CO-OPS Water Level and Meteorological Site Reconnaissance Procedures

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1. Introduction

The National Ocean Service (NOS), Center for Operational Oceanographic Products and Services (CO-OPS), operates a number of short and long term monitoring systems. CO-OPS provides the infrastructure, science, and technical expertise to monitor, assess, and disseminate coastal oceanographic and Great Lakes products and services necessary to support NOS missions of environmental stewardship, assessment, and prediction; safe navigation; and hazard mitigation.

In order to support the NOS and CO-OPS missions, new water level and meteorological stations are regularly required. The best method for assembling the information needed to install these stations is a reconnaissance. The primary objective of the reconnaissance is to determine the optimal location and configuration for data collection platforms (DCP), antennas, sensors, and support components. For a water level station, recovering historic bench marks and scouting locations for setting new bench marks is also essential. The reconnaissance consists of personnel visiting the site sufficiently far in advance of site preparation to:

- Locate an acceptable site.
- Obtain measurements and information necessary to design the station.
- Arrange for any permits/license agreements required.
- Arrange for utilities.
- Prepare a cost estimate and work schedule.
- Allow time for the procurement and fabrication of special support components (if necessary).

If possible, property owners should be contacted in advance to obtain oral or written permission to use or modify the site, otherwise, meet with the property owner as soon as the site is visited. An advance letter of permission, permit, security clearance, or some other written instrument may be required by the owner. A license or lease agreement may have to be executed before any work can be done. Even if the site is an existing NWLON station, some advance notice may be required or appreciated by the owner. A statement involving partnerships with the NOAA National Weather Service (NWS) and others should be included. For example, if NWS has special requirements or needs with the meteorological sensors at a particular site, CO-OPS needs to give the nearest Weather Forecasting Office (WFO) advance notice of the reconnaissance so that they can have a representative on site to better articulate their needs and verify proper placement for winds.

Accurate measurements and information is best obtained onsite. The locale can be investigated to determine which particular site will best accommodate the preliminary design and all the other site requirements. Any special installation requirements, such as explosion proof conduit on fuel piers, can also be determined through discussions with local authorities.

Once the reconnaissance information is collected and a report issued, the design is finalized, and a cost estimate and installation schedule can be determined.

2. Background

NOS is a Federal agency devoted to exploring, understanding, conserving, and restoring the Nation's coasts and oceans. NOS promotes safe navigation, supports coastal communities, sustains coastal habitats, and mitigates coastal hazards. NOS balances environmental protection with economic prosperity and leads the effort to ensure that our Nation's coastal areas remain safe, healthy and productive.

CO-OPS establishes standards for the acquisition and processing of water level and current data; collects and documents user requirements that serve as the foundation for all resulting program activities; designs new and/or improved oceanographic observing systems; develops software to improve data processing capabilities; maintains and operates oceanographic observing systems; performs operational data analysis/quality control; produces/disseminates oceanographic products; and archives the resulting oceanographic data.

A water level station is a stand alone system that collects, stores, and transmits water level, meteorological, and other environmental data. The primary requirement of a station is to accurately measure water level information with low power consumption, high reliability, and defined accuracy. The typical station includes an air acoustic water level sensor with protective well, or a single or dual orifice Paroscientific pressure sensors, or a shaft angle encoder in a sump (Great Lakes); a redundant pressure-based water level sensor; and a data collection platform with Geostationary Operational Environmental Satellite (GOES) transmitter, rechargeable battery, and solar panel. Stations may also include sensors that measure air and water temperature, wind speed and direction, barometric pressure, relative humidity, and conductivity. A stand alone meteorological (Met) station is a system that collects, stores, and transmits only meteorological data.

3. Types of Stations

There are several types of stations that CO-OPS maintains. They are:

- Basic Water Level Station
    a) Support structure (pier, platform, wharf, sump, etc.).
    b) Single DCP
    c) DCP enclosure
    d) Primary water level sensor (acoustic, pressure, shaft angle encoder)
    e) Protective well (for acoustic sensor)
    f) Top hat and bottom parallel plate assembly components or orifice and Dixon boards
    g) Protective well brackets
    h) Solar panel
    i) GOES antenna
    j) Bench mark network (minimum of five marks)
    j) Well temperatures
    k) Batteries

- NWLON Station
    a) Basic Water Level Station components as described above and following additional components:
    b) Multiple DCPs - primary & redundant
    c) Redundant pressure or shaft angle encoder water level sensor
    d) Water temperature sensor
    e) Air temperature sensor
    f) Barometer
    g) Wind sensor and redundant wind sensor as necessary
    h) Tower or pole for mounting wind sensor
    i) Bench mark network of ten marks
    j) Additional solar panels
    k) GPS antenna
    l) Air Pumps or nitrogen tanks for pressure sensors
    m) Two well temperatures
    n) Utilities (phone, electric, IP modem, radios)
    o) One or more batteries

- PORTS Water Level Station
    a) Same as a NWLON Station components as described above and may have following additional components:
    b) Conductivity sensor and conductivity protective well
    c) Relative humidity sensor
    d) Air gap sensor
    e) Line of sight radio
    f) IP modem
    g) Current meters

- Meteorological Station
    a) DCP
    b) DCP enclosure
    c) Barometer
    d) Wind sensor and redundant wind sensor as necessary
    e) Tower or pole for mounting wind sensor
    f) Air temperature sensor
    g) Relative Humidity sensor
    h) Conductivity sensor and conductivity protective well
    i) Air gap sensor
    j) Solar Panel
    k) GOES antenna
    l) Line of sight radio (for PORTS)
    m) IP modem (for PORTS)
    n) Utilities (phone and electric)

4. Equipment Needed

The following equipment, forms, and information are needed to perform a complete reconnaissance:

- Digital Camera/Videotape Recorder
- Published Bench Mark Sheet, if available, or historical bench mark descriptions
- Historical station information, if available
- NGS Datasheets for area - required in the lakes to reference NAVD88/Dynamic Heights for the International Great Lakes Datum
- Shovel and other digging equipment
- Bench Mark recovery items (survey ribbon, marking paint)
- Metal detector
- Sample License or Lease Agreement/Letter of Permission
- Weighted tape for soundings (knowledge of extreme high/low water levels in the area). In the lakes this reference is the Maximum and Minimum extremes, above or below Low Water Datum for the area. Rule of thumb is 5 to 7 ft. above and 5 to 7 feet below LWD, depending on the lake or given area.
- 50 or 100 m survey tape for Bench Mark recovery
- Engineering sketch pad
- Inclinometer
- Carpenters level or plumb bob
- Hand-held GPS
- Compass
- Chart section
- NGWLMS Well/Sounding Tube Worksheet
- Site Reconnaissance Field Notes form (Appendix A)
- All contact information

5. Office Information

After a general site has been selected for the installation of a water level or met station, the first step is to gather all relevant information. In many cases, the site is an existing or historic water level station, and office files can be consulted for much of the information. To find out if an historic water level station exists, consult the Index of Water Level Stations at http://www.co-ops.nos.noaa.gov/station_index_map.shtml Program requirements may also provide some direction.

If there is a historical site, assemble as much of the following information as possible:

- Water level datums and bench mark elevations.
- Identification of primary bench mark and its elevation above station datum
- To Reach statement and bench mark recovery notes.
- NGS Datasheets based on point radius.
- Support structure and harbor bottom elevations.
- Support structure plan and sun transit.
- Environmental data.

- Instrument shelter and utilities description.
- GOES transmission information (azimuth and elevation).
- Solar incidence.
- Ancillary sensor(s) requirements.

Water Level datums are required to determine the length and elevation of the protective well, and sump depth and intake height in the Great Lakes area. Observed highest/lowest water levels shall be used from long term control stations along with the estimated highest/lowest water levels from the short term stations. In the Great Lakes region the long term maximum and minimum water levels from the Master station or the nearest long term subordinate station are used to make these determinations. Ensure that the Great Lakes datums are based on the latest datum, International Great Lakes Datum 1985 (IGLD 1985) and then referenced to the given Low Water Datum on each lake.

The estimated values for a short term station can be determined using a prediction program such as Tides & Currents. Ensure that the datums are based on the National Tidal Datum Epoch (1983-2001) or IGLD 1985. To Reach statements and bench mark recovery notes are needed to find the historic site and recover as many historic bench marks as possible. This information can be found on the CO-OPS published bench mark sheet web page http://tidesandcurrents.noaa.gov/station_retrieve.shtml?type=Bench+Mark+Data+Sheets

Datasheets retrieved from the NGS web site are essential for replacing destroyed historic marks and for providing a connection to the North American Vertical Datum of 1988 (NAVD88) and Dynamic Heights for relating to IGLD 1985. The web site is http://www.ngs.noaa.gov/cgi-bin/ds_radius.prl

Support structure and harbor bottom elevations are required as they may impose physical constraints on the protective well and backup sensor mounting assembly elevations and lengths. These elevations typically have been documented for existing NWLON stations and can be determined at historic sites through levels to the bench mark network.

Information on the support structure's orientation and the path of the sun's transit is critical for locating a thermally acceptable site for the protective well.

Descriptions of the instrument shelter and utilities are typically available for NWLON sites and can be used to determine if adequate space and utilities exist for the DCP units.

The GOES satellite antenna azimuth and elevation angles are required to select an antenna site free of obstructions that may interfere with the transmission. GOES satellite azimuths are referenced in true degrees. If a compass is used to position the antenna, the local magnetic declination must be applied. The local magnetic declination offset can be found on the Coast Survey nautical charts of the area.

Solar incidence is needed to provide the proper orientation and elevation of the solar panel to provide maximum charging voltage.

Requirements for ancillary sensors should be determined in advance to allow adequate lead time for site preparation configuration and installation.

Site specific environmental data, particularly on wave climate, is important. Wave data are used in determining well length and elevation. Other types of environmental data may also be useful for design or validation processes.

Once a general location has been selected, use nautical charts, Coast Pilot books, quad maps, and aerial photographs to search for likely structures.

6. Site Visit

After compiling all information possible in the office, it is time to visit the site. Upon arrival at the general location, proceed to the site determined from the office documents. Seek out the owner or owner's representative of the structure most likely for the installation, introduce yourself and explain your purpose. Meet with any site associated partnership representatives. Ask permission to make measurements and determine which method the owner wishes to use to grant permission for CO-OPS to install equipment on the owner's property. Use the Site Reconnaissance Field Notes form in Appendix A to record all information.

Following receipt of owner permission, perform the following measurements at the structure:

- Pier/Bulkhead surface above harbor bottom
- Pier/Bulkhead surface above water surface
- Time and date of Pier/Bulkhead to water surface measurement
- Piling diameter
- Pier stringer size and separation
- Pier deck width
- In the Great Lakes, a survey level tie to the closest NAVD 88/Dynamic benchmark may be needed to determine the elevation for the placement of the gauge house, depth of sump as well as depth of intake. Also determine an elevation for the bulkhead or top of the sheet pile wall so that the intake depth, where it penetrates the wall can be determined. This is a critical engineering requirement for relating the station intake elevations to LWD.

Record contact information for the following individuals:

- Facility owner
- Local contact – the person who must be notified whenever the station is visited.

Make the following observations:

- Sky clearance in the direction of the GOES antenna and solar panels.
- Direction of prevailing winds.
- For wind sensor installations, choose an area free of obstructions that affect the path of the wind. Verify positioning with any associated partnership representatives.
- GPS latitude/longitude of station & bench mark locations. Record position to the tenth of a second.

Take digital photographs of the following:

- Proposed location of protective well, and intake as appropriate
- Proposed location of DCP and gauge house/structure
- Recovered bench marks
    a) Bench mark faces
    b) Setting (waist or chest high photo)
    c) At least two distance photos from different directions showing landmarks in the background.
- Locations for new marks

7. Documentation

Submit the following documentation upon completion of the reconnaissance:

- Site Reconnaissance Field Notes. Note that "How Too Reach the Station Location Statement" for the crew that will be doing the install is a part of the Site Reconnaissance Field Notes.
- Notes from meeting with any associated partnership representatives
- Bench Mark recovery notes
- All digital photos of bench marks, proposed DCP & well locations, and proposed bench mark installation locations if insufficient marks recovered.
- Site view drawing showing proposed gauge house or DCP location(s); proposed protective well, or sump locations; North directional arrow; recovered bench marks; proposed bench mark install location(s); solar incidence at protective well location(s), and in the lakes the closest electrical source.

Appendix A – Site Reconnaissance Field Note

National Oceanic and Atmospheric Administration
National Ocean Service
Center for Operational Oceanographic Products and Services

Site Reconnaissance Field Notes

GENERAL SITE INFORMATION			
Station Number	**Station Name**	**Date**	
Project Name	**Station Type**		**Permanent; Temporary; NWLON; Navigation; Hydro; COASTAL; Other**
Site Name	**Site Location** **City** **County** **State** **Zip code**		
How To Reach			
Property Owner: **Address:** **Phone:** **Cell Phone:** **Fax:**	**Local Contact:** **Address:** **Phone:** **Cell Phone:** **Fax:**		
Communications or Agreements Made To Date			**Contact dates?** **Letter, phone or meeting?** **Details of Discussion?** **Follow-up needed?** **MOU or permits needed?**

SITE DESCRIPTION		GEOGRAPHIC/OCEANIC DESCRIPTION	
Facility	**Public; Private; Government; Industrial; Commercial; Residential** **Accessibility**	**Geographic & Hydraulic Features**	**Open Coast; Sheltered Harbor; Bay; Sound; Marsh** **Tide Range; Wave Height; Currents**
Support Structure	**Bulkhead; Pier; Pilings; Other** **Wood; Concrete; Steel** **Measurements & Sizes** **Additional Bracing Necessary?**	**Shoreline/Bottom Characteristics**	**Sand; Sediment; Gravel; Stone; Rocks; Bedrock** **Bottom Slope** **Shifting Shoals? Erosion? Scouring?**
Structure Height **Above Bottom =** **Above Water Surface =** **Time of Measurement =** **Water Depth**		**Marine Growth**	**Light; Heavy; Kelp; Weeds; Barnacles; Mussels**
		Proposed Sensor & DCP Locations	

INSTRUMENTATION	SUPPORT STRUCTURES
Data Collection Platform To Be Installed	**Type Of Shelter To Be Used**
Sensor(s) To Be Installed	**Type & Length Of Well**
	Clamps Required

TOOLS/SUPPLIES	
Special Tools or Equipment Required	Boat Jet Pump Pneumatics Hydraulics Generator Welder Diving
Supply List	Lumber Hardware Pipes
Nearby Supplies/Services	

VERTICAL CONTROL/BENCHMARKS	
Level Procedures to be Performed	2nd Order, Class 1 3rd Order, Class 1 Other
Bench Marks (Designation/Stamping/Mark Type/Setting/Stability Code)	# Recovered # to be Installed Estimated length of run Quality of Bench Marks GPS Suitability

SERVICES/UTILITIES	
Telephone Requirements	# of lines required Origination Point Length of run Overhead/trench Estimated cost Type of cable Type of conduit
Telephone Company Info	Name Number Mail Address Contact
Electrical Requirements	# of lines required Origination Point Length of run Overhead/trench Estimated cost Type of cable Type of conduit
Electrical Contractor Info	Name Number Mail Address Contact
Other Contractors Info	Marine Concrete Diving Welding Price quotes received
Additional Information	