductor – 5 segment, enameled copper
- Insulation – 630 mils XLPE
- Bedding & Binder – Water swelling tapes
- Fiber Optic – 2 Stainless steel tubes ea. with 1 multi-mode and one single mode fiber
- Metallic Sheath – Welded and helically corrugated stainless steel.
- Jacket – Extruded black high density polyethelene (HDPE)
- Cable Surface – Graphite varnish

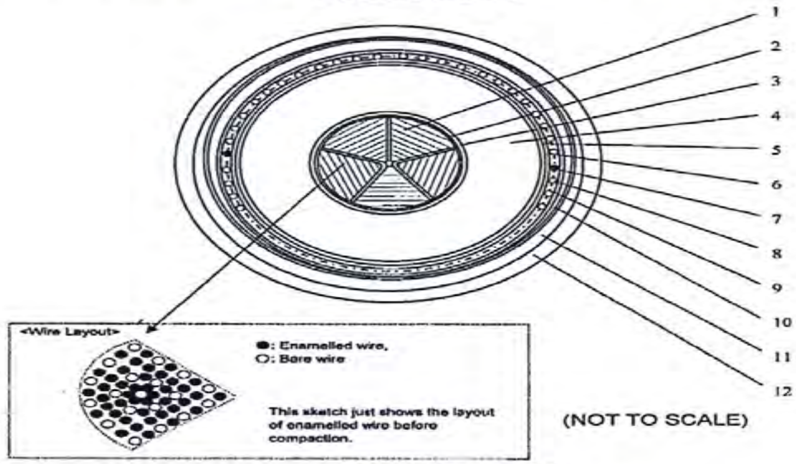
Cable Data

- Conductor Cross Section - 5,000 kCM
- Conductor Diameter – 2.45 in.
- Overall Diameter – 5.39 in.
- Weight – 24.3 lbs./ft.
- Minimum Bending Radius – 142 in.
- Maximum Pulling Tension – 38,000 lbs.

Cable Cross Section

J-Power Systems

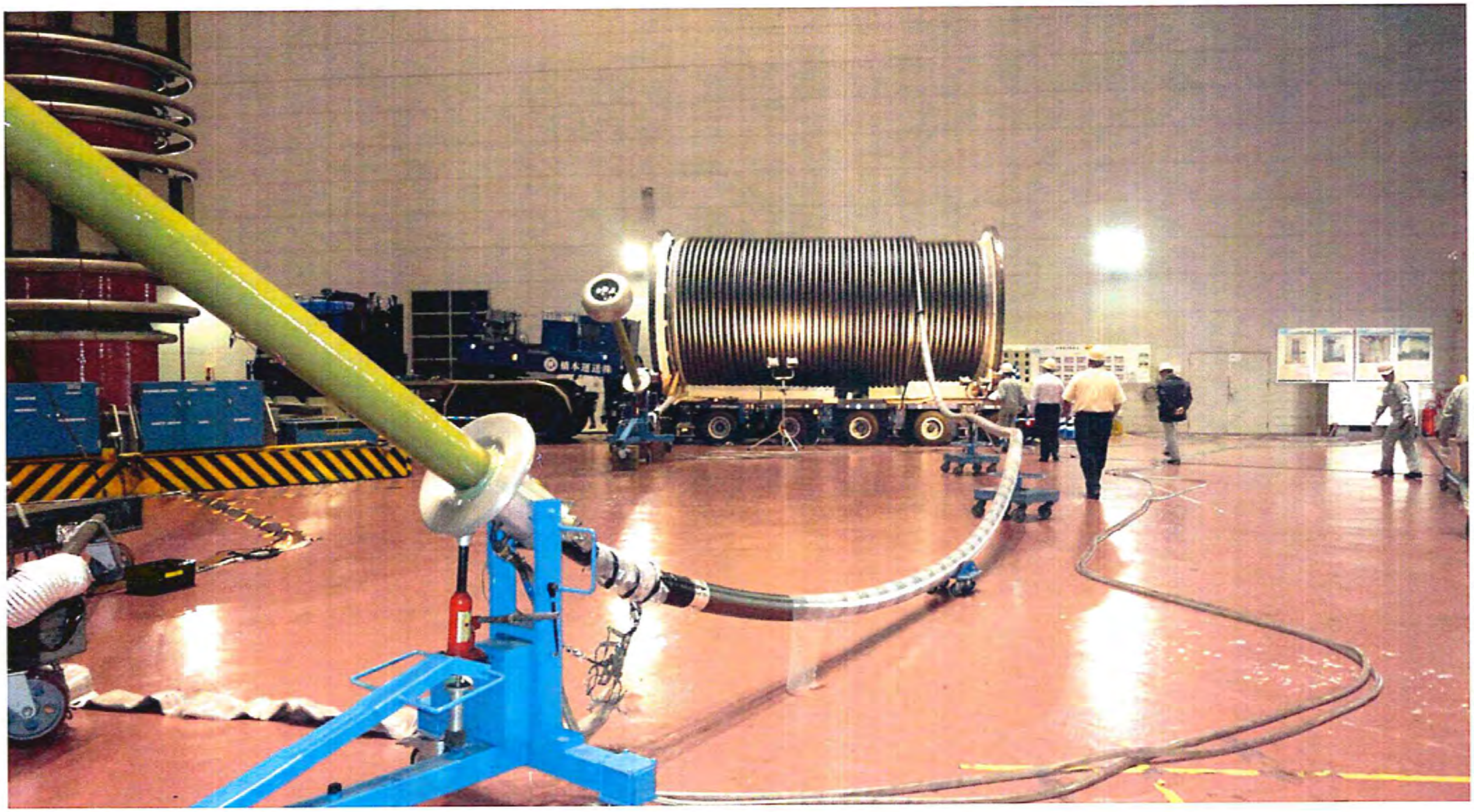
115 kV COPPER CONDUCTOR, XLPE INSULATED, CORRUGATED STAINLESS STEEL SHEATHED, HDPE JACKETED AND OPTICAL FIBER UNITS EMBEDDED POWER CABLE



(NOT TO SCALE)

1. COPPER CONDUCTOR
2. SEMICONDUCTING BINDER TAPE(S)
3. EXTRUDED CONDUCTOR SHIELDING
4. XLPE INSULATION
5. EXTRUDED INSULATION SHIELDING
6. SEMICONDUCTING SWELLING TAPE(S)
7. STAINLESS STEEL TUBE (OPTICAL FIBERS)
8. COPPER WIRE SHIELDING
9. SEMICONDUCTING BINDER TAPE(S)
10. CORRUGATED STAINLESS STEEL SHEATH
11. ANTI-CORROSION BITUMEN COMPOUND
12. HDPE OUTER JACKET WITH GRAPHITE COATING

Factory Testing



Reels Prior to Shipping from Osaka, Japan

Cable Reel Data

- Outside Diameter – 12.5 ft.
- Drum Diameter – 9.5 ft.
- Length – 25 ft.
- Cable Weight - 158,000 lbs
- Ea. Reel Shipped on Steel Frame

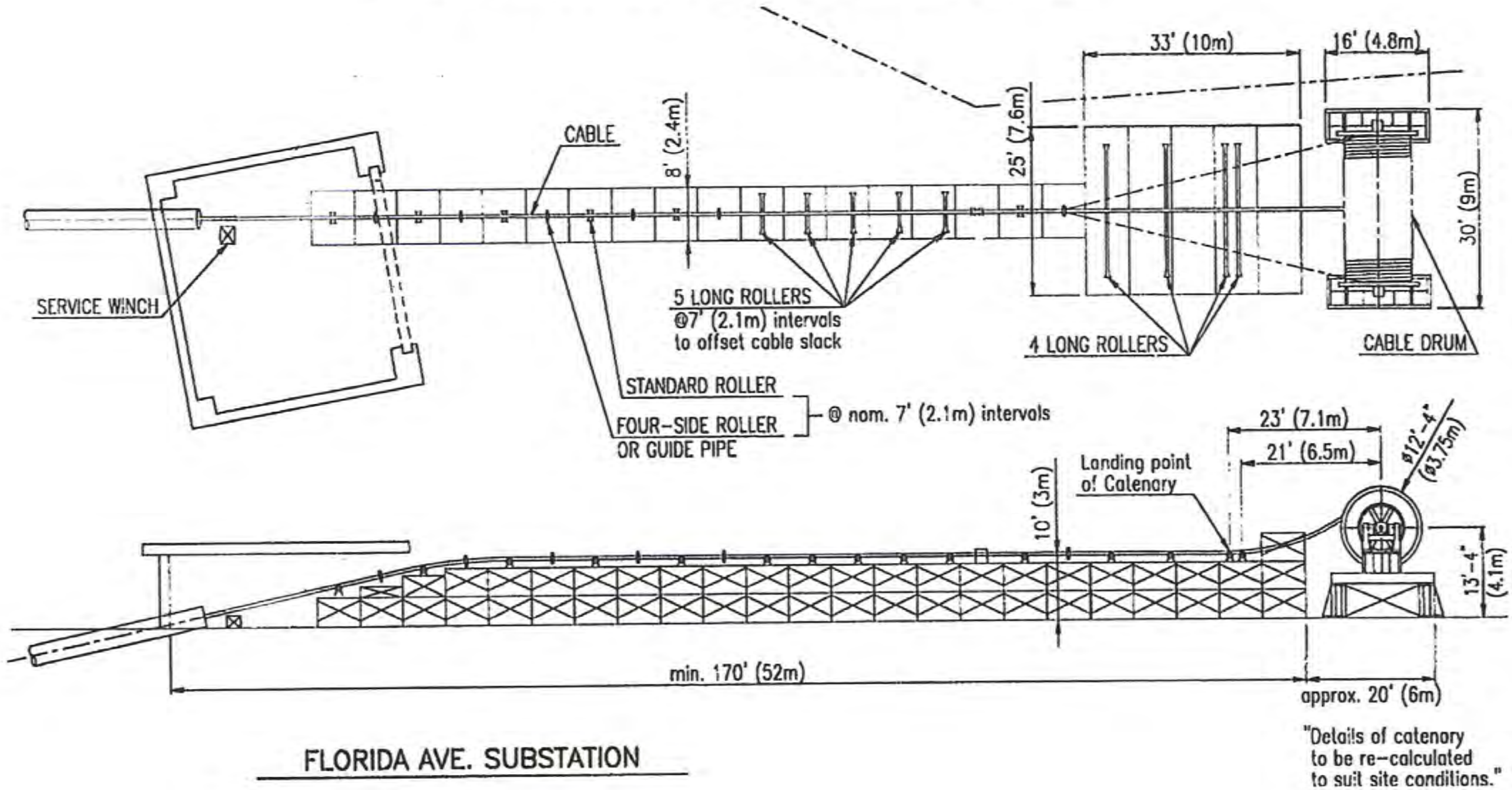
Delivery From Barge to Storage Yard in Orange Beach

Unloading from Barge to Storage Yard in Orange Beach

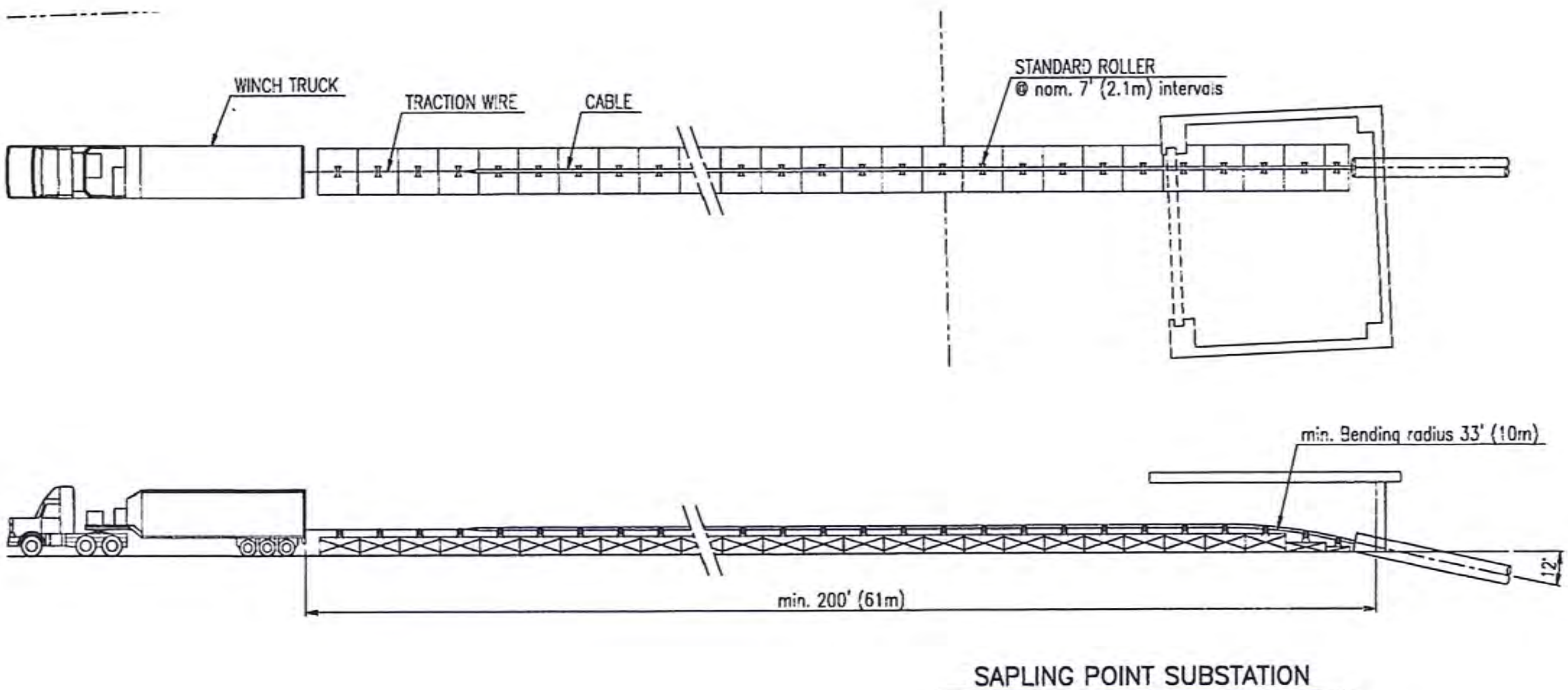
Cable Pull Length

- 6,131 ft. is the longest XLPE cable pull attempted in conduit.
- Approximately 200 ft. required on each end for racking and terminating.
- Total cable length approximately 6,500 ft.

General Arrangement of Cable Pull Florida Ave.



General Arrangement of Cable Pull Sapling Point



Cable Pulling

- Maximum allowable cable tension 38,000 lbs.
- Calculated pulling tensions 29,936 lbs.
- 100,000 lb. Cable winch & cable pusher utilized.
- 1-1/8 in. Winch line with swivel.
- Pulling lubricant utilized.
- Pull-out shoe utilized.
- Dead-man provided for stabilization of winch

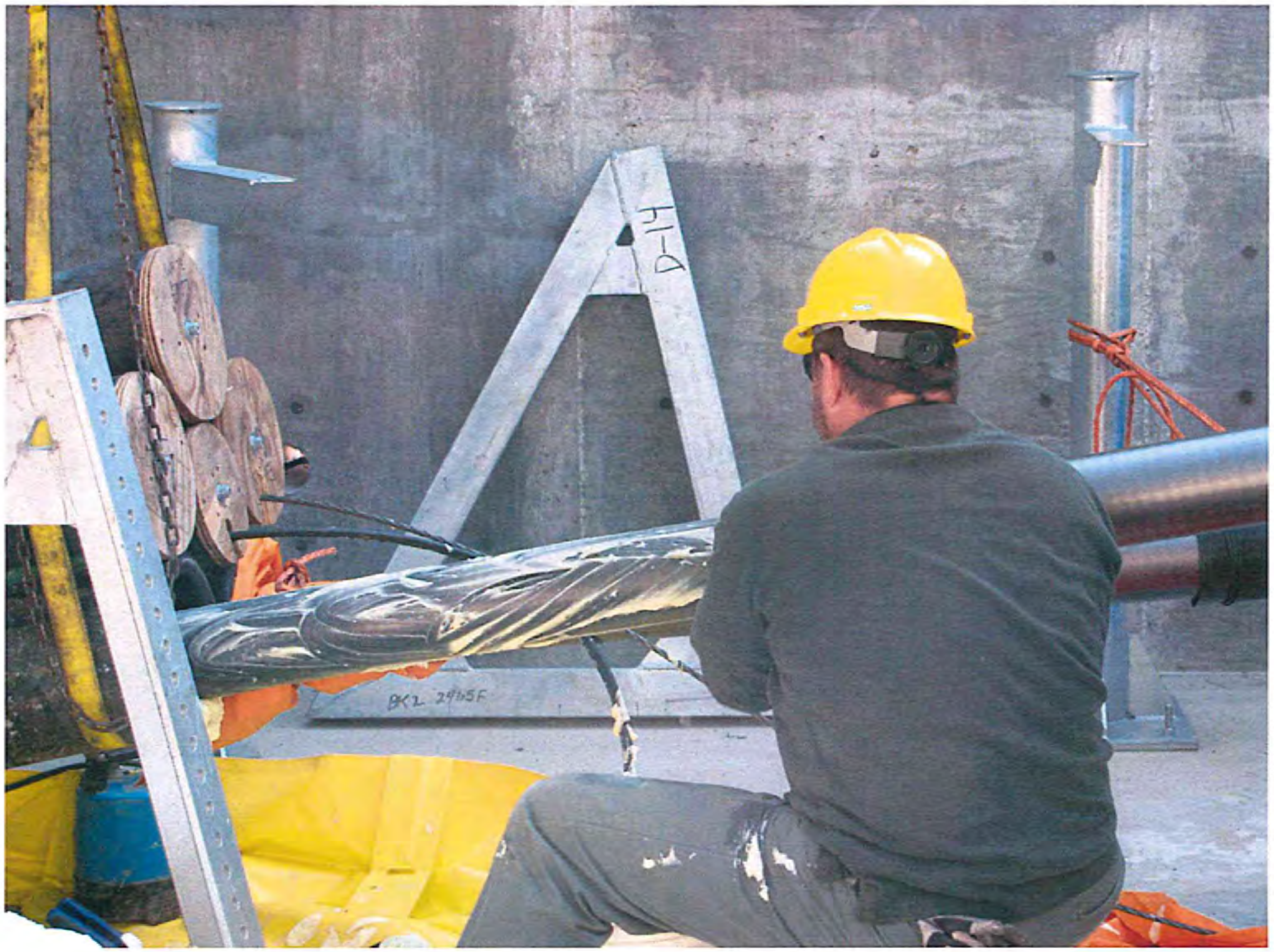
Reel Set-up at Pulling Location

Reel During Cable Pull

Pull-in Structure & Rollers

Cable Approaching Conduit

Application of Cable Lubricant



Pull Out Shoe

Rigging at Site

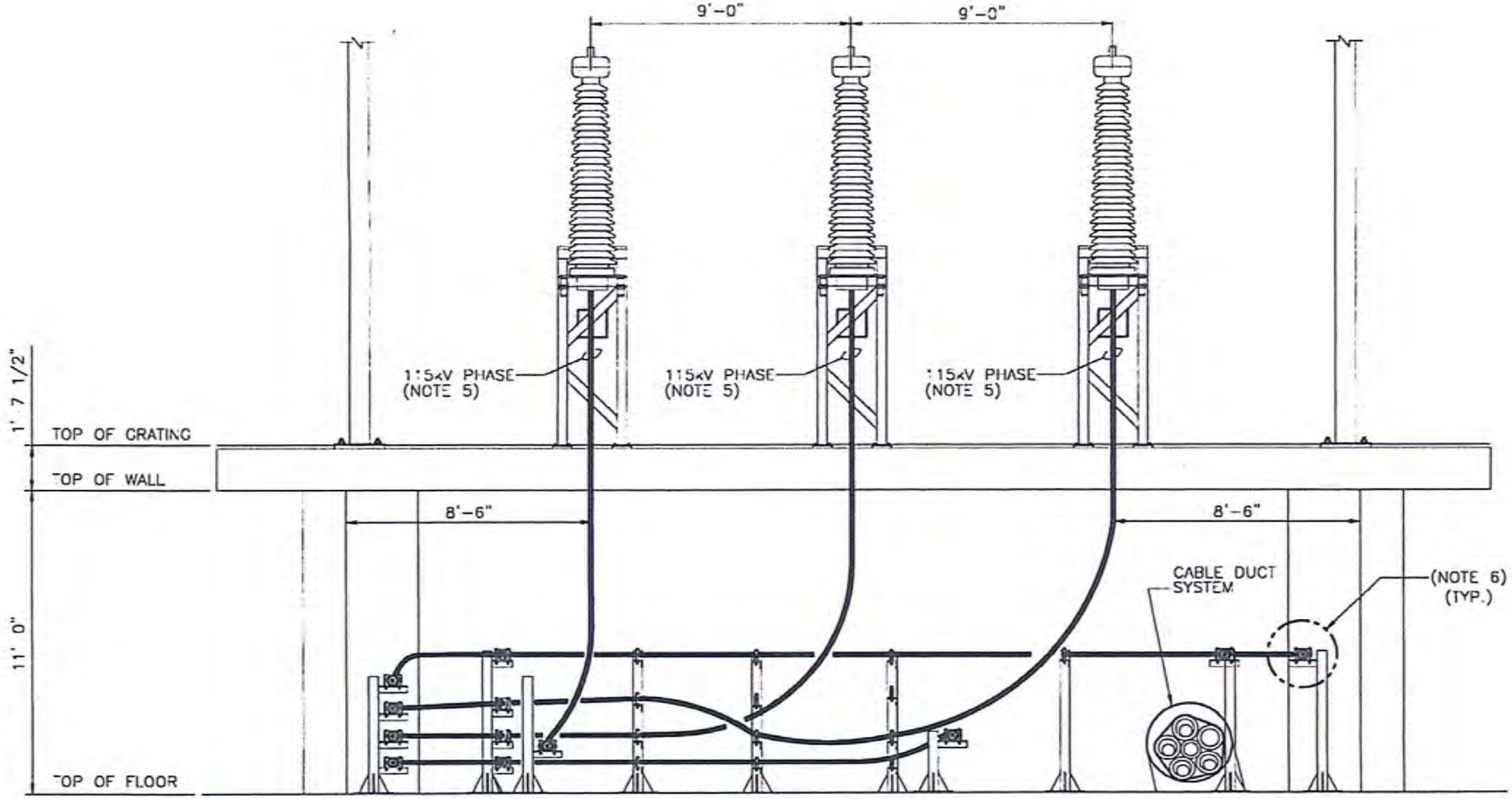
Rigging Arrangement at Pulling Winch

Monitoring of Pulling Tensions

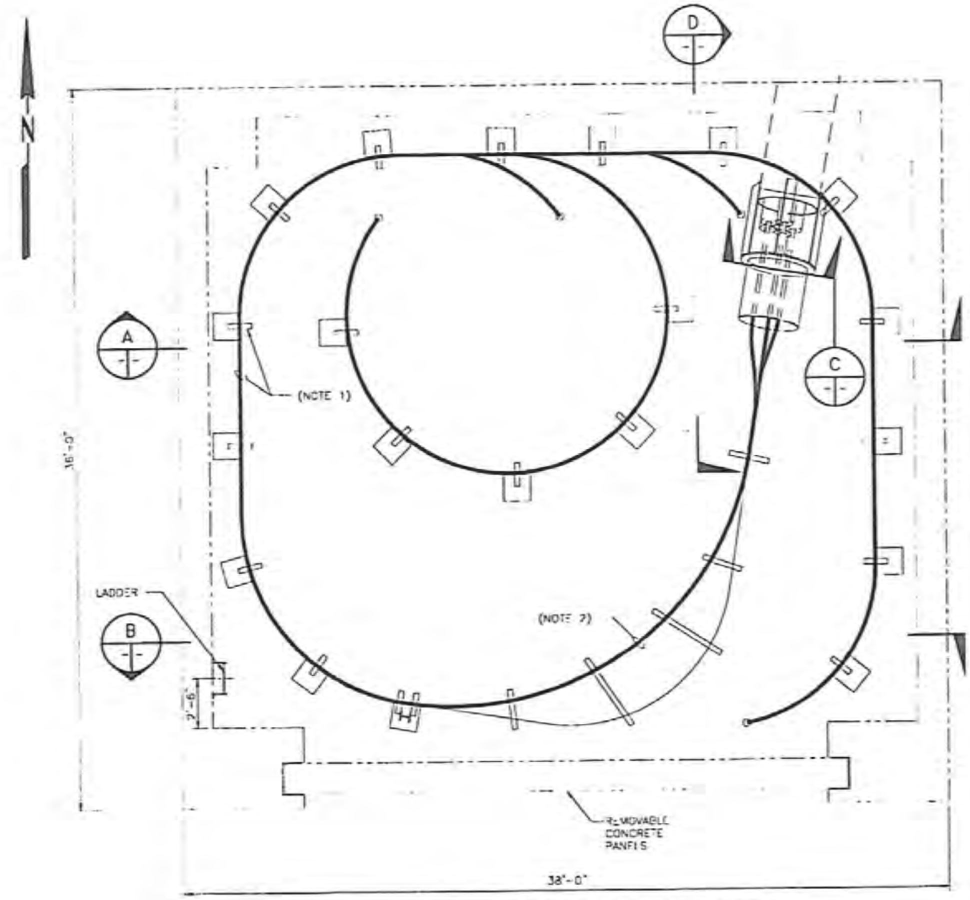
- Tension monitoring critical to successful installation.
- Tension monitored continuously by winch operator.
- Hardline communication between entry and exit.
- Tension, Distance, Speed recorded every 2 seconds.
- Remote monitoring available.
- Actual tensions well below calculated.

Tension Monitoring Equipment

Elevated Termination Structure



Proposed Cable Racking at Vaults

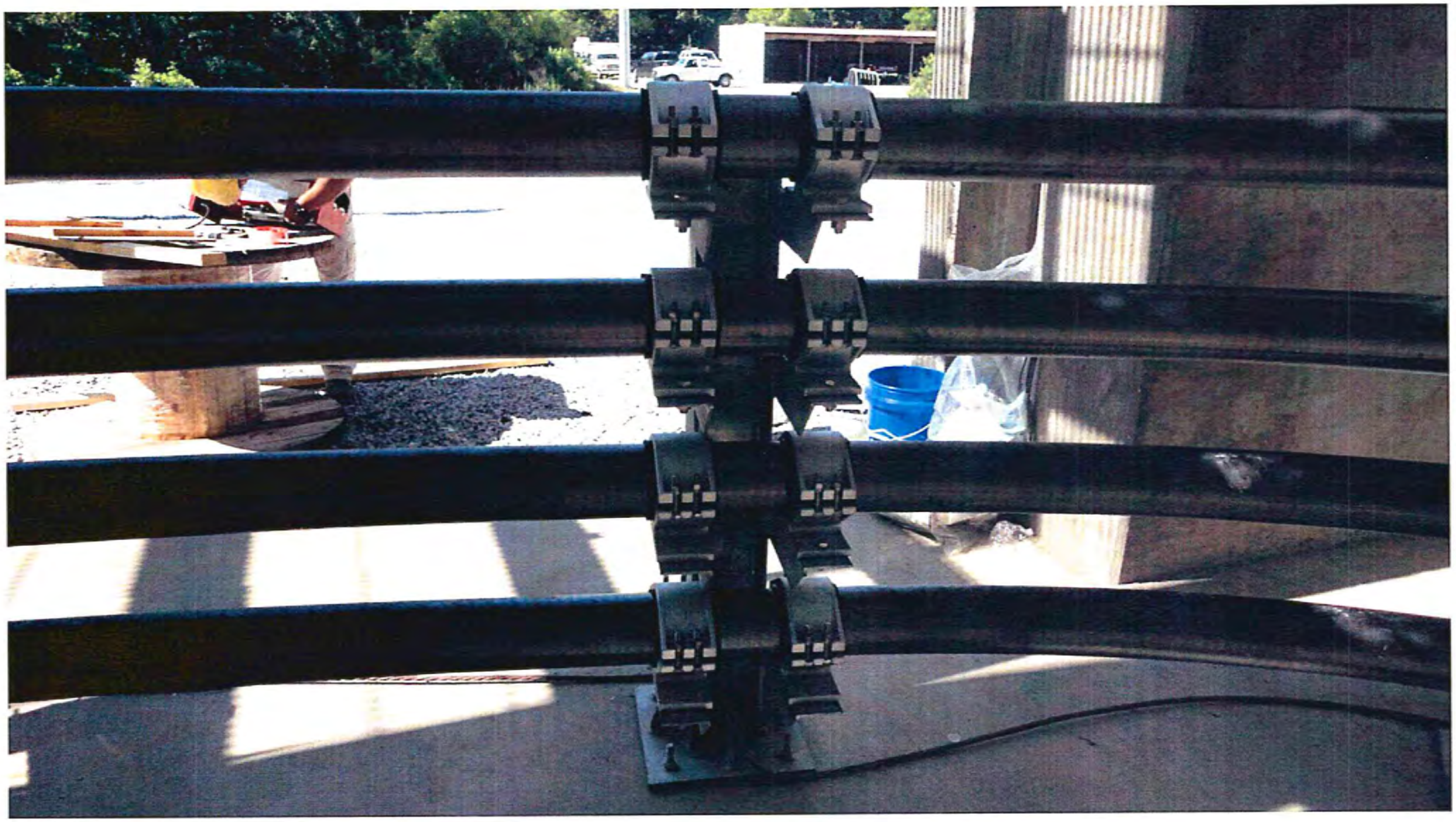


FLORIDA AVE. SUBSTATION CABLE LOOP PLAN

SCALE: NONE

Racking Cable in Vaults

Fixed Supports

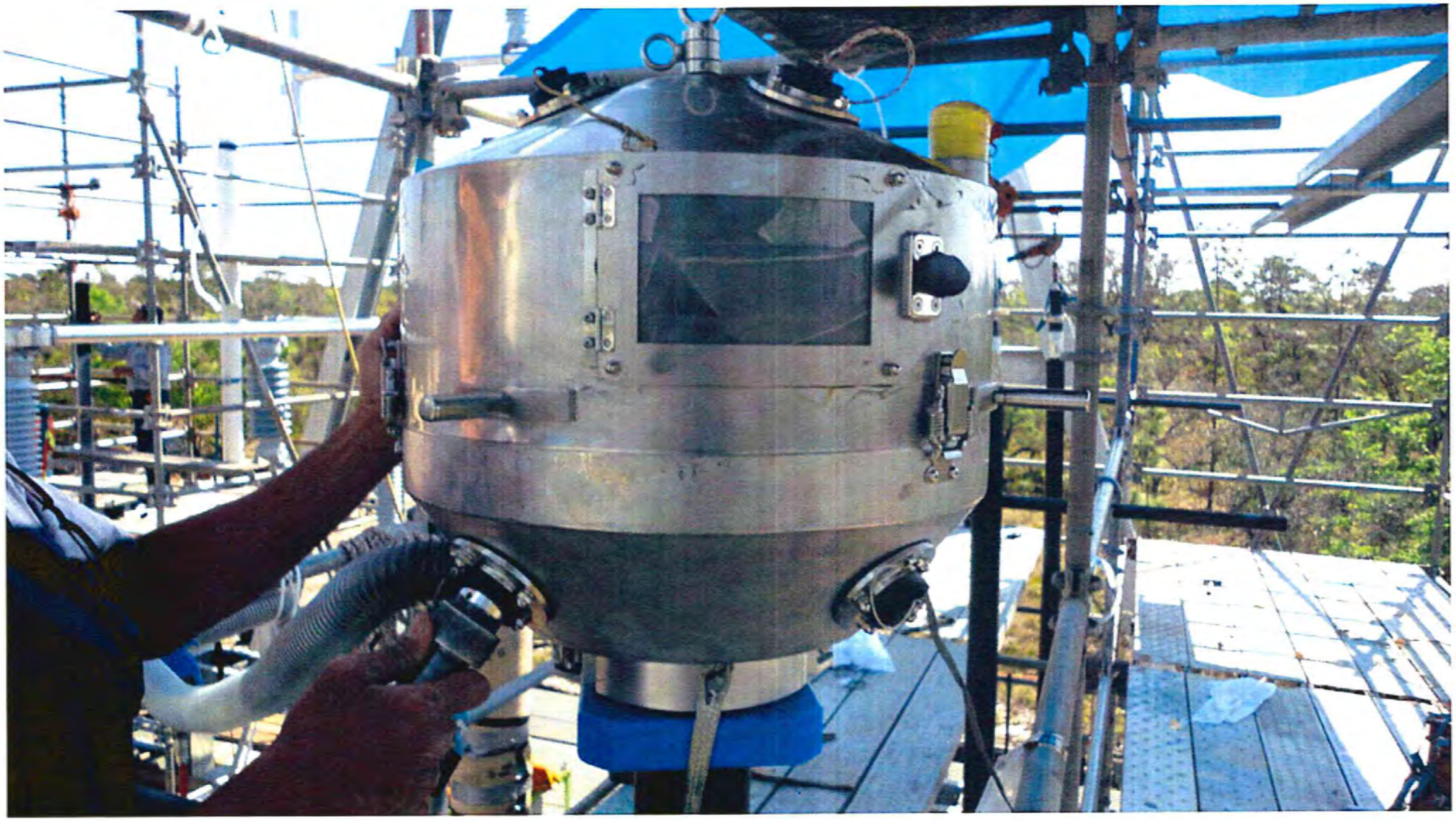


Supports Allowing Cable Movement

Completed Racking

Termination Installation

Sandblasting of Enameled Strands

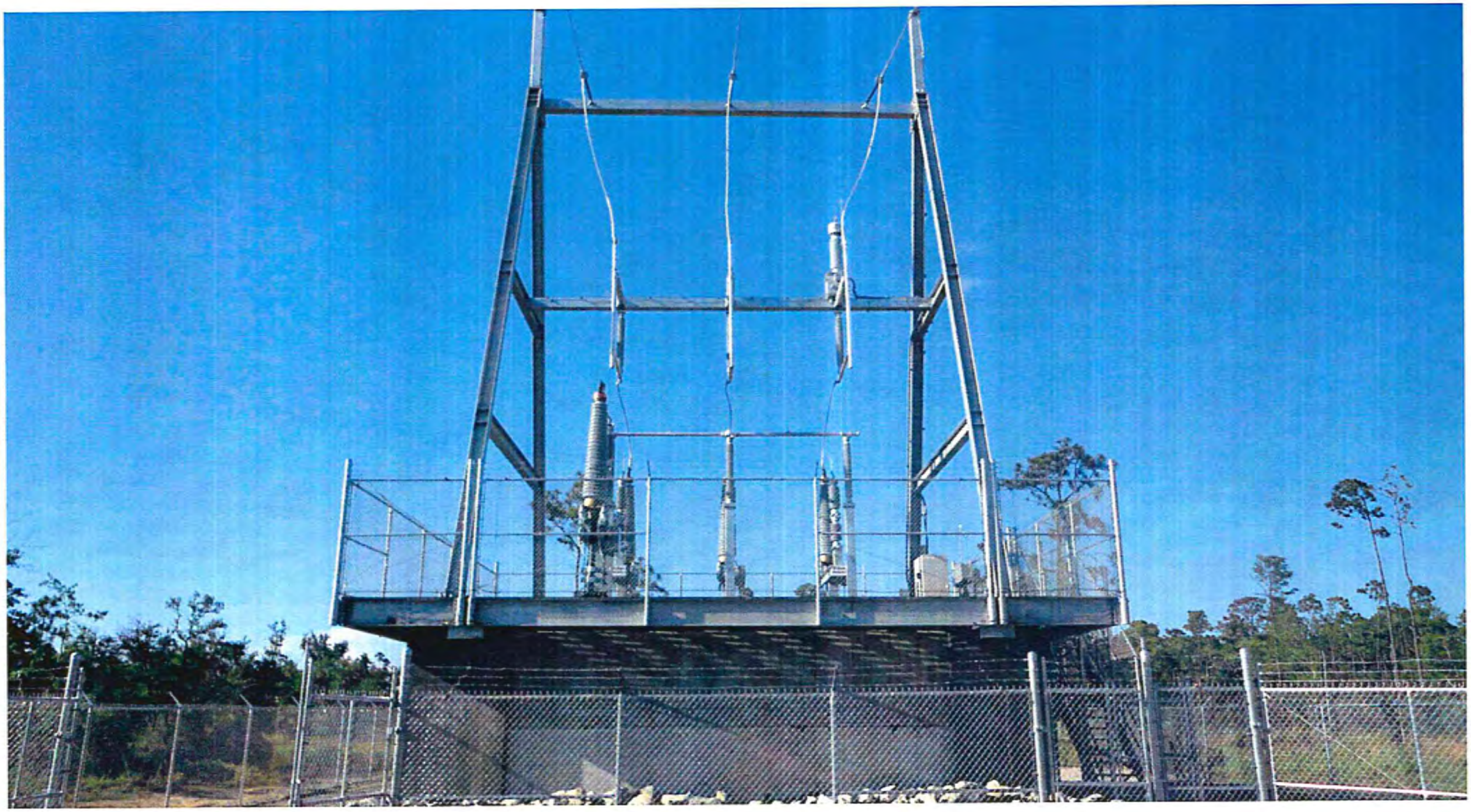


Spare Termination

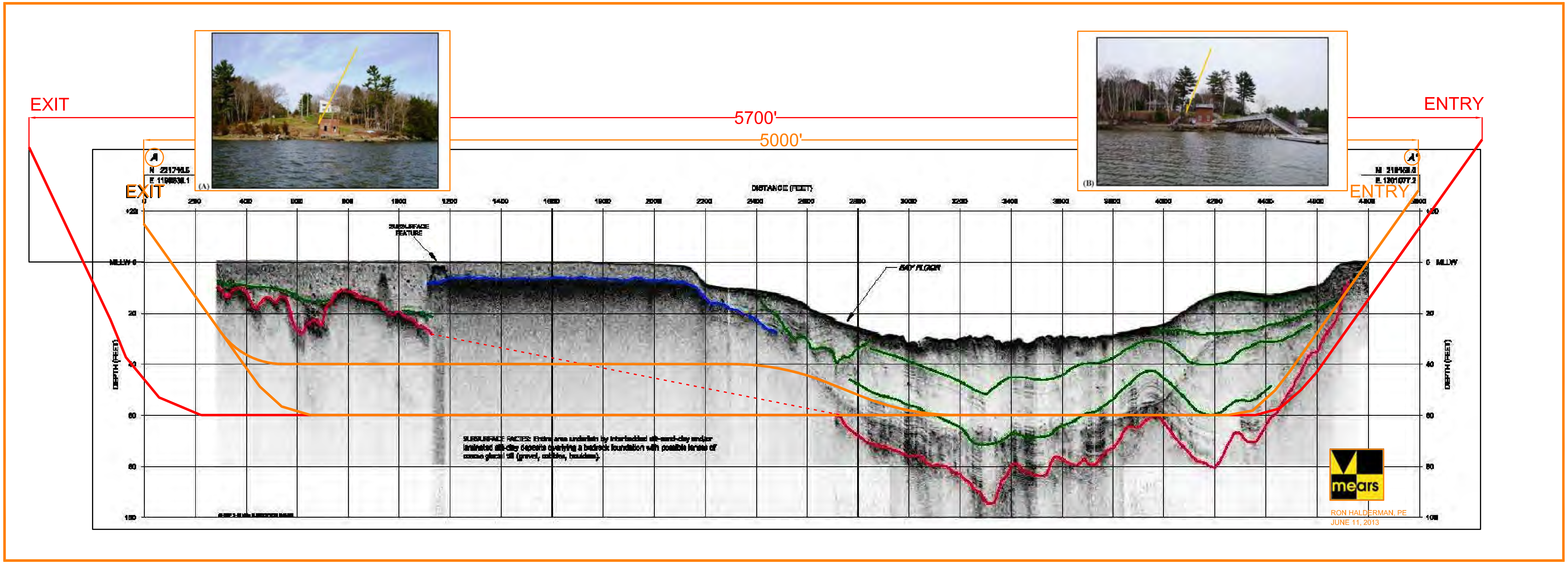
Termination Nearing Completion

Florida Ave. Termination Structure

Sapling Point Termination Structure

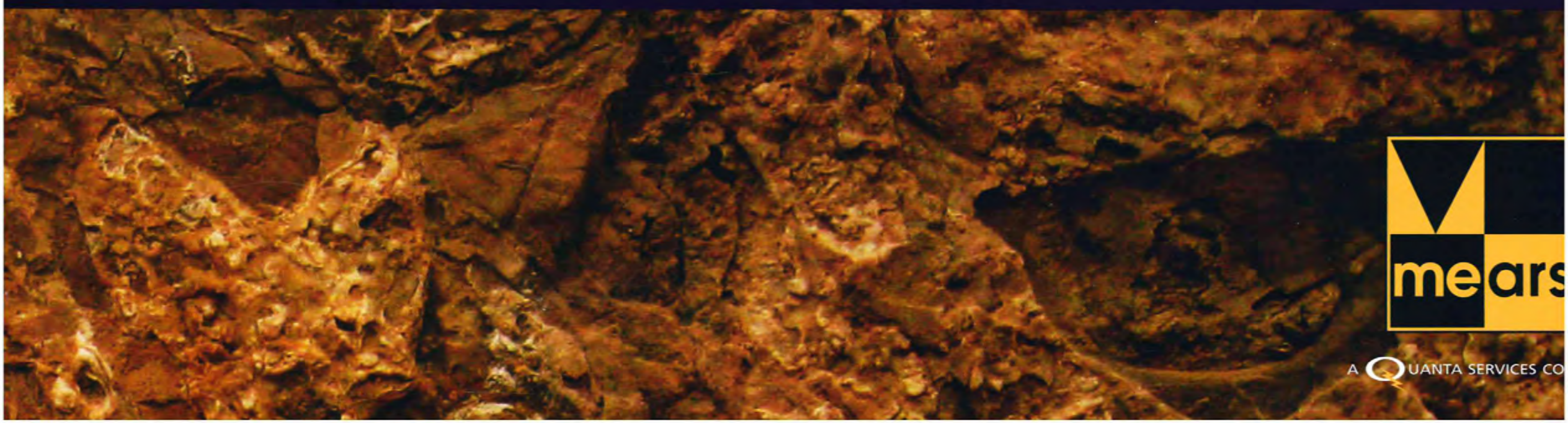


Wolf Bay 138kV Crossing



EXIT
ENTRY
5700'
5000'
EXIT
ENTRY
DISTANCE (FEET)
MLLW 0
0 MLLW
DEPTH (FEET)
SUBSURFACE FEATURE
BAY FLOOR
(A)
(B)
mears
RON HALDERMAN, PE
JUNE 11, 2013

HORIZONTAL DIRECTIONAL DRILLING



mears

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WE DO MORE THAN JUST DRILL

The Mears reputation as a leading horizontal directional drilling (HDD) company has been earned by working hard and smart for our customers, gaining their confidence in our capabilities by completing complex and innovative projects. Our professional construction and engineering teams have experience, expertise and ingenuity that is well-known to the oil and gas, electrical and water/wastewater industries.

Mears is part of a professional network of companies under Quanta Services, Inc. (a Fortune 500 Company). As part of this network, Mears is able to provide customers with the nation's largest pool of skilled workers, equipment and specialized services to deliver infrastructure solutions to the power and pipeline industries all across the world.

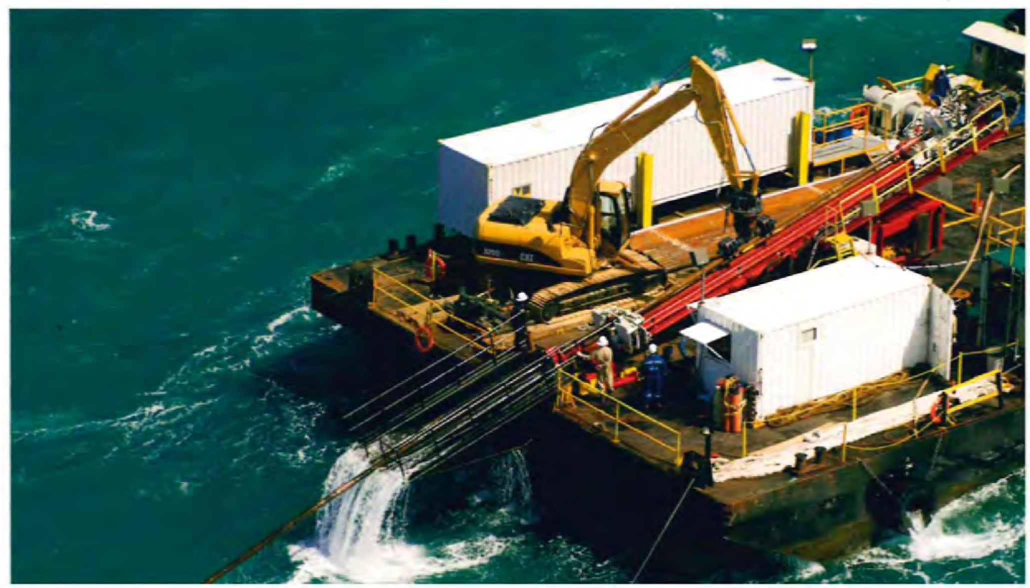
HORIZONTAL DIRECTIONAL DRILLING

Changing regulations, safety and quality standards and environmental concerns are an ever-present challenge to pipeline, power and utility companies responsible for installing and maintaining pipelines, cables and conduits. Led by a team of in-house engineers, project managers, steering technicians, international logistics and field personnel, Mears navigates the concerns of our customers through even the most complex projects.

With support from our Certified Equipment Managers, our fleet of horizontal directional drilling rigs and support equipment can complete projects with pipe diameter up to 60-inches, and our drilling capabilities include continuous lengths of over 11,000 feet.

Our experience also includes:

- Conventional HDD Crossings
- Marine Crossings (Water-to-Water and Shore Approaches)
- Hard Rock Drilling
- Design/Build
- Engineering, Procurement and Construction



MEARS' COMMITMENT TO SAFETY, QUALITY & ENVIRONMENT

Our **Safety Management System (SMS)** has allowed Mears to maintain the highest standards in health and safety, and it is our company policy to provide and maintain safe and healthy conditions for all employees, customers and the public. Our commitment to safety is at the core of our company values and forms a foundation for operational excellence. The **OHSAS 18001:2007** standard has elevated our safety practices to an even higher level for our employees and customers.

Mears' **Quality Management System (QMS)** is thoroughly designed and implemented to ensure client expectations and needs are exceeded. Guided by the **ISO 9001:2008** standard, Mears Group monitors and documents quality performance, effectiveness and compliance.

Additionally, our maintenance program, run by AEMP Certified Managers (CEMs), helps reduce downtime on projects and increases overall productivity by keeping equipment in optimum running condition.

The **Environmental Management System (EMS)** was established to strengthen Mears' commitment to protecting the environment by conducting our business operations in an environmentally responsible and sustainable manner. We recognize that by reducing and, when possible, eliminating waste, the environmental impact of our activities is significantly decreased.

To further our commitment to protecting the environment, Mears attained the **ISO 14001:2004** certification, and continues to place the value of environmental management as central to our corporate success.

DESIGN/BUILD

At Mears, we offer our clients the opportunity to have their project designed and built as one turnkey operation. Benefits of design/build project delivery include:

- Reduced owner risk
- Shortened project schedules
- Single point of contact
- Increased cooperation
- Reduced owner resources
- An environment of design and construction innovation

ENGINEERING, PROCUREMENT & CONSTRUCTION

Mears' engineering, procurement and construction (EPC) services provide a single source of contact and responsibility to our clients, saving them time and money. Through our EPC process, Mears' engineers, construction teams and subcontractors can communicate clearly and consistently with each other, ensuring that informative and collaborative decisions are made throughout the project. Additionally, having a single source of responsibility on a job enhances the safety and productivity of the project.

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A QUANTA SERVICES COMPANY

MEARS GROUP, INC. - HORIZONTAL DIRECTIONAL DRILLING

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281-448-2488
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Certified in Safety, Quality, and Environmental: OHSAS 18001:2007, ISO 9001:2008 and ISO 14001:2004

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A QUANTA SERVICES COMPANY

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ISO 9001:2008 Certified Company

NYSE – PWR

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