BATHYMETRY, SEDIMENT TEMPERATURE AND MAGNETIC FIELD STANDARD OPERATING PROCEDURE

1. Introduction

This *Pre- and Post-Energizing Bathymetry, Sediment Temperature and Magnetic Field Standard Operating Procedure* (SOP) is developed pursuant to Certificate Condition 163 (CC 163) (NYSPSC 2013). CC 163 states: Within six (6) months after issuance of this Certificate, the Certificate Holders shall submit to the Department of Public Service (DPS) Staff for review, comment, and approval in consultation with New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of State (NYSDOS), detailed Standard Operating Procedures ("SOP") for compliance monitoring studies to be conducted in the Hudson River. The SOPs shall be consistent with the Scopes of Study attached to this Certificate:

- Benthic and Sediment Monitoring Scope of Study (Attachment 2 to this Certificate)
- Bathymetry, Sediment Temperature and Magnetic Field Scope of Study (Attachment 3 this Certificate)
- Atlantic Sturgeon Pre-Installation and Post-Energizing Hydrophone Scope of Study (Attachment 4 to this Certificate)

In compliance with CC 163, the Certificate Holders will conduct, *a Pre- and Post-Energizing Bathymetry, Sediment Temperature and Magnetic Field Study* in the Hudson River Estuary and Lake Champlain.

Bathymetry, sediment temperature and magnetic field surveys will be conducted to characterize existing and post-energizing conditions proximate to the cable in Lake Champlain and in the Hudson, Harlem, and East Rivers. Cable installation and burial in Lake Champlain, Hudson River, and Harlem River will temporarily disturb and/or alter the sediment and bottom substrates. The bulk of the sediment disturbed will resettle in the trench created by the jet plow or shear plow and natural processes that control scour and deposition are expected to re-establish the original bottom contours along the cable route. Post-installation bathymetric surveys will be used to monitor recovery of the bottom substrate.

In addition, the energized transmission cables have the potential to impact magnetic fields in the vicinity of the cable and dissipate heat to the surrounding substrate. Monitoring will provide the measurement of the magnetic field and sediment temperature for comparison with modeling predictions and conditions prior to cable operation.

2. Bathymetric Monitoring

Post-installation bathymetric surveys will be used to monitor recovery of the bottom substrate. The bathymetry survey will be repeated 1 year after the cable installation and then 3 years after cable installation. Initially (year 1), the entire cable route will be surveyed to compare with the bottom elevations of the pre-installation survey. Where the substrate has returned to the pre-installation configuration, these segments will not be resurveyed during any subsequent survey.

If a cable segment has not returned to pre-installation condition after 3 years it will be resurveyed after 5 years (8 years after cable installation). This survey will provide a check on the long-term stability of the substrate on the cable route. The surveyed route will be recorded so that the past installation surveys for physical conditions can follow the cable route and can return to any selected survey locations.

The overall quality objective for the hydrographic survey is to obtain the highest quality hydrographic data using commercially available equipment and techniques. High resolution multi-beam side scan sonar will be used to survey a 30-foot wide swath centered on the cable route prior to installation. A bathymetric map will be developed showing ½-foot contour intervals (referenced to MLW) at a scale of 1"=100'. In addition, mapping will include a shaded relief presentation (sun illuminated diagram) of the proposed route.

Horizontal positions shall be in feet and referenced to the New York State Plane Coordinate System, East Zone, North American Datum (NAD83). Vertical elevations shall be in feet and referenced to the North American Vertical Datum (NGVD88). Elevations of the water bottom will be reported relative to NAVD88 and Mean Lower Low Water (MLLW) National Tidal Datum Epoch (1983-2001). Surveys will be conducted so as to achieve 100% coverage in the survey area, with at least one depth reading for every square meter.

Navigation will be conducted so as to achieve or exceed the resultant elevation/depth accuracy, the horizontal positioning system accuracy, and reported feature horizontal location accuracy described for general surveys and studies in Army Corps of Engineers Manual 1110-2-1003 (ACOE manual) (http://140.194.76.129/publications/eng-manuals/em1110-2-1003/toc.htm). This is substantially the same horizontal position accuracy as described in NOAA NOS Hydrographic Surveys Specifications and Deliverables (2008) (NOS manual) (http://www.nauticalcharts.noaa.gov/hsd/specs/specs.htm).

The intent will be to provide full bottom coverage using a multibeam system having a swath width of 3.5 times the water depth. High resolution coverage of the riverbed will be achieved, mapping the proposed cable route bottom, debris and other objects on the bottom, and bedforms in the survey area, including sandwaves, pronounced shell beds, etc. To achieve the required level of resolution, a typical survey will be comprised of 240 beams with a 0.5° beamwidth and a depth resolution of 0.02 feet.

Since accurate positions for each beam of the multibeam system must be determined, a vessel motion sensor (heave, pitch, and roll) and heading sensor are used. Additionally, real time kinematic (RTK) GPS is used to provide horizontal (+/- 1 cm) and vertical (+/- 2cm) position of the vessel when satellite coverage is available. To achieve the manufacturers' stated GPS accuracies, the contractor will set a shore-based GPS receiver over a known control point near the site. This receiver will incorporate a radio transmitter that will transmit L1 and L2 GPS correctors to the survey vessel.

The SOP for bathymetric surveying is as follows:

1. Verify before leaving dock that all navigation and instrument systems are working properly.

2. Calibrate and set navigation instruments based on the instrument-specific standard operating procedures.

3. Prepare survey equipment for the start of daily survey operations including: deployment of side scan sonar towfish into water, measurement of survey equipment offsets, daily speed of sound test, and other required pre-survey activities.

4. Navigate to coordinates of proposed cable route.

5. Align survey vessel along transect and confirm autopilot heading and operation. Start data acquisition and commence side scan sonar survey along transect. Conduct the side scan sonar survey using a high resolution side scan sonar system with a dual frequency (100 and 500 kHz) towfish. Export and log the side scan sonar imagery to a data acquisition platform.

6. Operate the side scan sonar system with a towfish height above the bottom of 8 percent to 20 percent of the range scale in use. For any towfish height below 8 percent of the range scale in use, the effective scanning range is defined to equal 12.5 times the towfish height, provided adequate echoes have been received.

7. Tow side scan sonar at a speed such that an object 1 meter on a side on the sea floor would be independently ensonified a minimum of three times per pass. The number of pulses per unit time, or pulse repetition rate, determines the speed at which the transducer (i.e. the vessel) can move along the track and still maintain the required coverage of the bottom. Longer operating ranges have a slower pulse repetition rate, which requires the vessel speed to be slower if the entire bottom is to be ensonified. The maximum vessel speed for three ensonifications can be calculated if the pulse repetition rate (prr) or the pulse period (pp) is known. The rate is the reciprocal of the period. This rate and/or period are usually published in the operating manual for the side scan sonar system. The calculation is as follows: maximum vessel speed (meters/ second) = target size (meters) X prr/3 (sec-1).

8. Use a digital depth sounder to collect water depth information along the proposed route. Log depth data.

9. Note relevant observations and changes in operational procedures to the field log. These may include: coordinates of observed obstructions or artifacts; areas where interferences or other conditions limit survey resolution; and coordinates where adjustments to towfish height, line spacing, or range scale are made.

10. Confirm successful data acquisition and storage, navigation and equipment calibrations and settings. Log time and coordinates at end of run.

11. Repeat steps 4-10 for collecting data along a transect until required coverage has been achieved in each survey section.

12. Verify position accuracy twice daily by occupying a known horizontal control point and comparing the measured coordinates with the published coordinates for that point. Position data will be input into the survey vessel's navigation computer. The vessel's navigation software and computer display will have the capability to display the following: the vessel's position, the intended survey lines, and other site features. Thus, the navigation software will provide real time graphic information to the helmsperson to assist with navigating the vessel accurately along the proposed cable route.

13. Document all raw survey data and information (e.g., field notes, instrumentation frequencies) must be documented electronically and/or in a field note book.

14. Back-up copies of the raw electronic data and make copies of all field log entries.

3. Magnetic Field Survey

At selected locations along the cable route a pre-installation and post-energizing magnetometer survey will be conducted. The Certificate Holders will include a pre-installation and post-energizing magnetometer survey in sensitive habitats where the cable route encroaches into small portions of Significant Coastal Fish and Wildlife Habitats (SCFWH) and designated exclusion zones identified during the settlement discussions for the cable route corridor. The cable avoids all shallow water SCFWH's with an upland route in the upper estuary and is confined to relatively deep water in the middle and lower estuary. In Lake Champlain, the monitoring sites will include deep water areas of the central lake and shallow water in the south lake area. Once the routing for a segment has been approved, the Certificate Holders will review existing data to determine survey locations. The final proposed locations will be provided to the NYSDEC, NYSDOS, and NYSDPS in tabular and map form for review. The Certificate Holders will survey 30% of the total length of the in-water cable. The post-energizing survey will occur 3 years after installation, assuming cable energizing, or when the transmission system is operating at 500 to 1,000 MW if it is not doing so 3 years after installation. The post-installation survey will be conducted within the same season as the pre-installation survey.

The towed magnetometer system is expected to be an Overhauser magnetometer similar to a SeaSPY magnetometer, or similar, or magnetic gradiometer from Marine Magnetics, Ontario, Canada, or similar, which has faster cycling rates (up to five magnetic measurements taken each second) and higher sensitivities. The grid size of any survey is highly dependent on the size of the magnetic field emitted by an object and in this case the cable will be energized to between 500 and 1,000MW. Based on discussions with Marine Magnetics, Inc., in order to detect magnetic field differences above background a survey centered on the cable and at 100 feet on either side of the cable will suffice to cover the cable route. .

The SOP for magnetic field surveying is as follows:

- Verify before leaving dock that all navigation and instrument systems are working properly.
- Calibrate and set navigation instruments based on the instrument-specific standard operating procedures.
- Prepare survey equipment for start of daily survey operations. Although, the magnetometer sensor is a towed unit (towfish) the inboard section of cable has to be routed to the control unit. The main considerations in routing this cable are as follows:
    - Avoid the cable passing close to the outboard/inboard engine.
    - Avoid the cable passing close to the main battery supply and charging cables.
    - Where it is necessary to cross other cables, do this at 90 degrees if possible.
    - Any runs parallel to other cables should be kept as short as possible and with maximum spacing (even spacing of a few centimeters can make an appreciable difference to the induced interference level.
- Neatly lay the tow cable out in long loops bow to stern on the deck beginning with the onboard end. As this is done remove any twists in the tow cable
- Deploy towfish manually from a vessel traveling 1 to 1 ½ knots. It may be necessary to increase the vessel speed as more cable is deployed to prevent the magnetometer from striking the bottom. The more quickly the desired cable length can be deployed and the desired tow speed attained reduces the chances of the magnetometer going too deep striking the bottom or becoming hung.
- Determine the approximate length of tow cable to be deployed to achieve the required survey depth.
- Eliminate the possibility of snagging, particularly in depths of water less than 10m (30ft), by tying a tail float on a light line of a suitable length will act as a drogue, and should the boat become stationary, will support the weight of the towfish.
- Tow magnetometer at manufacturers required speed.

- Tow magnetometer centered on the proposed route and at 100ft on either side of the centerline, to overlap the centerline.

- Note relevant observations and changes in operational procedures to the field log. These may include: coordinates of observed obstructions or artifacts; areas where interferences or other conditions limit survey resolution; and coordinates where adjustments to towfish height, line spacing, or range scale are made.

- Confirm successful data acquisition and storage, navigation and equipment calibrations and settings. Log time and coordinates at end run.

- Verify position accuracy twice daily by occupying a known horizontal control point and comparing the measured coordinates with the published coordinates for that point. Position data will be input into the vessel's navigation computer on which the vessel's position will be displayed along with the intended survey lines and other site features. Thus, the navigation software will provide real time graphic information to the helmsperson to assist with navigating the vessel accurately along the proposed cable route.

- Document all raw survey data and information (e.g., field notes, instrumentation frequencies, etc.) either electronically or in a field note book.

- Prepare back-up copies of the raw electronic data and make copies of all field log entries.

- Retrieve the towfish with the vessel at full stop (propeller) not turning) or maintaining just enough headway to keep the cable from going under the vessel.

4. Sediment Temperature Survey

The Certificate Holders will survey sediment temperature and thermal resistivity along the cable route both pre-installation and post-energizing at stations along the route at approximately five mile intervals. Sediment temperature will be measured directly with a temperature probe inserted into the sediment bottom. Temperature measurements will be made at a depth not to exceed 3 feet or shallower depending on the depth of the buried cable and taking into consideration any health and safety concerns. This depth will monitor any potential temperature rise within the maximum depth of most benthic organisms inhabiting the overlying sediment. Measurements will be taken at the same depth at horizontal distances of approximately 3 feet and 6 feet from the centerline of the cable.

The post-energizing survey will occur 3 years after completion of cable installation, assuming cable energizing, or when the transmission system is operating at 500 to 1,000 MW if it is not doing so 3 years after installation. The post-energizing survey will be conducted during the same season as the pre-installation survey.

At shallow water stations outside the navigation channel, a diver will be used to operate the temperature probe and collect data at the required depth. In instances where health and safety

concerns allow the use a diver in the navigation channel, a diver may also be deployed to collect the sediment temperature data.

In deep water and depending on how deep the cable is burried, within a federal navigation channel if there are any diver safety concerns from ships in the navigation channel, the temperature probe will be mounted on the end of AW Drilling Rod and vibrated, if necessary into the sediment to the desired depth. This method is the same used previously on this project to obtain thermal resistivity measurements of the sediment. When vibrating in the probe is required, these recommended steps will be followed:

- Locate the sampling station with an appropriate field positioning system.
- Double anchor the boat or platform to ensure keeping it on station.
- Measure the water depth adjusted to the water line.
- Attach probes to AW drilling rod.
- With an electric or hydraulic winch, suspend and lower the rod slowly until it contacts the bottom. A measuring tape attached to the top shackle of the will be used to calculate the penetration depth.
- Lower the rod to the top of the sediment.
- If sediment texture allows for the probe to be directly pushed to the desired depth do not vibrate the Rod, push the rod down to the desired depth.
- If, vibration is necessary, turn on the vibration head and continue penetration until the unit meets required depth (maximum 3 ft), ensuring the rod remains vertical.
- Turn off the vibration head.
- Allow temperature probe to equilibrate before recording the reading.
- Record temperature and thermal resistivity measurements.
- Slowly withdraw the rod by winch, using the vibration only if extraction is difficult.
- Upon reaching the surface, keep the rod in a vertical position.
- Wash rod to remove any sediment.

The sediment temperature and thermal resistivity sampling survey locations will include the locations where prior magnetometer readings have been collected, though the temperature survey may not be completely duplicative of such area. The measurement sites will avoid areas that may correspond to a transition point in substrate types. The sediment temperature readings at any site will be in uniform substrate conditions. In selecting survey locations, a variety of substrate types will be included. Sediment temperature and thermal resistivity data will be collected every five miles in Lake Champlain and the Hudson, Harlem, and East Rivers.

Once the segment details are known, the Certificate Holders will develop the detailed sampling points for the sediment temperature and thermal resistivity survey. The plan will provide the locations of where surveys will be completed and provide recommendation on appropriate survey equipment based on site specific information.

5. Reporting

Following completion of the survey the Certificate Holder will prepare a chart of the riverbed in the survey area, with 1/2-foot contours, at a scale of 1" = 100'. Depth data will be referenced vertically to the project datum and horizontally to the State Plane Coordinate System. Required final products will be delivered on CD. The survey maps will illustrate the location of ½-foot river-bottom contours referenced to MLW and shall also illustrate the NY State plane coordinate grid at 500-foot intervals.

Contours will be identified at 5-foot intervals in relationship to the MLW; additional contour labeling or other graphical means of identifying river depths may be required to facilitate use of the hydrographic data. In addition, the draft and final hydrographic survey maps generated by the Contractor will illustrate the Hudson River shoreline at MLW conditions.

Draft and final reports will be prepared for both the pre- and post-energizing bathymetric, magnetic field and sediment temperature sampling programs. The reports will include a description of procedures followed during the monitoring program, field data results, and accompanying QA/QC data.

Required final products will also be delivered on CD. The survey maps will illustrate the location of ½-foot river-bottom contours referenced to MLW and will also illustrate the NY State plane coordinate grid at 500-foot intervals. Magnetometer coupled with the bathymetric mapping will provide local variations in the magnetic field.

Sediment temperature data will be provided both in tabular format.

The post-installation final reports will also include a comparison of bathymetric, magnetic field and sediment temperature characteristics pre- and post-installation. Each report will be submitted to the Secretary of the PSC, NYSDEC, NYSDOS, and NYSDPS within 1 year of completing the field work.