THE STATE OF NEW HAMPSHIRE

BEFORE THE

SITE EVALUATION COMMITTEE

DOCKET NO. 2015-04

SUBSTITUTE PRE-FILED DIRECT AND AMENDED TESTIMONY OF WILLIAM F. WALL

APPLICATION OF PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
D/B/A EVERSOURCE ENERGY
FOR A CERTIFICATE OF SITE AND FACILITY FOR CONSTRUCTION OF A NEW
115 kV TRANSMISSION LINE

THE SEACOAST RELIABILITY PROJECT

March 29, 2017

Qualifications and Purpose of Testimony

Q. Please state your name, title, and business address.

A. My name is William Wall and I am a Project Director for LS Cable America with a registered address of 222 Bridge Plaza South, Suite 530, Fort Lee, NJ 07024.

Q. Briefly summarize your educational background and work experience.

A. I hold a City & Guilds Final Technical Certificate from the City & Guilds institute in London UK. I joined the submarine cable industry in 1973 as a Cable Technician with Cable & Wireless Ltd on a submarine cable installation vessel (Cableship) and spent 10 years installing & repairing submarine cables worldwide. I then formed an independent contracting company based in NJ specializing in submarine cable installation and repair in the US and overseas markets and operated that company for 18 years. In 2001 I joined Caldwell Marine International (then a subsidiary of General Dynamics) as Development Manager for submarine cables. In 2007 I joined Deepwater Wind as VP of marine operations. Deepwater Wind is a private developer of offshore wind farms on the east coast. In 2011 I joined Atlantic Grid Holdings as Director of Marine Operations. Atlantic Grid is the developer of the Atlantic Wind Connection (AWC) which is a High Voltage Direct Current (HVDC) submarine cable system planned to connect NJ to VA in the Atlantic off the east coast to transmit energy from future OSW facilities. In 2015 I joined LS Cable America (“LSCA”) as a Project Director.

Please refer to my resume, Attachment A, for further details.

Q. Have you previously testified before the Site Evaluation Committee?

A. No, I have not.

Q. What is your role in the Project?

A. Public Service Company of New Hampshire (“PSNH”) has awarded LSCA a contract to manufacture and install the submarine cable portion of this project. I am the Project Director for LSCA.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to provide additional information to the SEC in support of PSNH’s Amendment to the original Application dated April 12, 2016. I will be replacing Marc Dodeman for the purposes of testifying in support of the Project.

Underwater Construction

Q. Please describe LS Cable America's experience installing and maintaining underwater electric transmission lines.

A. LSCA has extensive experience in this area. Most recently in 2016, LSCA manufactured and directed the installation of a 32KM, 34.5KV submarine transmission cable system between Block Island RI and Narragansett on mainland RI for National Grid as part of the Block Island Wind Farm project. Within the same project LSCA manufactured and installed the 34.5KV distribution and export submarine power cables for the 5 offshore wind turbines of the Block Island Wind Farm. LSCA is currently manufacturing and installing a 230KV submarine cable system for the New York Power Authority. Other recent major projects under our responsibility were the National Grid submarine cable system between mainland Long Island NY and Captree Island NY. LS Cable has manufactured and installed numerous submarine cable systems and further details can be found in Attachment B.

Q. Please describe the existing cable corridor for the Project.

A. The existing mapped cable corridor runs from West to East across Little Bay. It can be located on National Oceanographic and Atmospheric Administration ("NOAA") Chart #13285 just adjacent to Welsh Cove. For further details, please refer to Attachment C, "NOAA Chartlet Little Bay Crossing."

Q. Please describe the cable survey that PSNH conducted.

A. PSNH hired a separate contractor who performed a dive survey of the area to determine the location and condition of existing out-of-service cables crossing Little Bay within the cable corridor. During the dive survey, divers made positive contact with all of the existing cables within the PSNH charted cable corridor in a non-invasive visual dive survey, and critically obstructive existing cable positions were verified. In all diver reported accounts, the physical condition of all existing out-of-service cables had been found to be structurally sound. The sediment found to be covering the cables in the inspection area trended toward soft, non-cohesive fine sands and soft mud with burial depths ranging from a maximum of 24" to areas of full exposure. Finally, divers reported that in none of the inspection sites were any of the cables found to be cemented in place by stiff sediment overburden or silt/clay accretion. Complete details can be found in the document "F107 Cable Survey Final Report (31Jul14)," Attachment D.

Q. Please describe what data was collected during the marine route survey, and describe how LSCA utilized the Marine Route Survey data that was collected by Ocean Surveys, Inc. (OSI) in the cable corridor area.

A. A Marine Route Survey (Marine Geophysical Survey) was performed April 20-23, 2013 by Ocean Surveys, Inc., (OSI) at the behest of Power Engineers, Inc. (Engineering consultant to PSNH). The tasks undertaken during this marine route survey were:

1) A hydrographic survey to determine water depths and record the existing topography.

2) A shallow subbottom profile survey to map shallow subsurface geology and identify buried submarine utilities.

3) Deep subbottom profile survey to map deeper subsurface stratigraphy and geology.

4) Side scan sonar survey, to map surficial sediments and obstructions as well as identify exposures of existing submarine utilities.

5) Magnetic intensity measurements, to measure the deviation in the earth's total magnetic field generated by ferrous objects on and below the bottom.

Subsequent sediment cores were taken along the anticipated submarine cable route by Normandeau Associates Inc. Geotherm, USA, an underground and underwater substrate testing company, analyzed the cores to provide further subbottom data in terms of geomorphology and substrate plasticity to assist in determining thermal resistivity and burial feasibility.

LSCA utilized this data to determine soil characteristics, identify obstructions and assess burial feasibility for the cable installation.

Q. Please describe how existing sections of the inactive cables that are currently in the cable corridor will be removed.

A. Data acquired by OSI during the Marine Route Survey and additional surveys will be utilized by to provide rough positioning of the existing out-of-service cables. Reference positions will be entered into a navigation suite, which will act as the central navigation system of the cable removal barge.

The installer will utilize surface grapnels to hook the existing power cable bringing the end on board. Divers may be used to assist in locating the cable end. All information to date indicates that the cables lie on or close to the surface in unconsolidated sediments. If some areas are more resistant to removal, hand jetting may be necessary to free those sections of cable.

Once a cable end is on board and a suitable length laid out on deck, it will be tied off with chain stays and sections will be cut off and prepared for onshore disposal. The barge will move along the cable and sections will be cut off until it is determined that the section of the cable corridor needed for the new cable system is clear. The cable end shall be capped before it is returned to the bottom of the bay. Should the cable snap before being entirely cleared from the route, additional grapnel runs or diver locates will be undertaken to relocate the cable and continue clearing the route.

Only sections of the existing out-of-service cables will be removed to create a clear route for the new cable system.

Q. Once the new 115 kV cables are ready for installation, how will the cables be transferred to the Project site?

A. Cable reels will be delivered by LSCA to a local port via a freighter. At this time it is understood that the local port will be a commercial dock in Newington, NH with suitable facilities.

It is expected that only one power cable reel will be loaded onto the installation barge and installed at a time. The barge will return to the storage dock between installations. Separate loading and installation operations are necessary due to the weight of the cable reels. Individual reels will be loaded between installations to allow the barge to operate with minimum draft.

Q. Please describe the jet plow.

A. The cable jet plow is a device which is laid on the seafloor and towed from the barge. Its main mechanical components are two skids which allow the sled to slide across the bottom, and an articulated blade which rotates down into the seafloor. The blade is fitted with water injectors along its leading edge which liquefy the sediment immediately ahead of the blade greatly reducing the force required to pull the plow forward. See Attachment E for "Jetting Sled Data Sheet." The cable is strung through the plow blade from the barge, and as the plow moves forward, the cable runs through the blade and is left embedded at a pre-determined depth underneath the seafloor.

Q. Please describe the process for making landfall on both the western and eastern sides of Little Bay.

A. The west shore of Little Bay will be the initial landing site for all three cable runs. They will terminate on the East shore. The cables will be landed into a common open-cut trench at each landing area. These trenches will extend as far seaward as practicable as can be reached by a tracked excavator at low tide. The landing trenches will be dug deep enough that a minimum of 42 inches of cover from the top of installed cables is met. The common landing trenches will be approximately 3 to 5 feet in width. Personnel staffed at the beach landings will include experienced project managers familiar with cable landing operations, field supervisors, and site engineers.

A jet plow will be set as close to the shoreline as possible at high tide to minimize the amount of diver burial between the end of the open-cut landing trench, and the start of the plow launch position. The cable, strung through the plow at its initial launch position, will be hauled ashore until its end is at the position of the transition structure with a suitable amount of over-pull to allow the cable engineers to terminate the end at the transition structure. Once the cable end is secured ashore, the jet plow will start moving seaward along the planned route. This initial landing procedure will be performed for all three cable installation runs.

The Eastern shore landing will be the final landing site for all three cable runs. The jet plow will be towed as close to the shoreline as possible at high tide to minimize the amount of diver burial between the plow recovery position and the end of the open-cut landing trench. At the Eastern shore landing, the cable will be unloaded from the jet plow by divers. A sufficient amount of cable to reach the termination point will be floated from the barge and pulled to shore. This initial landing procedure will be performed for all three cable installation runs.

Q. Please describe the submarine cable installation process.

A. Submarine power cable installation will be performed from an installation barge equipped with a four point mooring system. The lay barge will be fitted with a Differential Global Positioning System (“DGPS”), which will allow for the precise positioning of the lay barge and towed jet plow system.

The installation plan calls for laying the submarine cables from reels in three continuous parallel runs from shore to shore. The first installation run will include one power cable segment with one externally strapped fiber optic cable segment bundled in the same trench. The second installation run will include one power cable segment with one externally strapped fiber optic cable segment bundled in the same trench. The third installation run will include one power cable segment. The cables will be installed using the jet plow.

Following each jet plow operation, the lay barge will be towed back to the staging port to load the next reel of cable segments.

The cable lay barge, typically a 180'x 54' barge, will be fitted with a four point anchor winch system, and may also include a centrally placed pulling anchor. All anchors will be controlled by anchor winches on the barge, this will allow precise movement of the barge across Little Bay by controlling the anchor wires.

The cable lay barge is fitted with a DGPS that is capable of positioning the barge and jet plow to +/- 1.0 meter accuracy. The lay barge will be supported by a dedicated support tug boat, a crew boat to ferry crew and customer representatives to and from the barge, and several small work skiffs.

The jet plow will be controlled from the barge utilizing a program that allows for the accurate real-time measurement of cable positioning as the installation occurs, residual cable tension, and burial depth.

Cable handling will be controlled utilizing specialty linear cable engines and powered reel stands to precisely control the pay-out and hold-back of the cables during the installation operations.

Cable landfall operations will include the use of a large winch on the beach. This will be used to haul the cable end onto the beach at the beginning and the end of each cable laying and burial run. The winch will be fitted with a dynamometer to ensure the cable tension during the pull-in operation stays within LSCA recommended ranges.

Per National Electrical Safety Code ("NESC") requirement, the minimum the submarine cable can be buried at any point is 42 inches. The 42-inch requirement will extend from the landing trench out to the start of plow burial. Once the plow progresses to the line delineating the deep water channel, the plow blade will be lowered to the 8-foot burial depth. A typical 30 foot separation between the cables is required in the area where jet-plow installation is taking place, as this is the minimum safe working distance of the plow from each previously installed cable section. Wherever a 42-inch burial cannot be achieved with the jet-plow, articulated concrete mattresses will be installed over the top of the submarine cables as required. The intent of the concrete mattresses is to provide the submarine cables with robust, permanent protection from forces of external aggression such as anchors and fishing gear strikes.

Each run will have an initial cable landing on the Western shoreline, and be installed from West to East. The final landing (end being floated in) will occur from the end of plow position to the Eastern landing.

The remaining sections of cable between the open-cut trench on the shorelines and the end of the jet plow operation will be buried by divers using a hand jetting process. Prior to the start of diver burial operations at the Western shore landing area, a turbidity curtain will be deployed surrounding the entire work area. As divers bury the cable utilizing a jet hose, the deployed turbidity curtain will create a barrier to prevent suspended particulates from being allowed to migrate from the vicinity of the work area. Stronger currents preclude deployment of turbidity curtains in the deeper sections of the bay. Prior to the start of diver burial operations at the Eastern shore landing area, a turbidity curtain will be deployed around the intertidal portion of the work area. As divers bury the cable utilizing a jet hose, the deployed turbidity curtain will create a barrier to prevent suspended particulates from being allowed to migrate from the vicinity of the work area. See Attachment F for "Driver Jet Burial Procedure."

Q. How will PSNH ensure that the underwater segments of the Project comply with all of the requirements of the Certificate of Site and Facility when implementing the construction plan, including, the conditions set under each State and federal permit?

A. PSNH will require all contractors to comply with the requirements identified in the Certificate of Site and Facility in performance of this installation. The installer will be required to provide all as-built documentation for submittal to NOAA for the purposes of nautical charting. Per final permit requirements, it is anticipated that an environmental monitor will be on-site during the marine operations.

Q. Please describe any maintenance that is required for an underwater electric transmission line of this nature.

A. Typically, no maintenance is required on a buried submarine cable. Should a break occur due to a high voltage blowout or fault due to external aggression, the cable will be cut, raised to the surface, a section of new cable spliced in, laid on the seafloor, and diver buried and/or covered with an articulated concrete mattress.

Amendment to Application

Q. Have you reviewed the amended Project Description?

A. Yes, I have.

Q. Does the amended Project Description change anything to the pre-filed testimony originally submitted by Mr. Marc Dodeman of CMI?

A. No, it does not. The submarine cable design and installation across Little Bay has not changed since originally filed with the SEC.

Q. Does this conclude your testimony?

A. Yes.

ATTACHMENT A.

RESUME OF WILLIAM F. WALL

William F Wall

BIOGRAPHICAL DATA

Bill Wall has over 40 years of worldwide offshore marine experience specializing in submarine cable, marine utility and offshore wind projects. He has held positions ranging from sales, marketing, project management, contract negotiation and project implementation in the marine construction industry for companies including his previous positions at offshore wind developer Deepwater Wind, Caldwell Marine International, General Dynamics, Cable & Wireless PLC and British Telecom. He is currently the Marine Operations Director at The Atlantic Wind Connection. Having worked on projects as diverse as, submarine cable repair/installation, offshore wind farm installation, submarine pipeline projects and offshore oil & gas drilling Bill is well versed in the planning process and the day to day operational aspects of submarine cable projects. Very comfortable in presenting to any and all stakeholder groups, particularly skilled in delivering Power Point presentations and have often presented at industry conferences and seminars.

Mr. Wall received his Final Certificate from the City & Guilds Engineering Institute of London.

DOB: March 1 1952
Citizenship: US Citizen
Address: 42 Curtis Avenue, Manasquan NJ 08736 USA
E-mail: bill.wall@lscableamerica.com

RECENT CAREER REVIEW

LS Cable America

Joined LS Cable America in December 2015, as Project Director, have conducted operations across the full spectrum of submarine cable developments. Some highlights are:

- Sea-to-Shore 20 mile + submarine transmission cable Block Island RI to Mainland RI
- 230KV Submarine Cable Interconnector NY to VT for New York Power Authority
- 138KV Submarine Cable Interconnector PEI to New Brunswick Northumberland Strait, Canada
- Contract administration interface with utilities and system owners
- Operations interface with all major subcontractors

Atlantic Wind Connection

Joined AWC in May 2011, as Director, Marine Operations but have conducted operations across the full spectrum of project development. Some highlights are:

- Initiated Master Service Agreement (MSA) process to hire major sub-contractors
- Authored & developed RFP/specification documents for major engineering/geo-tech/geophysical contractors
- Reviewed all major subcontract bids, adjudicated bid process and hired successful bidders
- Conducted Desk Top Study processes
- Operations interface with EPC contractor (Bechtel)
- Conducted major port study with EPC contractor to vet mobilization & fabrication capabilities
- Developed & operated a web based supply chain portal to enable local supplier registration
- Actively recruited local, qualified vendors and sub-contractors to join the supply chain

- Provided supply chain portal template and operating model to BizMDOSW organization.
- Developed and authored Method of Procedure (MOP) documents for submarine cable system installation
- Developed and authored Method of Procedure (MOP) for jacket foundation operations
- Authored various technical chapters of the General Activities Plan (GAP) submittal to BOEM
- Interfaced with Labor organizations and contractors
- Responsible for both state & federal permitting activities for AWC.
- Main interface with BOEM, USACE and state DEP departments.
- Developed PAM acoustic responses to NMFS as part of USACE NWP 6 application
- Received NWP 6 from USACE for survey operations of Mid-Atlantic
- Developed survey & crossing plan with 10 existing submarine cable owners

Deepwater Wind

Joined Deepwater November 2007 (3rd employee on team), official title VP Marine Operations but again conducted operations across the full spectrum of project development. Some highlights are:

- Part of team that developed Joint Venture with PSEG to form Garden State Offshore Energy in NJ
- Developed technical presentations to NJ BPU & RI PUC as part of state OSW competition
- Technical member of team that wrote original proposals for the Block Island Wind Farm project
- Technical interface with Turbine manufacturers
- Developed the original submarine cable plan for the 34.5kv BITS & BIWF cable systems
- Authored original RFI for Block Island cable projects with multiple manufacturers
- Developed RFP/specification documents for engineering/geo-tech/geophysical subcontractors
- Reviewed all major subcontract bids, adjudicated bid process and hired successful bidders
- Conducted Desk Top Study program(s)
- Developed and managed geophysical survey campaigns NJ & RI in within BOEM/USACE regulations
- Specified and assembled team (drill ship, driller and geo-tech engineer firm) to conduct deep-bore drilling campaigns in accordance with BOEM/USACE requirements
- Developed and managed operations on deep bore geo-technical programs, 8 holes off RI and 1 hole off NJ all to +/- 300' depth. Due to Hurricane I had to develop and negotiate a stand-by agreement with drill ship.
- Interfaced with Supply Chain and contractors
- Developed and managed floating Lidar program offshore RI. Hired & managed CVA contractor for BOEM requirements. Installed first tension leg buoy with Zephyr Lidar system on board.
- Interface with foundation fabricators: visited major jacket/mono pile yards in GOM region.
- Interface with US Navy & existing submarine cable owners.

US Offshore Wind

I am experienced in all BOEM requirements both for OSW leases and transmission cable ROW in accordance with 30CFR585. I have worked closely with and know personally all US offshore wind developers and most of their management and financial equity teams.

European Offshore Wind

I have stayed current with the OSW industry in Europe, especially from the submarine cable aspect. I have good relationships with many in Europe on both the developer front and the supply chain. I have built good relationships with key staff at DONG, Elia and 50Hz (Belgium & Germany).

Submarine Cable Supply & Installation

I am well known by all in the submarine cable industry both on the supply/installation side and the utility/owners side. I have worked with many of the US & Canadian utilities (NYPA, N-Star, NGrid, PSEG, Smeco, BC Hydro etc) on major submarine cable projects. I know all the major engineering/environmental/permitting consultant firms who have worked on submarine cable and/or offshore wind projects. (Black & Veatch, AECOM, Mott MacDonald, Tetra Tech etc)

Merchant & Rate Based Transmission

Due to the inherent opposition in the US to overhead high voltage transmission lines many developers are now turning to innovative submarine cable solutions for long-haul transmission requirements. These projects can be either on a "Merchant" basis or a "Rate Based" approach. Either approach requires close interface with grid and Independent System Operators (ISO) such as PJM, NYISO, ISO New England etc. I am very familiar with this type of approach from a technical, business and financial point of view.

References

References from industry professionals are available upon request.

WILLIAM F. WALL (BILL)

Summary of Experience:

Mr. Wall has over 40 years of worldwide marine construction experience specializing in submarine power transmission cable and offshore wind development. In-Depth knowledge of the complete offshore wind and submarine power cable development, procurement and implementation processes.

Sales, marketing and contract negotiation experience covering the complete spectrum of marine projects, including risk management, insurance, indemnity, warranty and other contract areas. Project development & financing. Labor & project staffing experience in the marine market. Supply chain creation & management.

Hands-on project management experience in marine construction and offshore utility projects. Qualified in all aspects of submarine utility burial and embedment. Extensive experience in permit application and retention. Full scope of regulatory interface including outreach and stakeholder engagement.

Representative Projects: Representative Projects in which Mr. Wall has participated are outlined below:

- *Long Island NY:* 345kV NYPA Submarine power transmission cable project – Lay & burial of 4 EHV SCFF cables across LI Sound. Project Manager for cable embedment.
- *San Juan Islands WA:* Turnkey supply and installation of a 69kV 3/C submarine power transmission cable system inter-connecting 4 islands. All buried to 2m burial depth.
- *Rockland ME:* Fox Island Project - Turnkey supply and installation of 16kM of 35kV 3/C submarine power transmission cable buried to 2m burial depth.
- *Long Island NY:* ConocoPhillips Project – Major marine construction upgrade to the ConocoPhillips offshore loading facility in Long Island Sound, including the installation of 60" diameter mono-piles, 170' in length.
- *Vancouver Is. – WA State:* Installation of 3x SCFF 242Kv Submarine power transmission cable system 33km in length
- *Long Island NY/Norwalk CT:* Cross Sound Cable – Standby repair contract for the HVDC submarine power transmission cable system connecting Connecticut and New York across LI Sound.
- *London, England:* Centrica Project – Consultant contract to advise a major UK OSW developer on the installation of shallow water submarine cables off the coast of England. Desk Top Study presented to upper management in London.
- *Rhode Island & New Jersey*: Development of offshore wind farms & associated submarine cable systems
- *US Mid-Atlantic Region*: Development of an offshore Multi-Terminal HVDC submarine cable system (AWC)

Education: City & Guilds Engineering Institute London, Final Certificate 1975-1979

Professional History:

LS Cable America Inc.: Project Director 2015 -Present
Atlantic Wind Connection: Dir. Marine Operations 2011 - 2015
Deepwater Wind: VP 2007 - 2011
Caldwell Marine International: Business Development 2003 – 2007
General Dynamics: VP Business Development: 2001 - 2003
Margus Co. Inc: Vice President Operations: 1983 – 2001
Cable & Wireless (Marine): Submarine Cable Engineer: 1972-1983
British Telecom: Underground OSP Engineer: 1968 - 1972

Professional Certifications:
Offshore Survival & Operations Training Courses
Various Computer Application Courses

ATTACHMENT B.

LS CABLE & SYSTEM: SUBMARINE POWER CABLES 2017

Submarine Power Cables - 2017

LS Cable & System

Enable the Cabled World

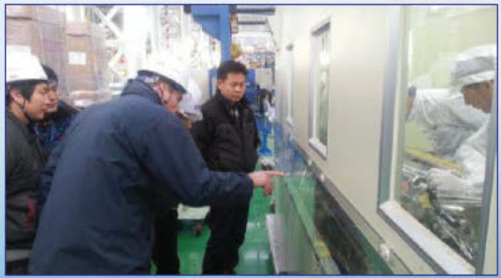
LS Cable & Systems – South Korea

Head Office

Central Research Lab

Donghae Plant

LS Cable & Systems – Manufacturing Process Donghae Plant



Selected Global Project Supply Experiences






Van Oord (Eneco)	Dong Energy	Energinet.dk	ZTT (Corpoelec)	Qatar Petro.	KEPCO
HVAC 150kV	HVAC 150kV	HVDC 285kV	HVAC 230kV	HVAC 132kV	HVDC 250kV
25.7km	10.5km	23.5km	40km	100km x 2	3 x 101.3 km
EPC	EPC	EPC	EPCI	EPCI	EPCI
2013-2015	2012-2014	2013-2014	2012 -2015	2012 - Present	2009 - 2012

North American Submarine Cable Projects

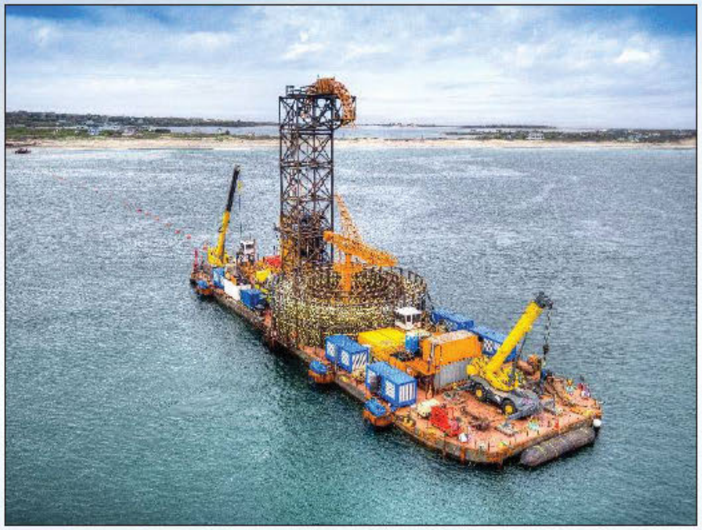
Client	Project	Voltage	Contract
National Grid	Captree Island NY	35KV AC 3/C	S & I
NYPA	NY – Vermont Interconnector	230KV AC 1/C	EPC
Maritime Elec.	PEI – NB Interconnector	138KV AC 3/C	EPC
Deepwater Wind	Block Island Wind Farm	35KV AC 3/C	S & I
National Grid	Block Island Transmission	35KV AC 3/C	S & I

Captree Island NY Submarine Cable Project

SUBMARINE CABLE PROJECT

- Engineering & Project Planning
- Cable Manufacturing & Shipping
- RC/PLGR
- Initial Landing
- Cable Burial by Plow
- Final Landing

Block Island RI Submarine Cable Project



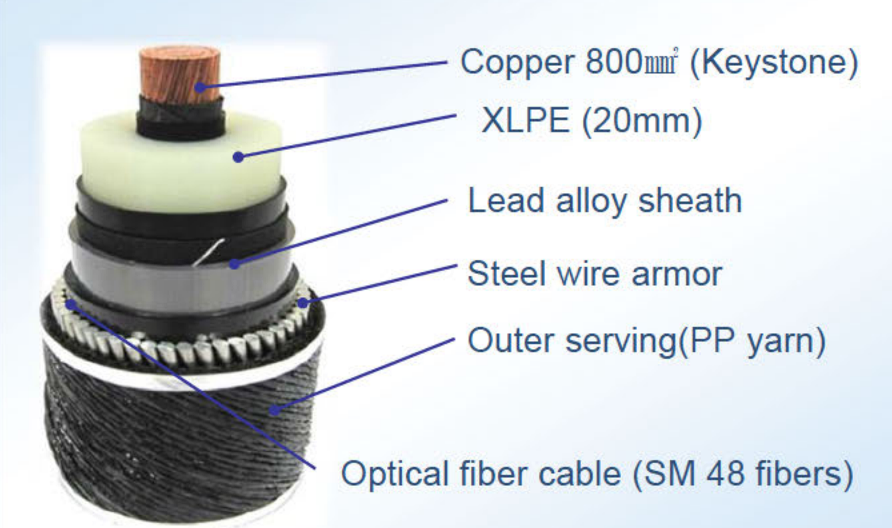
SUBMARINE CABLE PROJECT

- Engineering & Project Planning
- Cable Manufacturing & Shipping
- RC/PLGR
- Initial Landing
- Cable Burial by Plow
- Final Landing

AC 230kV XLPE Margarita Island Interconnector (Turnkey)

Project Site & Cable Route

Cable Construction



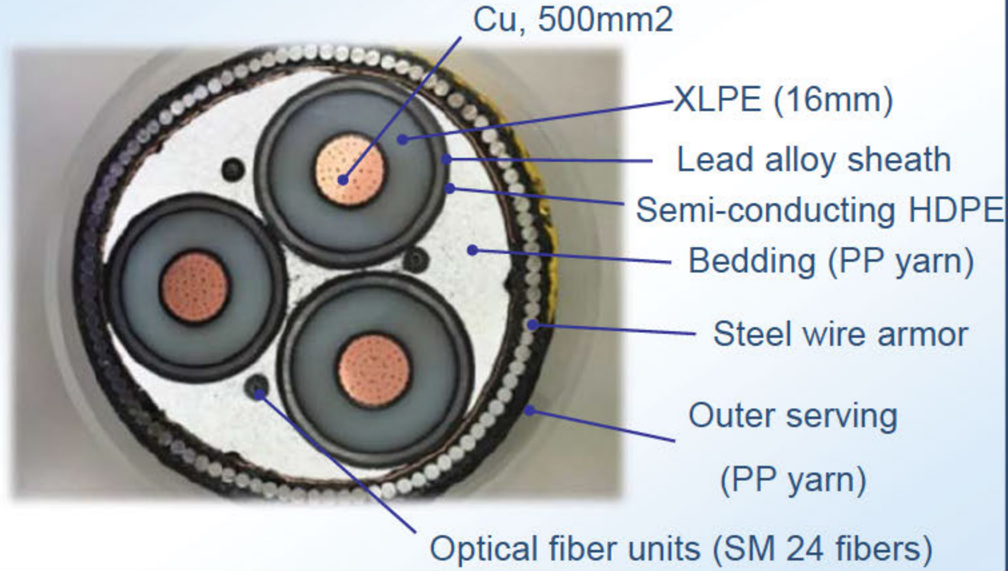
Project Descriptions

Customer	Corpoelec
Capacity / Voltage	350 MVA / AC 230kV
Outer dia. / Weight in air	134mm / 42 kg/m
Route length	Total 80km (1cct + 1 spare line)
Water depth	Up to 80m
Period	Jul. 2012 - May 2015

AC 132kV XLPE Halul Island Interconnector (Turnkey)

Cable Route

Cable Design



Customer Name	Qatar Petroleum
Contact Point	almarri@qp.com.qa
Capacity	200MW (100MW x 2ccts)
Outer dia. / Weight in air	193mm / 72 kg/m
Cable length / Water depth	2 x 100km / Up to 40m
Period	May 2012 ~ Jun. 2016 (Ongoing)
Installation partner	Jan De Nul (protection by Canyon)

AC 132kV XLPE Halul Island Interconnector (Turnkey)

Cable Transfer

Loaded Turntables

Cable End Cut

Shore Landing

Transition to Land

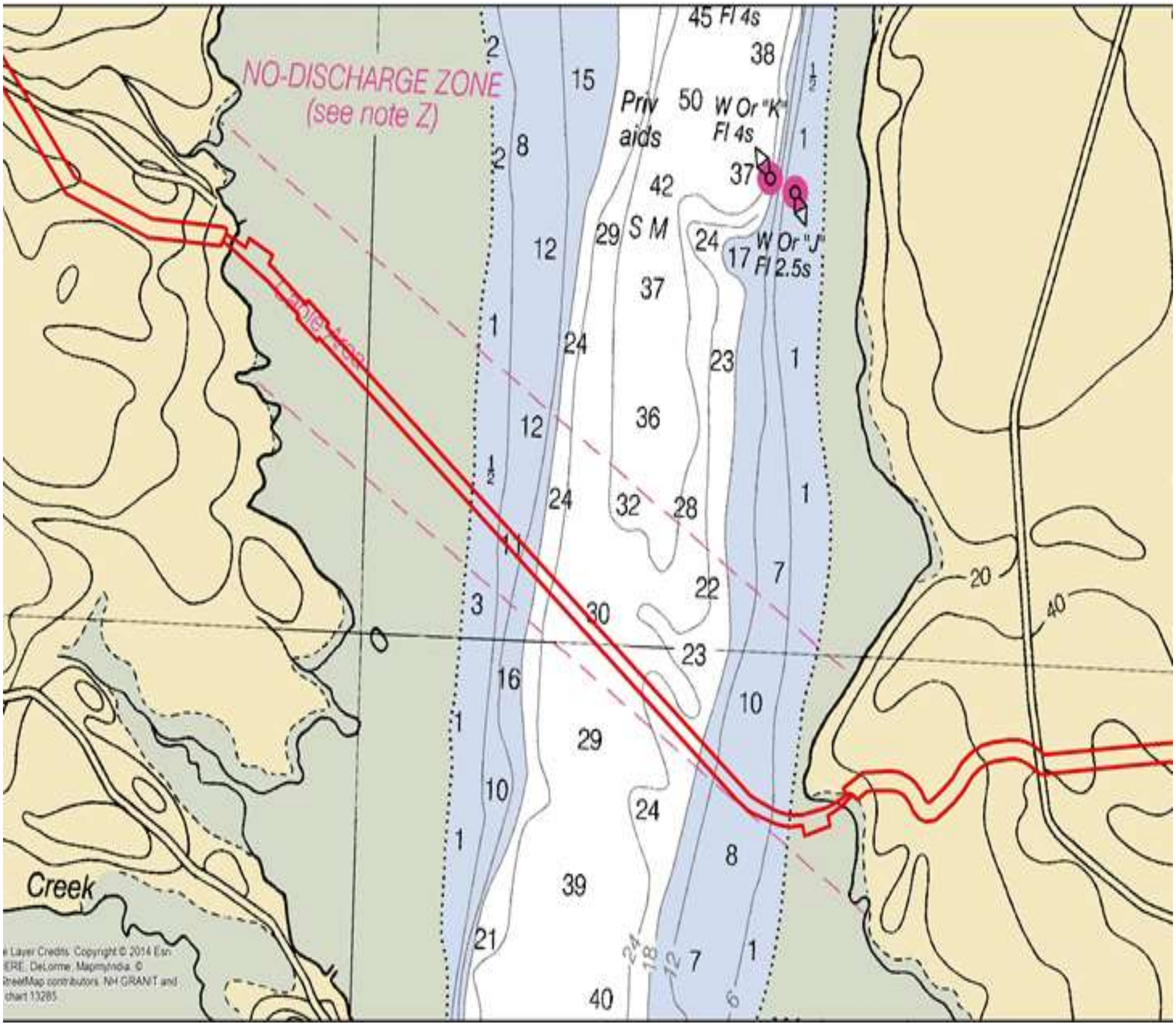
Substation Construction

Thank You

LS Cable & System

ATTACHMENT C.

NOAA CHARTLET LITTLE BAY CROSSING



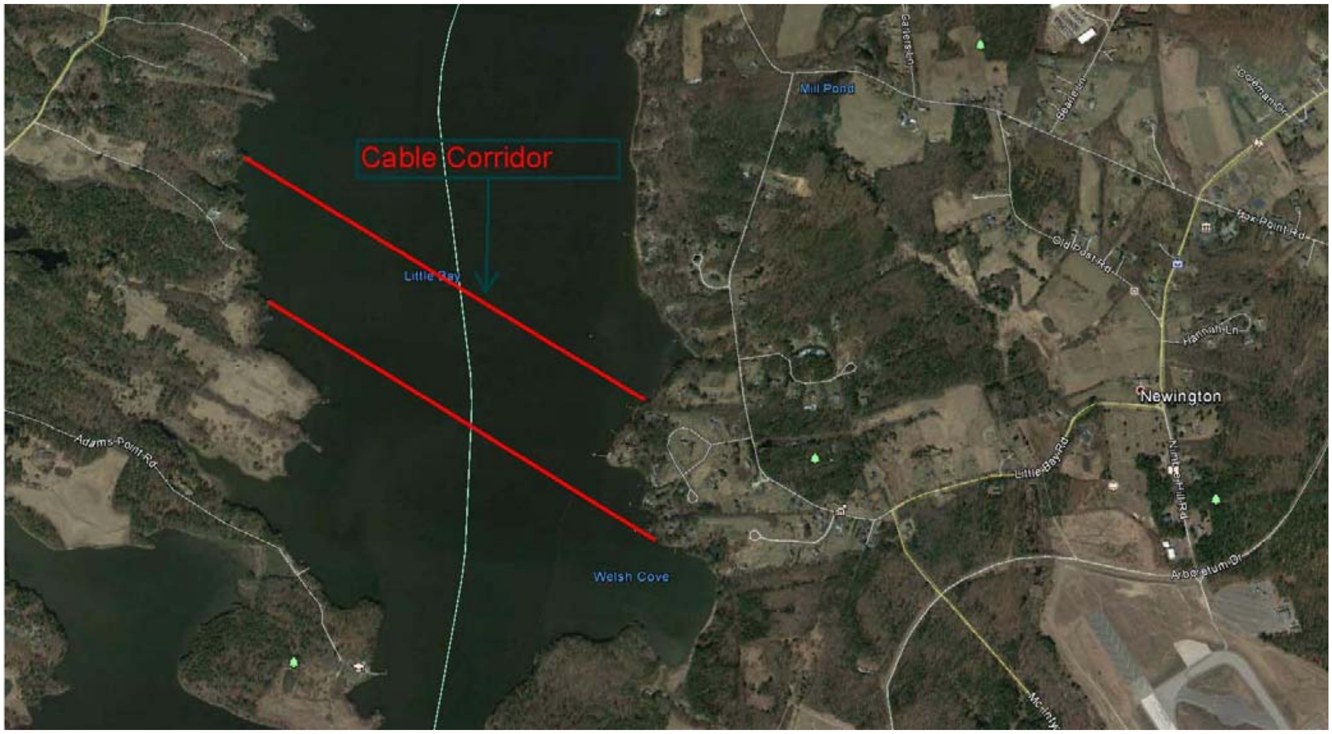
NO-DISCHARGE ZONE
(see note Z)
Priv aids
45 Fl 4s
W Or "K" Fl 4s
W Or "J" Fl 2.5s
S M
Creek

ATTACHMENT D.

F107 CABLE SURVEY FINAL REPORT

Caldwell
Marine International, LLC

PSNH – F107 CABLE SURVEY
FINAL REPORT



Presented to Public Service New Hampshire / Northeast Utilities

31 July, 2014

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Introduction and Project Background

In May 2014, Public Service New Hampshire following their review of bids received for the supply and installation of the F107 cable system, invited bid teams (submarine cable manufacturers / installers) to provide technical presentations of their installation proposals. During the review of Caldwell Marine's installation pricing and methodologies, the requirement to clear the submarine cable corridor (see **Figure 1**) in Little Bay (West of Newington, NH) was discussed.

Since this cable corridor is populated by four existing out-of-service PSNH cables, the section of the corridor being considered for the new F-107 cables must be cleared of existing utilities to allow unhindered cable plow burial during installation operations. Public Service New Hampshire contracted Caldwell Marine International, LLC to conduct a dive investigation of the four existing out-of-service cables that cross Little Bay.

During the week of July 14, 2014, Caldwell Marine conducted a diver investigation and hydrographic sounding survey within the Public Service of New Hampshire cable corridor spanning Little Bay.

Project Area (from NOAA Chart 13285)

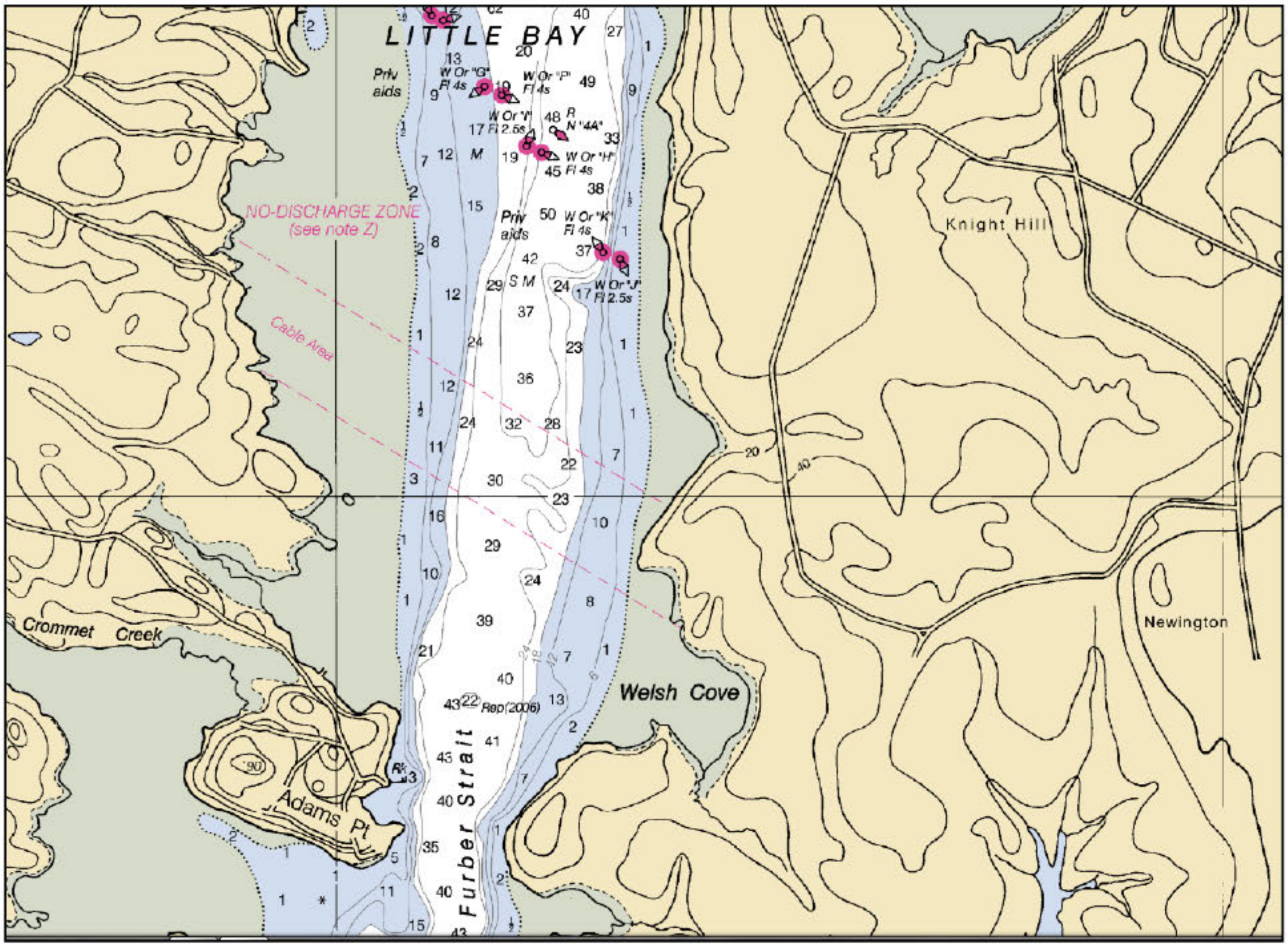

Figure 1. Little Bay Cable Corridor

The primary focus of this survey was to determine existing out of service as-laid cable locations and cable conditions for consideration of recovery operations in preparation of the route design of the future F107 transmission project.

Owner Supplied Areal Information

In April 2013, Ocean Survey, Inc (OSI) conducted a full scale hydrographic survey, which included side scan, magnetometer, and sub bottom profile data collection within the cable corridor (**Figure 2**).

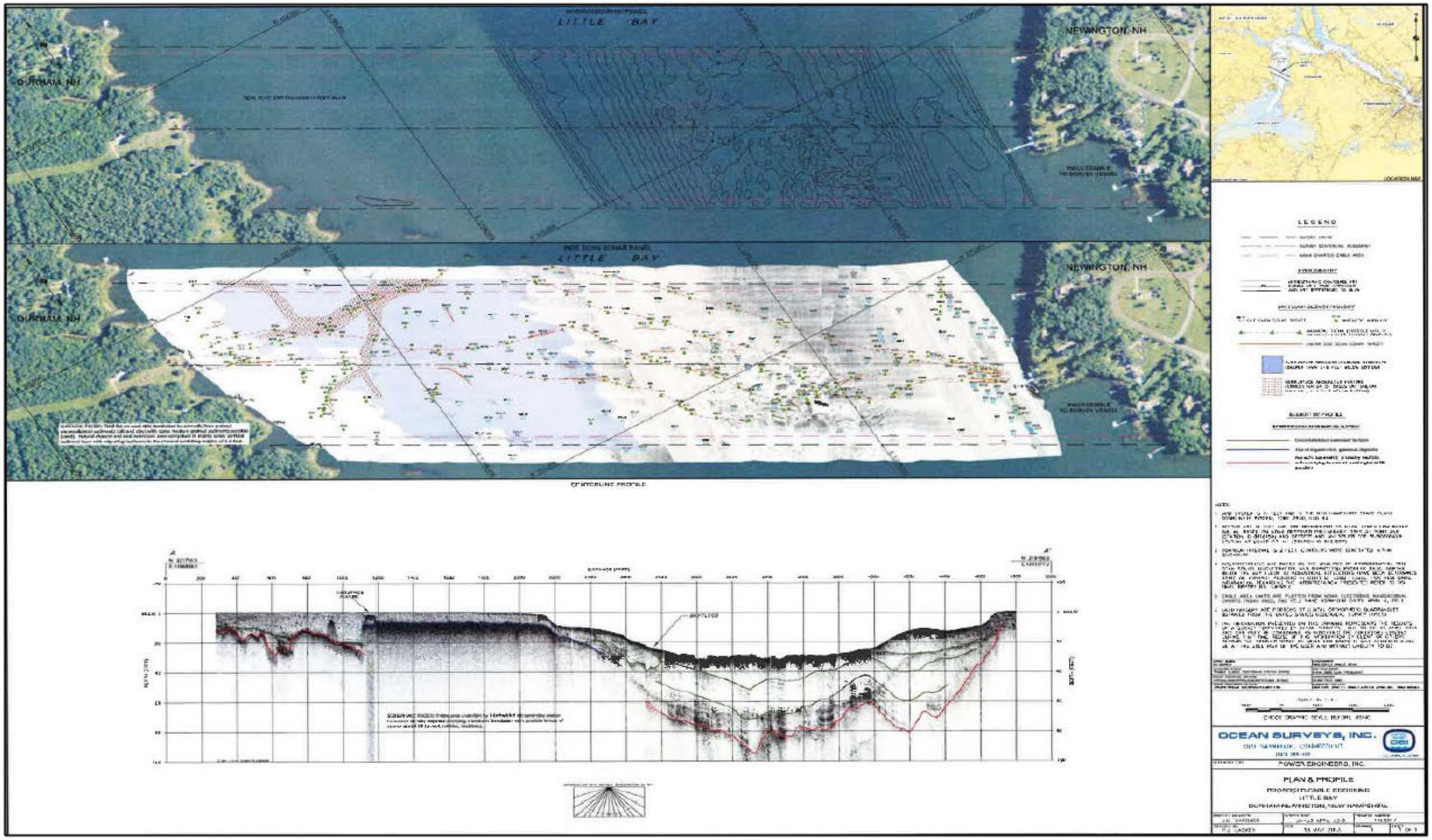

Figure 2: OSI Survey Drawing

This survey identified the four (4) existing out of service cables, as well as other anomalies, within the corridor. Due to the existing cables being located mostly in the northern half of the cable corridor, CMI advised PSNH that the most feasible route for a new cable would be in the southern part of the corridor (**Figure 3**.)

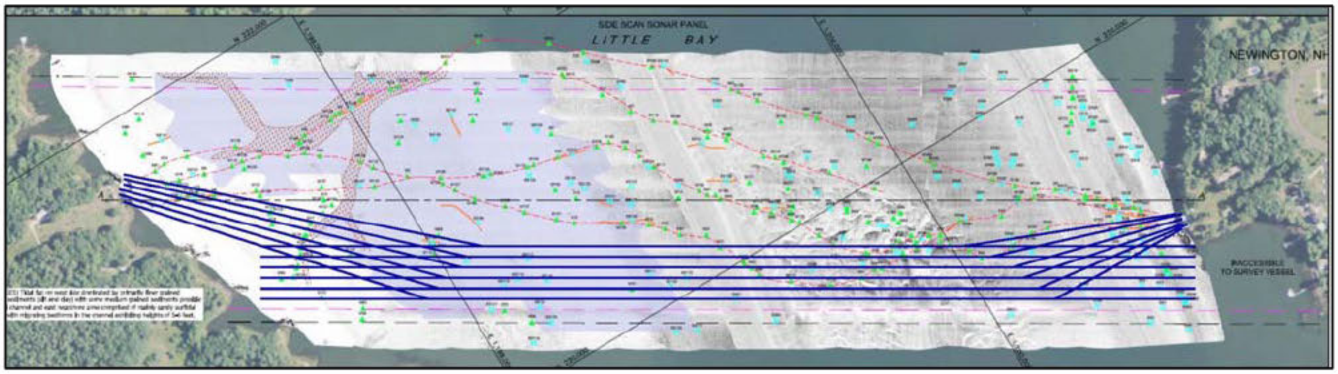

Figure 3

CMI divers first inspected the cable corridor where the new system would most likely be obstructed by the existing cable segments. CMI divers then proceeded along the proposed cable route inspecting for any other possible obstructions. Finally, divers searched for the other existing cables in the northern half of the corridor to verify the as-laid position of the remaining out of service cable segments, and determine their condition and depth.

Surface supplied dive operations were conducted from the *Little Johnny*, a 26' aluminum hulled work vessel. Survey operations were conducted from the *Little Lexi*, a 25' aluminum hulled shallow water survey vessel.

Upon arrival at the work site, utilizing a Differential Global Positioning System (DGPS,) the CMI team located the position of the existing four cables at the approach to the Eastern shore (**Figure 4.**) These locations were consistent with the OSI drawings provided. Over the next four days, divers followed the cables westerly across Little Bay marking as-laid position, overall cable condition, and depth of burial. Divers also investigated the various anomalies identified in the OSI as-found survey drawing and found them to be sunken trees and light debris covered by sand overburden.

Figure 4: View of the work area at the Eastern Shore landing approach; floats were affixed to the as-found cables by divers.

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Marine International, LLC

Summary of Field Investigation Operations

Public Service New Hampshire
As-Found Cable Dive Investigation and Sounding Survey

Coordinate System Ref: State Plane
Datum: NAD 83
Zone: 2800-New Hampshire
Units: U.S. Survey Foot

Cables numbered 1-4 from South to North
Soundings Referenced to MLLW in feet

			Geoid		NAD 83		Water	Burial	
Date	**Dive #**	**Cable #**	**Latitude**	**Longitude**	**Northing**	**Easting**	**Depth (ft)**	**Depth (in)**	**Cable Condition and Bottom Notes**
15-Jul-2014	1	1	43° 05.9263' N	70° 51 3857' W	219269 20	1200652.47	11.9	0	Pt. 5873. 3"Cable in good condition. Recoverable. Compact gravel bottom.
15-Jul-2014	1	1	43° 05.9233' N	70° 51 3763' W	219251 06	1200694.60	11.6	0	Pt. 5875. 3"Cable in good condition. Recoverable. Compact gravel bottom. SS126, M71
15-Jul-2014	1	2	43° 05.9249' N	70° 51 3745' W	219260 88	1200702.54	11.3	0	Pt.5876. 1" cable in good condition. Recoverable. Compact gravel bottom.
15-Jul-2014	1	3	43° 05.9326' N	70° 51 3707' W	219307 81	1200719.00	11.0	0	Pt.5877. 1" cable in good condition. Recoverable. Compact gravel bottom.
15-Jul-2014	1	4	43° 05.9357' N	70° 51 3660' W	219326 85	1200739.74	10.6	0	Pt. 5878. 1" Cable in good condition. Gravel bottom.
15-Jul-2014	1	1	43° 05.9368' N	70° 51.4027' W	219331 96	1200576.10	12.0	0	Pt. 5879. 3"Cable in good condition. Recoverable. Compact gravel bottom.
15-Jul-2014	2	1	43° 05.9523' N	70° 51.4482' W	219424.15	1200372.86	15.0	3-6	Pt. 5880. 3"Cable in good condition. Recoverable. Compact gravel bottom.
16-Jul-2014	1	1	43° 05.9401' N	70° 51.4081' W	219351 81	1200551.89	12.0	0-3	Pt. 5883. 3"Cable in good condition. Recoverable. Compact gravel bottom.
16-Jul-2014	1	1	43° 05.9473' N	70° 51.4280' W	219394.69	1200462.88	12.0	0-3	Pt. 5925. 3"Cable in good condition. Recoverable. Compact gravel bottom.
16-Jul-2014	1	1	43° 05.9524' N	70° 51.4491' W	219424.77	1200368.66	15.2	3-6	Pt. 5926. 3"Cable in good condition. Recoverable. Compact gravel bottom.
16-Jul-2014	1	1	43° 05.9536' N	70° 51.4617' W	219431 51	1200312.50	19.0	3-6	Pt. 5929. 3"Cable in good condition. Recoverable. Compact gravel bottom. M167, M192
16-Jul-2014	1	1	43° 05.9543' N	70° 51.4767' W	219435.12	1200245.69	24.0	12	Pt. 5931. 3"Cable in good condition. Recoverable. Compact gravel bottom. M35, M188
16-Jul-2014	1	2	43° 05.9342' N	70° 51 3903' W	219316.69	1200631.66	12.0	0-4	Pt. 5932. 1"Cable in good condition. Recoverable. Compact gravel bottom. M153.
16-Jul-2014	1	2	43° 05.9430' N	70° 51.4076' W	219369.40	1200554.13	12.0	0-4	Pt. 5933. 1"Cable in good condition. Recoverable. Compact gravel bottom.
16-Jul-2014	1	2	43° 05.9486' N	70° 51.4245' W	219402.69	1200478.58	12.0	0-4	Pt. 5937. 1"Cable in good condition. Recoverable. Compact gravel bottom.
16-Jul-2014	1	2	43° 05.9602' N	70° 51.4447' W	219472 29	1200387.98	14.6	1-5	Pt. 5939. 1"Cable in good condition. Recoverable. Compact gravel bottom.
16-Jul-2014	1	2	43° 05.9708' N	70° 51.4665' W	219535.74	1200290.32	22.0	1-6	Pt. 5941. 1"Cable in good condition. Recoverable. Compact gravel bottom. M44
17-Jul-2014	1	2	43° 05.9708' N	70° 51.4665' W	219535.74	1200290.32	27.9	10	Pt. 5942. 1"Cable in good condition. Recoverable. Compact gravel bottom.

Caldwell
Marine International, LLC

Public Service New Hampshire
As-Found Cable Dive Investigation and Sounding Survey

Coordinate System Ref: State Plane
Datum: NAD 83
Zone: 2800-New Hampshire
Units: U.S. Survey Foot

Cables numbered 1-4 from South to North
Soundings Referenced to MLLW in feet

			Geoid		NAD 83		Water	Burial	
Date	Dive #	Cable #	Latitude	Longitude	Northing	Easting	Depth (ft)	Depth (in)	Cable Condition and Bottom Notes
16-Jul-2014	1	2	43° 05.9761' N	70° 51.4788' W	219567.46	1200235.06	25.3	4-6	Pt. 5943. 1"Cable in good condition. Recoverable. Compact gravel bottom. M44
16-Jul-2014	1	2	43° 05.9877' N	70° 51.5010' W	219636.92	1200135.75	27.4	0	Pt. 5944. 1"Cable in good condition. Recoverable. Compact gravel bottom. Cable on surface. SS52, M165
16-Jul-2014	1	2	43° 06.0008' N	70° 51.5227' W	219715.57	1200038.39	28.0	6-8	Pt. 5945. 1"Cable in good condition. Recoverable. Compact gravel bottom. SS52, M166
16-Jul-2014	1	2	43° 06.0065' N	70° 51.5309' W	219749.84	1200001.56	30.0	12	Pt. 5946. 1"Cable in good condition. Recoverable. Compact gravel bottom. SS52, M167
16-Jul-2014	2	1	43° 06.1121' N	70° 51.7867' W	220380.38	1198856.76	10.9	0-3	Pt. 5950. 3"Cable in good condition. Recoverable. Compact gravel bottom. M15, SS132
16-Jul-2014	2	1	43° 06.0928' N	70° 51.7586' W	220264.34	1198982.96	14.0	3	Pt. 5951. 3"Cable in good condition. Recoverable. Compact gravel bottom. M97
16-Jul-2014	2	1	43° 06.0800' N	70° 51.7404' W	220187.36	1199064.72	18.3	5	Pt. 5952. 3"Cable in good condition. Recoverable. Compact gravel bottom. M67
16-Jul-2014	2	1	43° 06.0719' N	70° 51.7335' W	220138.45	1199095.90	20.5	0	Pt. 5953. 3"Cable in good condition. Recoverable. Compact gravel bottom. M67, M21
16-Jul-2014	2	1	43° 06.0512' N	70° 51.7236' W	220013.13	1199141.18	23.7	0-4	Pt. 5954. 3"Cable in good condition. Recoverable. Compact gravel bottom. M187, M20
17-Jul-2014	1	1	43° 06.0018' N	70° 51.6624' W	219715.71	1199416.29	32.0	0-12	Pt. 5958. 3"Cable in good condition. Recoverable. Compact gravel bottom. Southern most point of cable route. M40
17-Jul-2014	1	NA	43° 06.0162' N	70° 51.6629' W	219803.10	1199413.46	32.0	NA	Pt. 5960. Investigation of SS69. Found sand and gravel bank piled against tree.
17-Jul-2014	1	1	43° 06.0069' N	70° 51.6637' W	219746.45	1199410.35	32.0	24+	Pt. 5961. 3"Cable in good condition. Recoverable, but with 2' of burial. Compact gravel bottom. M40
17-Jul-2014	1	1	43° 05.9999' N	70° 51.6519' W	219704.29	1199463.24	32.0	18	Pt. 5963. 3"Cable in good condition. Recoverable, but with 1.5' of burial. Large anchor hooked on cable. Compact gravel bottom. M175
17-Jul-2014	1	1	43° 05.9999' N	70° 51.6519' W	219704.29	1199463.24	28.0	NA	Pt. 5964. 100' Circle search for Cable1, SS73, M180, M57. Tree with sand piled against it found.
17-Jul-2014	2	NA	43° 05.9926' N	70° 51.5796' W	219663.11	1199785.44	28.0	NA	Pt. 5965. Search for SS73, M180, M57. Sand and Gravel bank against tree.
17-Jul-2014	2	NA	43° 05.9589' N	70° 51.4781' W	219463.19	1200239.52	22.0	NA	Pt.5968. 50' circle search for SS50. Tree with sand piled against it.
18-Jul-2014	1	4	43° 05.9725' N	70° 51.4113' W	219548.44	1200535.93	12.0	0-6	Pt. 5972. 1" cable followed from Pt. 5878. A 2' square cinder mooring block SS12.
18-Jul-2014	1	3	43° 05.9686' N	70° 51.4236' W	219524.22	1200481.41	12.0	4-6	Pt. 5973. 1" cable followed from Pt. 5878. A 2' square cinder mooring block SS12.

Conclusions

Having made positive contact with all of the existing cables identified by the OSI survey within the PSNH charted cable corridor in a non-invasive visual dive survey, critically obstructive existing cable positions have been verified. In all diver reported accounts, the physical condition of all existing out of service cables were found to be structurally sound. The sediment found covering the cables in the inspection area trended toward soft, non-cohesive fine sands and soft mud with burial depths ranging from a maximum of 24” to areas of full exposure. Finally, divers reported that in none of the inspection sites were any of the cables found to be cemented in place by stiff sediment overburden or silt/clay accretion, which means that any of the cables within the corridor would be suitable for removal. It should be noted that the sections of the approach areas nearest to the landings areas are very shallow and inaccessible by boat. Should permitting or regulatory agencies require PSNH / NU to remove all existing cables identified during the survey within the corridor, it is probable that this could be achieved.

As per the originally anticipated design of the F-107 cable route, the new cables should be routed towards the Southern half of the charted cable corridor. Using an assumed minimum 10m separation between each new phase cable and a safety buffer zone on either side of each of the extend cables, it is recommended that at least 150-200m (~500-660 feet) from the southern edge of the cable route be cleared of existing cables and debris. Caldwell also recommends a route clearance swath towards the existing cable vaults being performed as needed where the cable route turns northerly towards the vaults at the landing approaches. This translates effectively to removing the two cable sections at a minimum:

1) The southernmost cable (identified as Cable #1) should be removed from the area of recorded data point 5876 across Little Bay to at least the area of recorded data point 5950.
2) Cable #2 (immediately north of Cable #1) should be removed from the area of recorded data point 5876 to ~500 feet west of recorded data point 5965.

An as-found drawing overview of data points collected by Caldwell Marine is shown in figure 5.

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Marine International, LLC

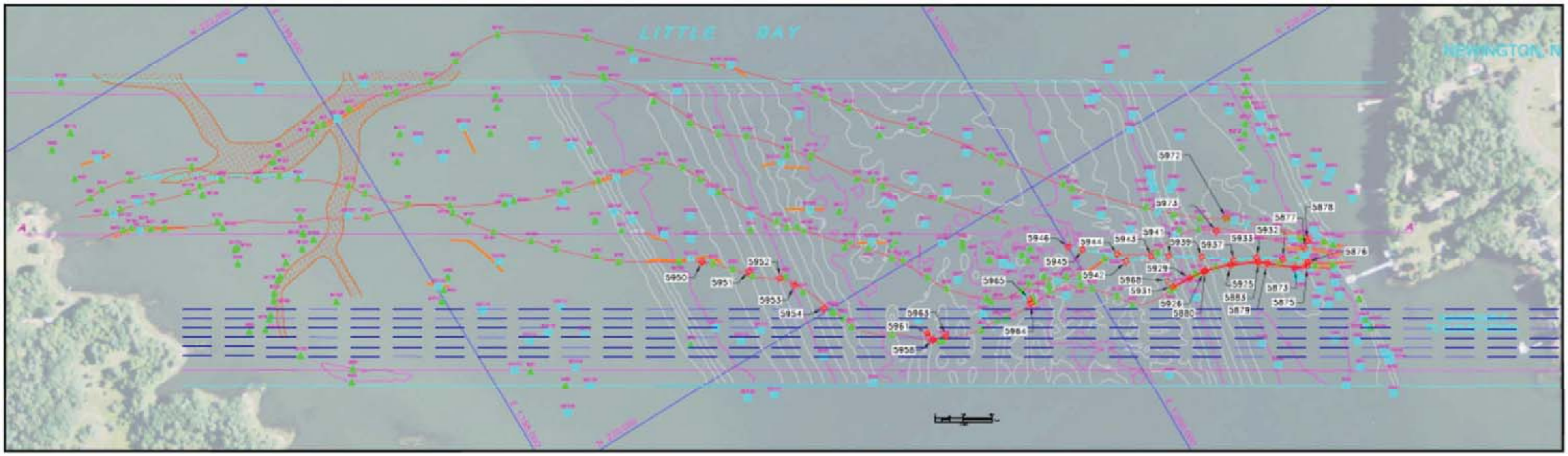


Figure 5.

ATTACHMENT E.

JETTING SLED DATA SHEET

kokosing INDUSTRIAL

DUROCHER MARINE DIVISION
958 NORTH HURON STREET | CHEBOYGAN MI 49721
PHONE 231.627.5633 | FAX 231.627.2646

Jetting Sled Data Sheet

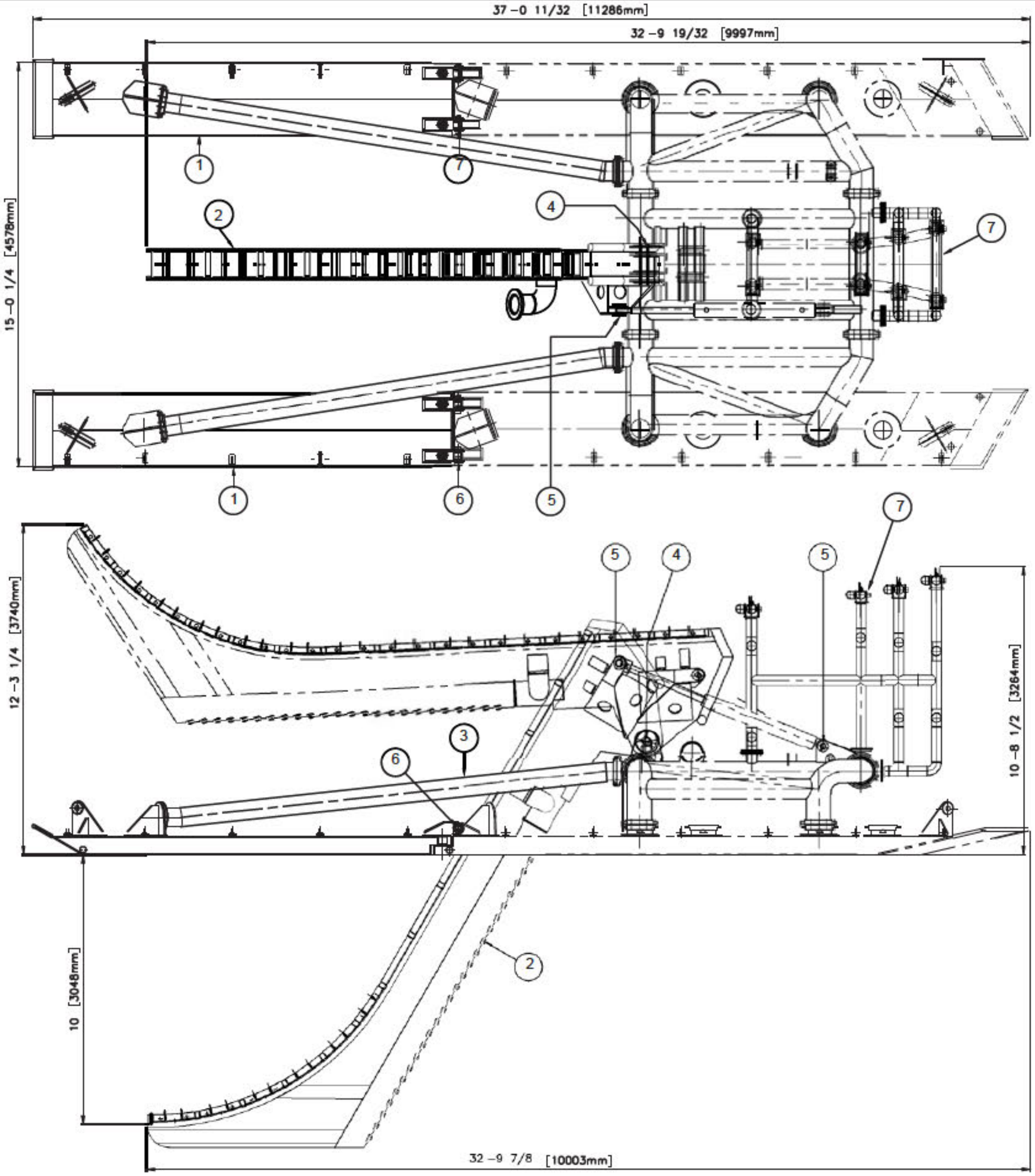
3 Meter Blade

958 North Huron Street
Cheboygan, MI 49721
Phone (231) 627-5633
Fax (231) 627-2646
www.durocher.biz

TABLE OF CONTENTS

1 <u>PHYSICAL DIMENSIONS</u> 3 Meter Burial Mode

Length overall	37’ - 0-11/32”	(11.29 m)
Width	15' - 1/4"	(4.57 m)
Height (Share up)	10’ - 8-1/2"	(3.27 m)
Weight in air (approx)	12 tons	(10,886 kg)



PARTS LIST FOR DRAWING No. JO373-120-001

REF	DWG/SUPPLIER	DWG TITLE/DESCRIPTION	QTY
1	JO373-110-001	SKID CONSTRUCTION EXTENSION	1
2	JO373-120-004	JET TOOL ASSEMBLY	1
3	JO373-130-001	CROSS BEAM ASSEMBLY	1
4	JO266-150-001	JET TOOL PIN AND KEEP PLATE	1
5	JO266-150-002	RAM PIN AND KEEP PLATE	2
6	JO266-150-004	SKID EXTENSION PIN & KEEP PLATE	4
7	JO266-140-001	BURIAL BELLMOUTH ASSY	1

NOTES

1. ALL WELDS 5/16" BUTT OR FILLET EXCEPT WHERE OTHERWISE STATED. ALL WELDS TO BE CONTINUOUS.
2. ALL MATERIAL ASTM A36 EXCEPT WHERE OTHERWISE STATED.
3. CORRECT SEQUENCE WELDING TO BE OBSERVED TO AVOID DISTORTION OF SECTIONS DURING WELDING.
4. GENERAL TOLERANCE EXCEPT WHERE OTHERWISE STATED
   ±1/64" LESS THAN 20"
   ±3/64" FROM 20" TO 40"
   ±5/64" ABOVE 40"
5. REMOVE ALL BURRS, SHARP EDGES AND WELD SPATTER BEFORE PAINTING.
6. SHOTBLAST AND PRIME WITHIN 4 HOURS.
7. PAINT TO BE TWO PART EPOXY WITH ZINC RICH PRIMER, COLOUR YELLOW.
8. ALL MEASUREMENTS IN INCH.
9. QTY 1 PER ASSY
10. FOR ALL OTHER INFORMATION SEE DRAWING J0266-000-001

DO NOT SCALE : IF IN DOUBT, PLEASE ASK

THIRD ANGLE PROJECTION

ISS	DATE	PURPOSE	BY	CHKD	APP
1	27/8/14	FOR MANUFACTURE	NTB	KSM	JDF

106 THE HUNDRED
ROMSEY
HAMPSHIRE
SO51 8BY
UNITED KINGDOM

eta
The Submarine Cable Specialists

WEBSITE: www.eta-ltd.com Tel: 44(0)1794 521216

CLIENT
DUROCHER MARINE

PROJECT
3m SHALLOW WATER JETTING SLED

TITLE
JETTING SLED
GENERAL ARRANGEMENT

SCALE 1:48 | SHEET SIZE A3

DRAWING No. J0373-000-001 SHT.1 of 2 | ISSUE 1

Photo of cable jetting sled (left side-back)

Photo of cable jetting sled (right side-front)

2 PERFORMANCE SPECFICATIONS

The Durocher Marine cable jetting sled has a burial tool capable of jetting a trench up to 11'. The plow stinger has the capability to trench basically from 0.0' to 10.0'. The stinger consists of a single leg jetting tube with an integral cable depressor down the back of the jetting tube. High volumes of water are directed down the main jetting tube, which exits through a configurable nozzle array down its leading edge.

The stinger has a series of 52 jetting blocks, each of which two jet positions allowing the nozzle orientation and size to be varied to suit different soil conditions.

A summary of the tools features are listed below;

Configuration	Single leg diver loaded jetting tool, with variable jetting nozzle array and integral enclosed bell mouth & depressor.	
Soil types	Sands & Clays up to 20 kPa	
Max water depth	132 feet	(40.0 m)
Soft soil - bearing capacity	2 kPa	
Jetting speed (max)	1650 ft/hr	(500 m/hr)
Max burial depth - 10' 0"	10' 0"	(3.05 m)
stinger Std trench width	12.75"	(325 mm)
Product diameter	3/8" to 8.5"	(10-220 mm)
Product MBR	4' 11"	(1500 mm)
Jetting Nozzles	3/4" BSP stainless steel blanking plugs, either closed or with 3/8" or 3/4" through holes.	
Water Pump requirement 10' (3m) Mode Supplied down 1 x 8" hose	Surface Supply (approx 300kw / 400hp) Water pump duty 1000m^3/hr @ 11 Bar. (4300 US gal/min @ 360 feet head) Subsea Supply (approx 85kw / 110hp) Water pump duty 1000m^3/hr @ 3 Bar. (4300 US gal/min @ 100 feet head)	
Water Pump requirement 16' 4" (5m) Mode Supplied down 2 x 8" hose	Surface Supply (approx 765kw / 1025hp) Water pump duty 2500m^3/hr @ 11Bar. (11,000 US gal/min @ 360 feet head) Subsea Supply (approx 210kw / 280 hp) Water pump duty 2500m^3/hr @ 3 Bar. (11,000 US gal/min @ 100 feet head)	
Max tow tension	25 tones (please see stability graphs, section 6.6)	

3 CONTROL SYSTEM

The control system on Durocher Marine cable jetting sled consists of a topside unit (housed in two separate portable transit cases), an umbilical, a subsea breakout, a pod and a number of harnesses to connect to the surveillance and instrumentation sensors. An overall schematic of the control system is shown at the end of this section.

The control system provides the drivers, sensors and surveillance equipment required to ensure the safe and correct functioning of the sled. A summary of these features is given below:

Burial Depth	Controllable burial depth via one or two stinger ram(s). Both rams contain integral position sensors
Safety Features	Automatic stinger relieve function at high tow tensions, based on topsides relief valve setting (CCV supply) 3 x 110 volt LIM with 5 ms cut off.
Sensors	Sled pitch and roll sensors Pump pressure at the surface (sensor not supplied) Pump pressure subsea (sensor not supplied)
Surveillance	2 x mini monochrome CCD cameras, with topsides monitors 2 x 300 W lights with variable intensity control
Control Screen	Touch screen control panel & real time graphical display of vehicle status.

4 HYDRAULIC SYSTEM

The Durocher Marine cable jetting sled uses a top-side hydraulic power pack to supply hydraulic flow/pressure to the stinger control rams which control the sleds variable jetting depth. The power pack is connected to the sled via a hydraulic umbilical (comprising supply and return hoses). A summary of the hydraulics system is given below:

Deployment rams	One or two subsea specification with spherical bearings both ends, fitted with integral ROTA linear transducers
Power pack	Gasoline driven hydraulic power pack
Control System	Directional control valve with speed control, relief and check valves, directly connected to the topsides control system

5 JETTING SLED TRIALS PROCEDURE

Out of water testing and in-water testing is planned prior to cable burial operations.

Task Plan Jetting Sled Trials	
Item	**Description**
1	Morning Action Plan (MAP) meeting with entire crew to discuss work plan
2	Divers complete Pre-Dive Checklist and test all dive gear
3	All power systems are powered down, electrical power off
4	Sled is restrained to barge deck
5	Connect an earthing lead
6	Perform visual inspection of entire sled (sensors, umbilical, pins, lifting points, etc.)
7	Perform visual inspection to insure all bolts and keepers are on cable door
8	Energize electrical system, confirm output to computer
9	Energize hydraulic system, test operation of hydraulic ram
10	Check all hydraulic connections for minor leaks
11	Stop position of jet tool is sitting on barge deck (never leave suspended)
12	Start water pump, pressurize system at engine idle only
13	Stop all power systems and turn electrical power off
14	Connect lifting gear to sled and slowly lift of barge deck
15	Check connection of sled pull wire, direct pull wire winch operator
16	Signal crane operator to set sled in water, manage umbilical and water supply hoses
17	Set sled on seabed while directing crane and winch operator
18	Assure all systems off, diver down crane rigging to inspect sled on seabed
19	Diver unhook crane and direct crane rigging to surface. Diver move to rear of sled.
20	Topside crew move barge approximately 50' away from sled on seabed
21	Confirm ALL STOP on everything, diver inspect sled on seabed
22	Alert diver, energize all sled systems and bring water pump to idle
23	Alert diver, slowly lower jet tool into seabed while diver monitors sled skids on seabed
24	Support crew confirm operation of sled control systems and data logging

25	Alert diver, topside winch slowly tighten sled pull wire, support crew monitor tensiometer
26	Diver alert topside when sled travel begins. Diver **ALWAYS behind sled** during forward travel
27	Continue sled travel while lowering jet tool to project burial depth
28	Whenever sled movement stops, bring jet tool water pump to idle position
29	Sled stops, raise jet tool to up position
30	Testing complete, diver position in center of sled
31	Crane operator lower rigging to diver
32	Diver connect rigging to sled, direct crane operator to tighten rigging
33	Diver leave bottom, return to deck of barge
34	Sled pull wire winch operator standby to manage pull wire slack
35	Topside crew standby to manage water supply hoses and umbilical
36	Crane operator directed by topside personnel to lift sled to surface and set on barge

ATTACHMENT F.

DIVER JET BURIAL PROCEDURE

Diver Jet Burial Procedure

Durocher Marine (DM) is providing the following descriptive / narrative information in support of the SRP 107 Submarine Cable Installation Project. The intent of this document is to provide a narrative regarding equipment and methodology employed by DM when performing diver retro-burial operations to bury submarine cable in a shallow water environment.

Diver hand jetting can be used in cases where a submarine cable is being installed and there is a section that cannot be buried using a jet plow system. Other instances could be where the cable transitions from the plow to the shore trench or the cable burial is prevented due to obstructions either on or in the sea bottom. Burial in these instances are commonly performed by a diver utilizing a hand-held jetting system.

This simple burial method utilizes water supplied at approximately 60 to 150 psi pressure from a barge mounted water jet pump, fed down a supply hose to feed the handheld diver burial nozzle or water-lift. The water supply hose is typically 2” to 3” in diameter.

The jet nozzle produces a strong jet stream with compensating ports opposing the main jet so that the nozzle has neutral forces in the water to help the diver control the direction of the flow while the water-lift uses the jet hose pressure to pick up and move the material.

(See typical jet nozzle & water-lift photos below)

Desco Compensated Brass Jetting Nozzle

Field Engineered Lance Type

Compensated Brass Jetting Nozzle

Jet Eductor type Water-lift

Burial by Diver with Jet Nozzle

Specific to submarine cable burial, the diver operated jet nozzle method is the simplest and least invasive. It should be noted that the nozzle method is not a means of excavation. The water jet is simply aimed down under and around the submarine cable, causing the material under the cable to fluidize. This fluidization of the bottom soils allows the submarine cable to sink into the seabed. In denser or cohesive material, the burial process can take additional effort as the diver must work the water jet back and forth over the cable in sections to break up the dense bottom to allow the cable to sink into the seafloor.

Given the known sediment conditions on site, the minimum burial depth should be easily achieved. This providing that the underlying bedrock is below the targeted burial depths as indicated in the bid documents.

Diver hand jetting is also a useful tool for probing the river bottom and loosening obstructions such as trees, boulders, rocks and other debris so they can easily be moved from under the cable and/or out of the trench.

If the diver needs to make a trench and keep it open for any length of time the jet nozzle be used in conjunction with a water lift (see next).

Burial by Diver with Water-Lift

The Contractor shall maintain a complete water lift system on the barge for use as needed on the project. The water lift will remove seabed material from under the submarine cable and discharge it on the sea floor away from the submarine cable. The water-lift can also be used to backfill the trench at completion of burial by redepositing the stock pile of discharged material back onto the cable by reversing the procedure.

The system is designed with a diver deployed water jet eductor utilizing a 30-degree bend near the intake end. At the center of the bend the high-pressure water jet hose is connected to an internal jet nozzle. The internal jet nozzle is aimed toward the discharge end of the water lift pipe. The water jet stream moves the water in the main pipe and creates a suction at the inlet. The nozzle suction is created by the venturri principle and the height of the lift attained depends on the size of the pipe and the output of the jet pump. This system can, when designed efficiently, move multiple cubic yards of material per hour and discharge it 20’ to 30’ away. The diver operated water-lift has been utilized in numerous cable and pipeline burial projects around the country.