Field Reconnaissance Procedure for Observing System Installation Planning

Procedure Number: SOP # 3.1.1.7
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Approved By: Kate Bosley and Chung-Chu Teng, February 2017
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Approved By: Kate Bosley and Chung-Chu Teng, September 01, 2020

1. **Title:** Field Reconnaissance Procedure for Observing System Installation Planning

2. **Purpose**:

To provide procedural guidance for completing field reconnaissance, a step in planning the successful installation of oceanographic systems. This procedure should result in the creation of a field reconnaissance summary and design recommendations. The summary must include information which aids in furthering design efforts such as: recovered bench marks, sketches and measurements of the proposed sites, facility and structural information such as photographs, existing drawings, local contact information and other relevant data.

3. **Background/History**:

CO-OPS provides the national infrastructure and technical/scientific expertise needed to monitor, assess and distribute tides, currents, water levels, meteorological data and other coastal oceanographic products and services that support NOAA's mission of environmental stewardship and environmental assessment and prediction.

CO-OPS operates the National Water Level Observation Network (NWLON) and the Physical Oceanographic Real Time System (PORTS) to support its diverse missions. CO-OPS frequently upgrades, relocates, rebuilds and installs new stations to maintain the NWLON and PORTS function as well as support partner requests for tertiary stations. Thorough planning and coordination are critical to the success of station installation projects.

4. **Scope/Applicability**:

This SOP is primarily applicable to personnel responsible for completing field reconnaissance and contributing to design efforts. Design engineers, field party chiefs

and project leads will find this SOP useful for understanding how the feasibility and scope of installation of oceanographic instrumentation is determined.

5. Main Processes:

1. Review desktop recon documents and summary
2. Plan field reconnaissance trip
3. Perform field reconnaissance trip
4. Write and present a report on the field reconnaissance trip
5. Determine next steps

6. Detailed Sub-Processes/Checklists:

The following processes, roles and responsibilities, and work flow provide detailed guidance for accomplishing the tasks illustrated in the orange box of the Station Design Workflow found in Appendix A. The respective team leads of the Design and Development Engineering Team (DDET) and Field Operations Division (FOD) will assign the field reconnaissance responsibility at the conclusion of the desktop reconnaissance when the complexity of installation is determined.

6.1 Review desktop recon documents and summary

The DDET team lead will review the recommendations and proposed alternatives from the desktop reconnaissance study and discuss with the design engineer, field team lead, Project Lead (if CRR/CRR-Ops) and other stakeholders as appropriate. The discussion will determine what deliverable documents are necessary from the field recon including measurements, sketches, photos, and additional site information need to be documented during the site visit for each alternative to advance design efforts. The field crew chief during the field reconnaissance will be responsible for delivering the requested documents and information to the design team for the next planning steps.

6.2 Site Visit Planning

Based on the results of the desktop recon, resourcing, scheduling and other constraints, the field reconnaissance team may include DDET design engineers, FOD field team members and/or other personnel as appropriate (see Appendix A for the workflow diagram for decision point). It is often advantageous to arrange reconnaissance trips of existing stations so that they occur during a scheduled maintenance trip, though this is not always feasible. When scheduling the site visit, ensure the facility manager, engineer or other property owner representative are available to discuss design alternatives and the impact of the alternatives to facility operations.

6.3 Site Visit

The goals for a field reconnaissance trip for each design option are:

- Meet with Local Contact and/or Facility Representative to discuss project scope, facility impacts, permissions, schedule, unique site safety, security, and environmental compliance/impact concerns, historical wind, storm surge flood, storm water runoff, and inundation observations/elevations that have impacted their facility's operation and structural design, etc.
- Photograph the locations of all potential design alternatives and surrounding area.
- Sketch the existing supporting infrastructure, take measurements required for design alternatives.
- Take notes, sketches, and photos concerning potential design alternatives.
- Collect all measurements as listed below in Section 6.3.3 of support structures, surroundings, and the nearby water column that will be required to complete a station design.
    - The design team will determine the scope/extent or project area that requires detailed measurements prior to the recon trip to ensure all relevant measurements are captured during recon.
    - The design team will also determine if a dive is required during the site recon
- Search for existing bench marks and potential bench mark(s) locations.
- Determine contact points for "dig-locate" services.
- Makes notes about safety and ease of access for operations and maintenance to keep future recurring costs minimal.

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

- Basic hand tools (screwdrivers, wrenches, etc.)
- Digital Camera
- Tape measure
- Weighted tape and/or acoustic depth sounder
- Engineering sketch pad
- Shovel/digging implement
- Flashlight
- Carpenters ruler
- Lumber crayon
- Pipe caliper
- Inclinometer
- Carpenters level
- Handheld GPS
- Portable CTD (if required from desktop recon)
- Laser range finder
- Compass
- Reconnaissance Forms (Water Level - Appendix B, Meteorological - Appendix C, & cGNSS - Appendix E)
- Reconnaissance Plan (cGNSS Recon Plan - Appendix D)
- Sample License Agreement/Letter of Permission
- Published Bench Mark Sheet (for existing historic sites)

- NGS Datasheets for area
- Nautical chart with compass rose for determining local magnetic declination
- IP Modem Kit which consists of a Verizon IP Modem, AT&T IP Modem, Small Battery, and an Antenna

Bring all Personal Protective Equipment (PPE) needed to access the facility. Check with the facilities representative for what PPE is required. Typical PPE for general field reconnaissance activities are listed below:

- Steel toe boots
- Hard hats
- Personal Flotation Device
- Safety glasses
- Climbing harness

6.3.1 Meet with Facility Representative

Meet with the facility representative to discuss the proposed installation, potential design alternatives and standard licensing agreements. The facility representative should be a person with the authority to make decisions to permit installation of the equipment required by the installation project. If the facility representative does not have this level of authority, make sure to determine who does and record their contact information.

Request as-built drawings of the site from the facility representative. Receipt of as-built drawings does not preclude collection of measurements while onsite; as-built drawings are very useful for reference but often deviate from existing conditions. If possible, tour the locations with the facility representative and get their input about each location. Determine which alternative is the most favorable to the facility.

Leave a copy of the standard licensing agreement (see SOP 3.1.2.1 in ROS) and conceptual drawing of standard station components found in Appendix F and/or Appendix G with the facility point of contact. Confirm with the facility representative if any underwater structure components exist that might hinder successful sensor operation during lowest observed water events. Validate with the facility representative or other reputable local contacts, approximate elevations in reference to the facility structure proposed of extreme high and low water events. This is extremely important where CO-OPS may have no previous historical datum information.

Discuss other logistic concerns such as access times or concerns (seasonal or daily), other facility uses that may impact data quality or data communications, site safety and security concerns, utilities logistics, and other restrictions the owner/representative may have.

6.3.2 Bench Mark Search (For new or historic reoccupation station locations)

Using historic bench mark data and the NGS bench mark datasheets retrieved during the desktop recon, find as many marks as possible within a 1 mile radius from the proposed

location. A minimum of five bench marks of stability Class C or better are required for a Basic Water Level Station. If the number of recovered marks falls below five, scout out proposed locations for bench marks to be done during station installation. At sites predetermined as NWLON, at least three of the five marks shall be set in bedrock or a deeply driven rod (Stability Class B or greater), as described in SOP 3.2.3.3.C1 User's Guide to Vertical Control and Geodetic Leveling for CO-OPS Observing Systems, Sections 2.3 "Class A Bench Marks" and 2.4 "Class B Bench Marks". If no existing marks meet these criteria, investigate potential locations for setting a mark in exposed bedrock or a deep driven rod. Carefully note the location of areas for driving deep rods, recording the nearest street and intersection, coordinates, mile markers, etc. to aid in the locating of utilities by the local utility marking service.

For field reconnaissance of cGNSS installation, use the historic PBM sheet and the NGS datasheets retrieved during the desktop recon, identify the bench mark closest to each potential recon site and determine a possible leveling procedure between the bench mark and a proposed antenna location. The proposed leveling procedure should be performed concurrently with the recon cGNSS antenna setup to determine the recon sites' viability.

Location of existing buried utilities is required to avoid any underground utilities during the rod driving procedure. Document Dig-Locate service point of contact. Dig approval typically must happen not more than two weeks before actual deep rod installation. At least one of the bench marks to be used in the station's network must meet the criteria for GPS observations as described in Section 3.1 of the User's Guide for GPS Observations, keyword "GPS Users Guide" (SOP 3.2.3.3.C4 in ROS). Complete an obstruction diagram for the proposed GPS bench mark, a blank obstruction diagram is provided in Appendix E.

6.3.3 Measurements

Use the handheld GPS to acquire the latitude and longitude of the proposed location. Record the position in degrees, minutes and seconds, precise to the tenth of a second (DD MM SS.s) or in decimal degrees, precise to five decimal places (DD.ddddd).

Collect measurements to ensure the chosen location meets the minimum sensor siting requirements for the proposed sensor. Siting criteria can be found in the following documents:

- Sensor Siting Criteria for Microwave Radar Water Level Sensor - Waterlog Field Installation Guide V1.0 (SOP 3.3.1.1.C)
- Sensor Siting Criteria for Aquatrak, Wind, Barometric Pressure, Air Temperature, Solar Radiation, Dew Point, Rainfall, Current, Conductivity, Water Temperature, Water Pressure and Meteorological Towers - NGWLMS Site Design, Preparation, and Installation Manual (SOP 3.2.3.1.A1).

When collecting measurements to support the design effort, take into consideration the structural components, footprints, and structural stability required for the sensors and

support equipment to be installed. Collect measurements of the area surrounding the proposed site and the structural components of the facility which could impact the sensor's performance or how the support equipment will be fastened to the facility structure. Non-critical objects such as cleats or existing conduit typically do not need to be measured in detail unless they present an obstruction to installation, however their general location(s) and size(s) should be measured and photographed. For measurements taken to ensure sensor performance or general siting of equipment (i.e. antenna height or conduit run) measure to the nearest 1/4 inch and for measurements taken of potential support structures or obstructions (i.e. concrete bulkhead or light post) measure to the nearest 1/8 of an inch.

Sketch the plan and elevation views of the recon location(s) and note the measurements in the sketch. The form for reconnaissance for the meteorological sensors is found in Appendix C and the form for cGNSS obstructions is found in Appendix E.

Suggested measurements of typical construction types are listed below. It is the responsibility of the field reconnaissance team to determine all measurements required while on site.

Pier or Dock

Collect measurements (in inches) of the following components of a pier structure, at least in the general areas of the two (or more) proposed installation location(s):

- Pier width and length
- Size, material, condition, location of deck boards, pier stringers and pilings (number, separation, and orientation)
- Existence of wave barriers (prevents attenuation of waves into protected area) and rough estimate of depth of the barrier
- Cross bracing location, size, condition
- Location of boat cleats and fenders within the proximity of proposed installation that might impact location choice or sensor risk
- Spacing of piles and other structural components that could impact sensor performance
- Size of railings and other vertical (potential mounting supports i.e. could clamp a mounting device to the structure) structures
- Measure to any other infrastructure which might be a part of the proposed installation design (i.e. bracket anchor point, lower leveling point, etc.)
- Typical boat sizes that dock along the pier (interference sources for antenna)

Concrete Pier and Bulkhead

Collect measurements (in inches) of the following components of a bulkhead structure, at least in the general areas of the two (or more) proposed installation location(s):

- Bulkhead width and length
- Cap thickness

- Ask the facility representative if the concrete is precast, prestressed, reinforced and /or poured on site
- Bullrails, or jersey walls along the upper edge of the bulkhead in proximity of proposed location
- Measure the bulkhead face
- Type of pavement (thickness if possible) and underlying foundation
- Location of bollards, cranes, rail, davits or any other components in proximity of proposed location which could impact the design
- Number and size of any pilings that line the offshore end of the bulkhead in proximity of proposed location (if applicable)
- Note size of railings and other vertical (potential mounting support) structures
- Measure to any other infrastructure which might be a part of the proposed installation design (i.e. bracket anchor point, lower leveling point, etc.)
- Note any exposed rebar or cracking concrete

Water & Harbor Bottom Depth

From the deck level of the structure at each location where the installation is proposed, measure:

- To the water's surface. Note the date, time to the nearest minute, and time zone used (i.e. UTC, EDT, PST, etc.).
- Several measurements to the harbor bottom along the face of the structure, at the proposed sensor locations and / or any specific area of interest.

The first measurement allows the design engineer to determine the height of the structure with respect to tidal datums. The second set of measurements allows the design engineer to create a harbor bottom profile to ensure the sensor can measure accurate water levels or currents even in the lowest probable scenario.

If a dive is required during the field reconnaissance, document the underwater structural elements that might be part of the proposed installation design or could impact sensor performance.

Review the measurements on site and ensure the preferred location meets the minimum sensor siting criteria. If the measurements are close or do not meet the minimum sensor siting criteria, collect measurements at alternate location(s). Custom support components can be designed and fabricated but are more costly and could impact installation timeframe.

Utilities and Communication

Check for potential shading issues for solar panels at the proposed location. Identify source for AC power and evaluate if a phone line is feasible. Consult with a utility

representative or site electrician while onsite if possible to determine the feasibility of connecting to utility.

Evaluate the line of sight to the appropriate GOES satellite to ensure telemetry will be feasible; identify alternate location for GOES antenna if needed.

Use the IP Modem Kit to measure the cellular signal strength. Connect the IP Modem Kit to your laptop or a loopback to determine signal strength. Perform this for each service provider IP Modem in the kit. Record the service provider and the respective signal strength.

Check with the facility representative to determine if any nearby radio frequency (RF) may potentially interfere with wireless communications. If so note type of operations, if possible RF band/frequency range and frequency (how often) the interference may occur (i.e. intermittent, twice daily, etc.).

If GOES line of sight, copper phone service, and IP modem/cellular service are not an option, determine if an Iridium antenna can be installed with at least ½ of the total horizon available for Iridium and/or BGAN connectivity. The NGS Visibility Obstruction Diagram (Appendix E) can be used to document Iridium visibility and obstructions.
At existing stations determine if the electronics enclosure has enough internal free space for a cGNSS system (batteries, receiver, etc.).

Logistics Information

While not critical for station or component design, collecting logistics information can be critical to efficient installation execution. Some examples of critical logistics information include but are not limited to:

- Methods of personnel transportation to the site (especially if not on the CONUS mainland)
- Shipping methods and points of contact for them, known and preferred (from local knowledge)
- Lodging options
- Location of hardware stores (if any) and quality of local supplies
- Local dive rental options including O_2 kits
- Contact information for renting a small boat (if needed)
- Local or nearest EMS, hospital, and dive chamber (recommend completing NOAA Form 57-03-21
- Diving Emergency Assistance Plan and draft of NOAA Form 57-03-21 Dive Operations Plan)
- NOAA presence in the area
- Local utility (power, copper, phone, and cellular phone) POC
- Local service technicians
- Dig-Locate service contact information

6.3.4 Photos

Photographically document every part of the recon location that can be seen, including from a distance, to document the recon location in relation to open water. If available, use a small skiff or boat to obtain photos of the structure underneath of the deck level.

Stand in the proposed location of the wind tower or cGNSS antenna, if one is to be installed, and take photos 360º from that location to record possible obstructions. If a cGNSS antenna is to be installed, take photos of the North, South, East, and West horizon from the perspective of the antenna using a fisheye lens.

Take photos of simulated leveling runs from each cGNSS recon location to a suitable bench mark to identify any possible obstructions.

Take digital photos of all recovered bench marks as detailed in Attachment R Requirements for Digital Photographs of Survey Control, which is located in the CO-OPS Field Library, keywords “digital photographs”.

6.4 Write and present a summary of the field reconnaissance

A brief (4-6 paragraphs) draft summary detailing the field recon should be written by the FCC. The synopsis should include:

- Completed Field Reconnaissance form (see Appendices B, C, D, & E for appropriate form)
- Scanned copies of the field notes, location sketches and measurements
- Photos and video
- cGNSS obstruction diagram
- Data and results from cGNSS campaigns
- Summary of discussion with the facility representative
- Any additional site specific considerations learned during the recon not documented in the reconnaissance form

The field reconnaissance form, summary and documentation collected during recon should be stored in the project folder created by the DDET. The folder shall reside in the FERS project directory on the CO-OPS Common shared network drive:

\\esp-s-nas01\co-ops_shared_data\CO-OPS_Common\Engineering Review Board\
Field Engineering Review Subcommittee\
Submitted Plans\
<PROJECT NAME>\
Recon

<PROJECT NAME> is the name of the project. Any project documents created should be saved to the folder.

The design team should meet to review the draft reconnaissance summary, discuss the findings, and potential design alternatives or conduct a similar discussion by email. The design team will update the draft summary to include comments, questions and concerns discussed during this meeting in the final revision of the summary and save it in the location mentioned above.

7. Quality Assurance/Control:

While on site, discuss the latest plans for the facility including future improvements and construction schedules with the facility representative. Understanding the facility's plans for the site will ensure CO-OPS invests resources in the most responsible and sustainable way possible. To ensure the viability of the design alternatives and recommendations, provide them to the facility representative for concurrence before moving forward with design efforts. If part of a CRR/CRR-Ops, the Project Lead will ensure CO-OPS resource managers have resourced design tasks and continue project oversight.

8. Management/Responsibility:

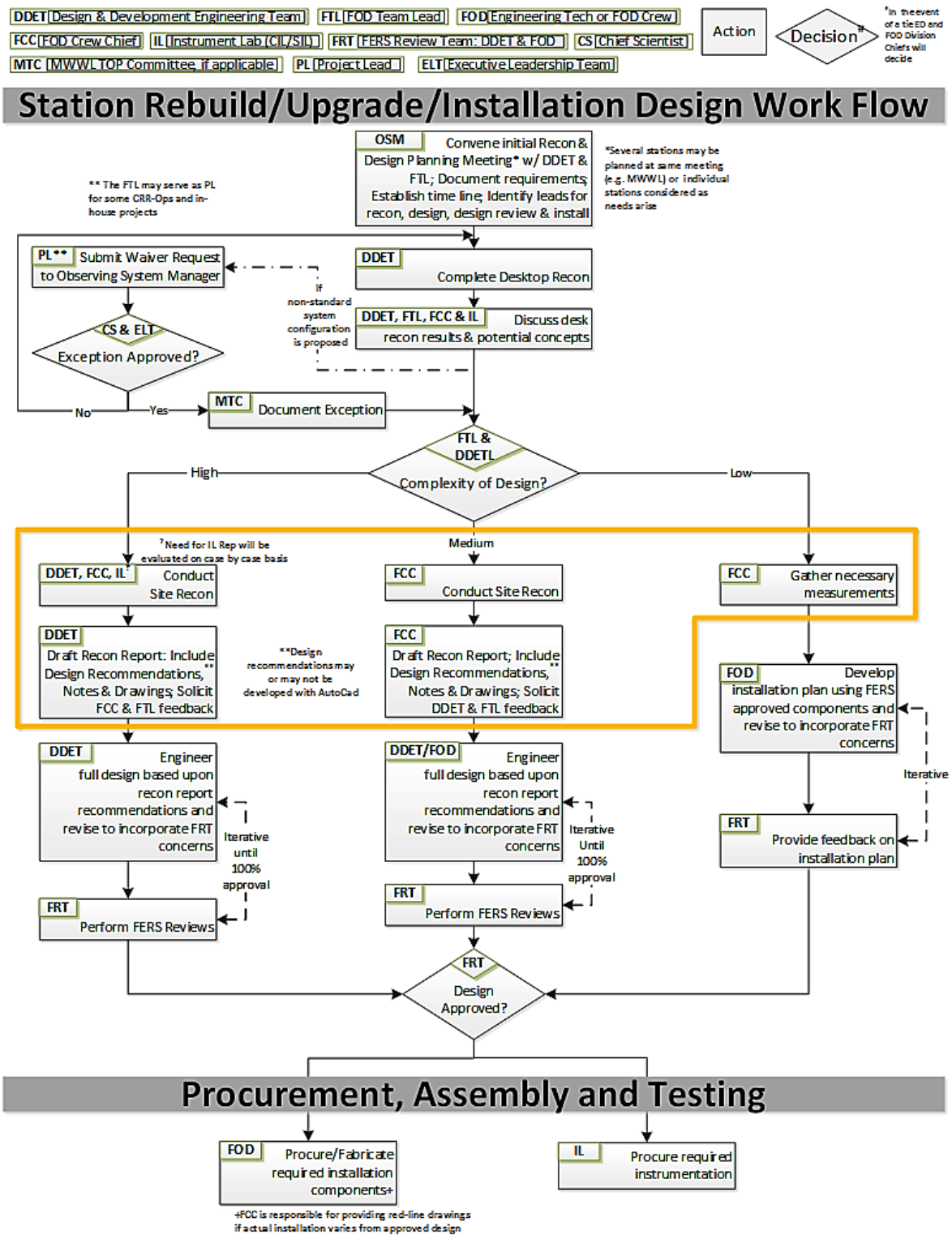
The respective team leads of DDET and the FOD Field Teams coordinate field reconnaissance plans with the PMT Representative, OSM, and other project stakeholders, and work with the project team to identify potential station locations. The field team lead oversees that the field tasks are being accomplished in a reasonable time and communicates/resolves concerns between the DDET and Field team leads.

The responsibility for maintaining this SOP resides with the DDET Team Lead.

9. Change History:

Date	Author(s)	Approver(s)	Changes
02/2015	Servary	Teng/Bosley	SOP Created
09/2015	Roche	Teng/Bosley	SOP Revised
02/2017	Samant	Teng/Bosley	Updated flow chart for waiver
09/2020	Loesch, Hogan, Breuer, Eng	Teng/Bosley	Added additional reconnaissance information and forms for cGNSS system reconnaissance. Revised text to eliminate jargon and update to current practices.

Appendix A: Station Design Work Flow Diagram



Appendix B: Site Reconnaissance Form

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:** **Email:**	**Local Contact:** **Address:** **Phone:** **Cell Phone:** **Fax:** **Email:**			
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/Handheld GPS) No. _____of Bench Marks, No. ____ of Class A Marks, No. _____of Class B Marks, No. ____ of Class B Marks.	# Recovered # to be Installed Estimated length of run Quality of Bench Marks Static GPS Suitability
SERVICES/UTILITIES	
Utility (AC power and/or Phone) Requirement	# of lines required Origination Point Length of run Overhead/trench Estimated cost Type of cable Type of conduit
Utility (AC power and/or Phone) Company and Contractor Info	Name Number Mail Address Contact
IP Modem	Service Provider Signal Strength
Contractors Info	Marine Concrete Diving Welding Price quotes received
Site Notes	

Appendix C: Meteorological Reconnaissance Form

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

Meteorological Reconnaissance Form

Station Number | Station Name | Date

Type of Station | City | County

Reconnaissance performed by: | State | Zip Code

General Site Information

Does the proposed site consist of predominantly flat terrain? (Small gradual slopes are acceptable) ☐YES ☐NO

If NO, explain: | Are there Benchmarks present? ☐YES ☐NO

Surface that the tower will be mounted on: | Area surrounding the proposed station is mostly

Does the proposed site put the sensors at risk of contamination from wind blown dirt in the direction of the tower? ☐YES ☐NO

Prevailing wind direction: | Can standing water collect at the base of the proposed tower? ☐YES ☐NO

Wind Sensor Reconnaissance

Is it possible to mount the wind sensor at 9 to 10 meters above the base of the proposed tower? ☐YES ☐NO ☐N/A

If NO, at what height can the wind sensor be mounted? (m)

If the wind sensor is to be mounted on a rooftop location, is it at least 6 meters above the highest rooftop obstruction? ☐YES ☐NO ☐N/A

Is a horizontal distance of at least ten times the height of any obstruction maintained between the wind sensor and that obstruction? ☐YES ☐NO ☐N/A

Is it possible that large obstructions (temporary or permanent) could obstruct the wind sensor? i.e. Cruise ships docked at port or large trucks parked on a pier, etc... ☐YES ☐NO

Notes

Air Temperature/Relative Humidity Sensor Reconnaissance

Is it possible to mount the AT/RH sensors at least 1.2 to 2.0 meters above the base of the proposed tower? ☐YES ☐NO ☐N/A

If NO, at what height can the AT/RH sensors be mounted? (m)

Is a horizontal distance of four times the height of any obstruction maintained between the AT/RH sensors and that obstruction? ☐YES ☐NO ☐N/A

Notes

CO-OPS METEOROLOGICAL RECONNAISSANCE
SENSOR OBSTRUCTION FORM

PLEASE INDICATE ANY AND ALL OBSTRUCTIONS WITH THEIR APPROXIMATE HEIGHT AND HORIZONTAL DISTANCE FROM THE TOWER ON THE DIAGRAM.

CHECK IF THERE ARE NO OBSTRUCTIONS IN THE AREA: ☐

MAJOR OBSTRUCTIONS BEYOND 80M? ☐ YES ☐ NO

IF YES EXPLAIN	
DESCRIPTION OF THE PROPOSED AREA SURROUNDING THE METEOROLOGICAL TOWER	

Appendix D: cGNSS Recon Plan

Approximate Schedule
List each day's itinerary

1. List of Tasks to Complete On Site

Find prospective cGNSS antenna locations identified in desktop recon; at each:

- Collect series of photos showing horizontal view of North, South, East, West
- Collect all relevant measurements to any nearby obstructions (i.e. obstructing line of sight greater than 10° above the horizontal from proposed antenna location)
    - Height of any objects next to potential radar water level sensor sites
- Identify the supporting structures to which the antenna will be attached. Make sure the structure is stable
- Antenna mount methods shall be discussed and determined on site
- Collect all photos and measurements required to develop mounting design
- Take picture from each GNSS occupation (take panoramic shot if possible using fisheye lens)
- Conduct temporary occupations with portable GNSS kit (6-24hrs, 24hrs is preferred)
- Determine length of cable run required from prospective cGNSS antenna location(s) to NWLON enclosure
- Gather info on activity that my take place near cGNSS antenna installation site (vessel mooring, fishing, tourists, etc.)

Inspect existing DCP enclosure

- Determine locations inside for:
    - 2x 40 Ah batteries, GNSS receiver, IP modem, cabling
- Take multiple photos of inside that can be used to annotate proposed locations of all cGNSS system components
- Select location where cabling will come into enclosure (GNSS antenna, IP antenna, etc.)
    - Will new penetration be required?
    - Can an existing penetration or existing conduit be used?
    - Width of existing conduit & number of cables currently running through.

- If it seems that location of GNSS equipment in the existing NWLON enclosure may not be the best option, gather information, measurements, and photos of location where an additional GNSS enclosure could be mounted.

Find prospective solar panel locations:

- If not required at this location, consider options available

IP modem installation (we already know cell coverage from NWLON station's modem)

- Find prospective location for IP modem antenna (needs to be far away enough from GNSS to avoid interference, at least 5' away).
- Collect all photos and measurements required to determine required mounting hardware and setup
- Determine length of cable run required from antenna location(s) to NWLON enclosure

Station Bench Marks

- Recover existing bench marks; confirm suitability for campaign GPS survey

Discuss any potential permitting issues with site POC.

2. Portable GNSS System Configuration and Metadata Log

Portable GNSS gauge must be setup for 1 hour log files, to be linked together later for each site recon campaign.

Metadata	
IP Address	
Modem Make/Model	
Station Name	
Login Info (only needed to make configuration changes!): default UNAVCO logins	
GNSS Receiver Make/Model	
GNSS Receiver #1 Serial No.	
GNSS Antenna #1 Make/Model	
GNSS Antenna #1 Serial No.	
GNSS Receiver #2 Make/Model	
GNSS Receiver #2 Serial No.	
GNSS Antenna #2 Make/Model	
GNSS Antenna #2 Serial No.	

3. Equipment Packing List

Item	Owner/Packer (Initials)	Location/Box #
Misc. Tools and Equipment		
Small step ladder		
Measuring tapes		
Handheld GPS		
Cameras		
Hammer and WD40 (in case needed on enclosure's combo lock)		
Tie wraps		
Duct tape		
Tool bag/ standard tool kit		
Ratchet straps		
extra GNSS antenna cable		
Klein tool (steel fish tape)		
Pad/paper/clip board writing utensils		
iGage OPUS x90 Kit (backup to portable GNSS kit)		
Handheld compass		
Level		
Handheld laser range sensor		
PFD		
Tarp		
SHOVEL		
Documentation/Printouts		
This site recon plan		
WTS Sato travel itineraries		
Bench mark map and 'to reach' descriptions		
Portable GNSS Kit		
NetR9, IP modem, & battery in pelican case		
GNSS antenna		
GNSS antenna cable		
Battery Charger		
USB connection for data download		
Chain and lock		
Antenna radome cover (can I borrow from Brandywine?)		
Government laptop w/ VPN capability		

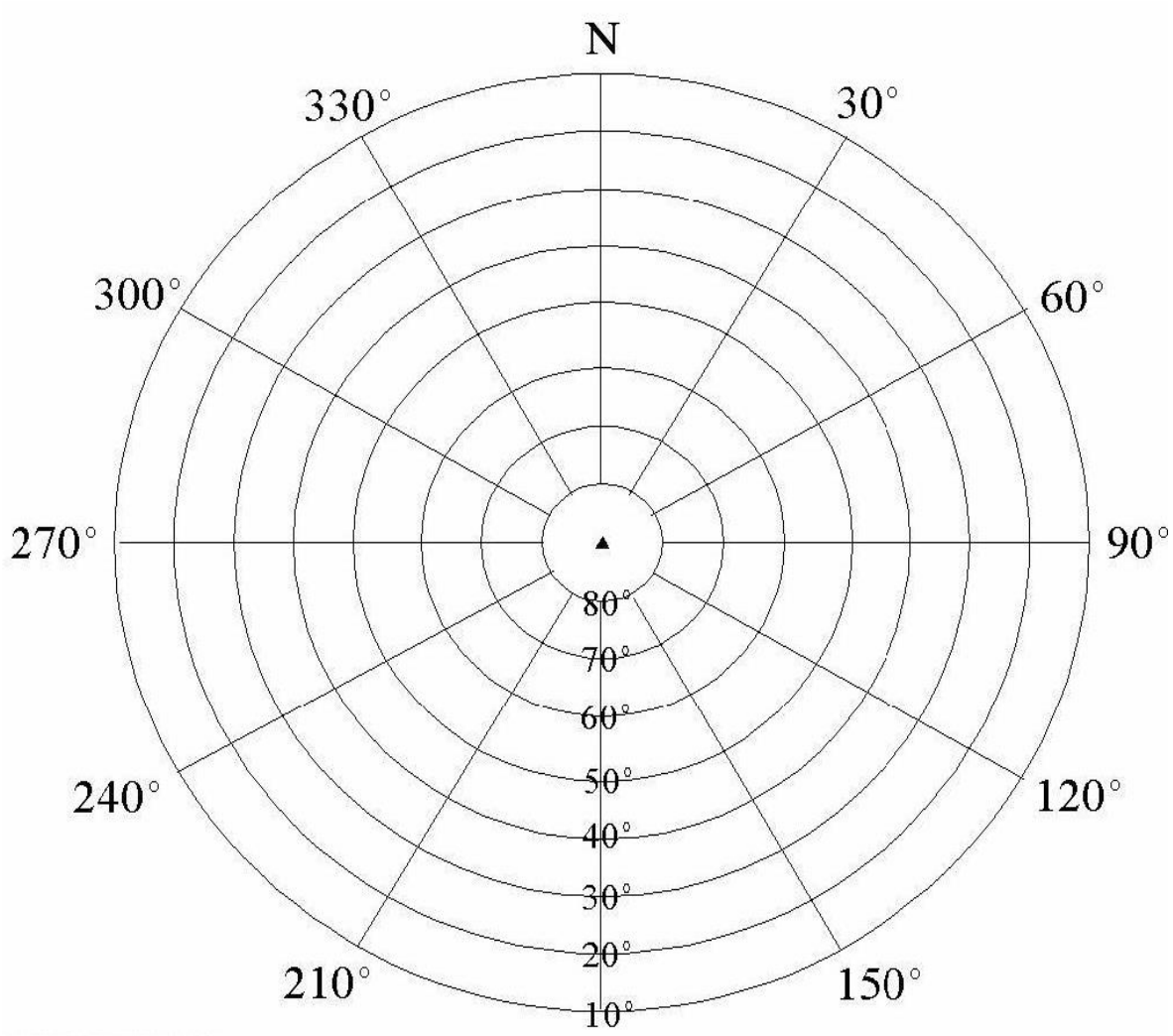
Temporary GNSS Antenna Mounting Hardware		
2m tripod (borrow from FOD)		
Seco GNSS antenna mount		
Lighter weight, pole top GNSS antenna mount (made from ODU bolt)		
Several sections of extension pole/mast and couplers (1.5” aluminum)		
Hose clamps		
Andrews clamps		
SS tie wraps		
Sand bags		
Omega clamp		
Lag screws		
Roof mounting plate		

4. Short Term GNSS Occupation Log

Location Description	Occupation Time Start (LT)	Occupation Time End (LT)	Comments	Operator Initials

Appendix E: cGNSS Obstruction Diagram

NATIONAL GEODETIC SURVEY VISIBILITY OBSTRUCTION DIAGRAM



INSTRUCTIONS:

Identify obstructions by azimuth (magnetic) and elevation angle (above horizon) as seen from station mark.
Indicate distance and direction to nearby structures and reflective surfaces (potential multipath sources).

4-char ID: _____ Designation: _____

PID: _____ Location: _____

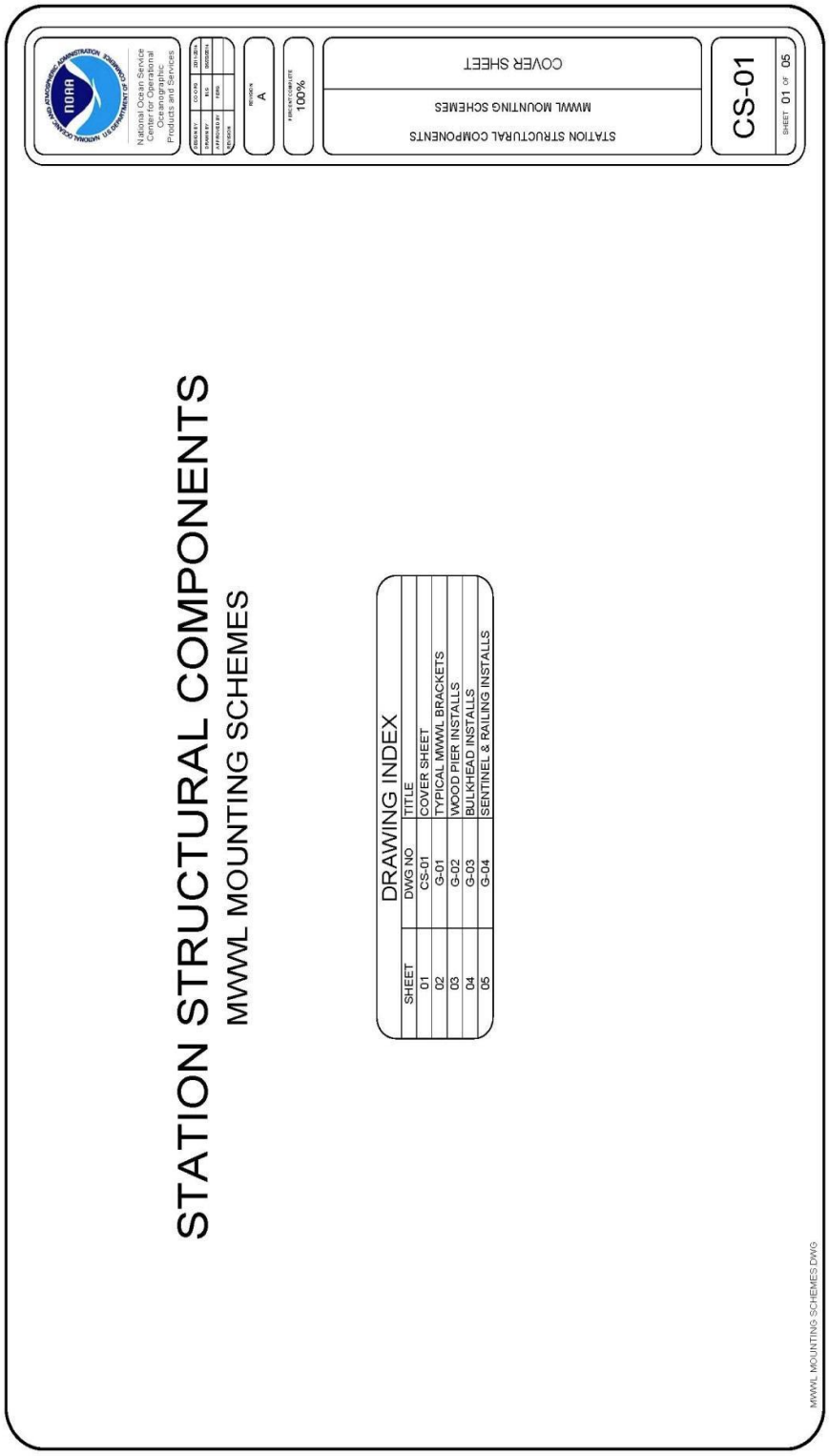
County: _____ Reconnaissance By: _____

Height above mark, meters: _____ Agency/Company: _____

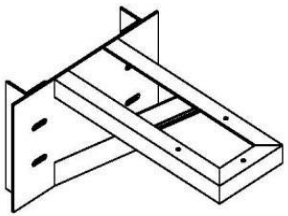
Phone: (_____) _____ Date:_____

Check if no obstructions above 10 degrees ☐

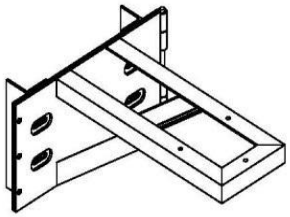
Appendix F: Microwave Water Level Mounting Schemes



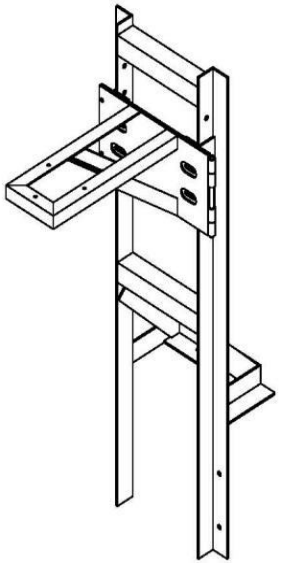
NOTES:
1. THE FOLLOWING 5 STYLES COVER THE BASIC BRACKETS THAT ARE USED TO MOUNT THE MWWL SENSOR WITH GEODETIC COLLAR.



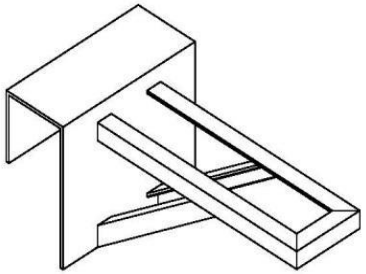
TYPICAL FIXED ARM BRACKET



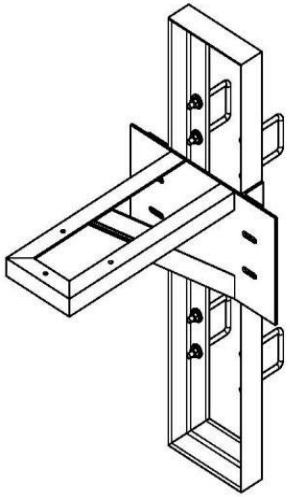
TYPICAL SWING ARM BRACKET



BULKHEAD MOUNT
& SWING PLATE



TYPICAL JERSEY WALL BRACKET



MWWL RAILING BRACKET
& FIXED PLATE
(SENTINEL MODEL)

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DESIGN BY	CO-OPS	2011-2014
DRAWN BY	SLS	04/03/2014
APPROVED BY	FERS	
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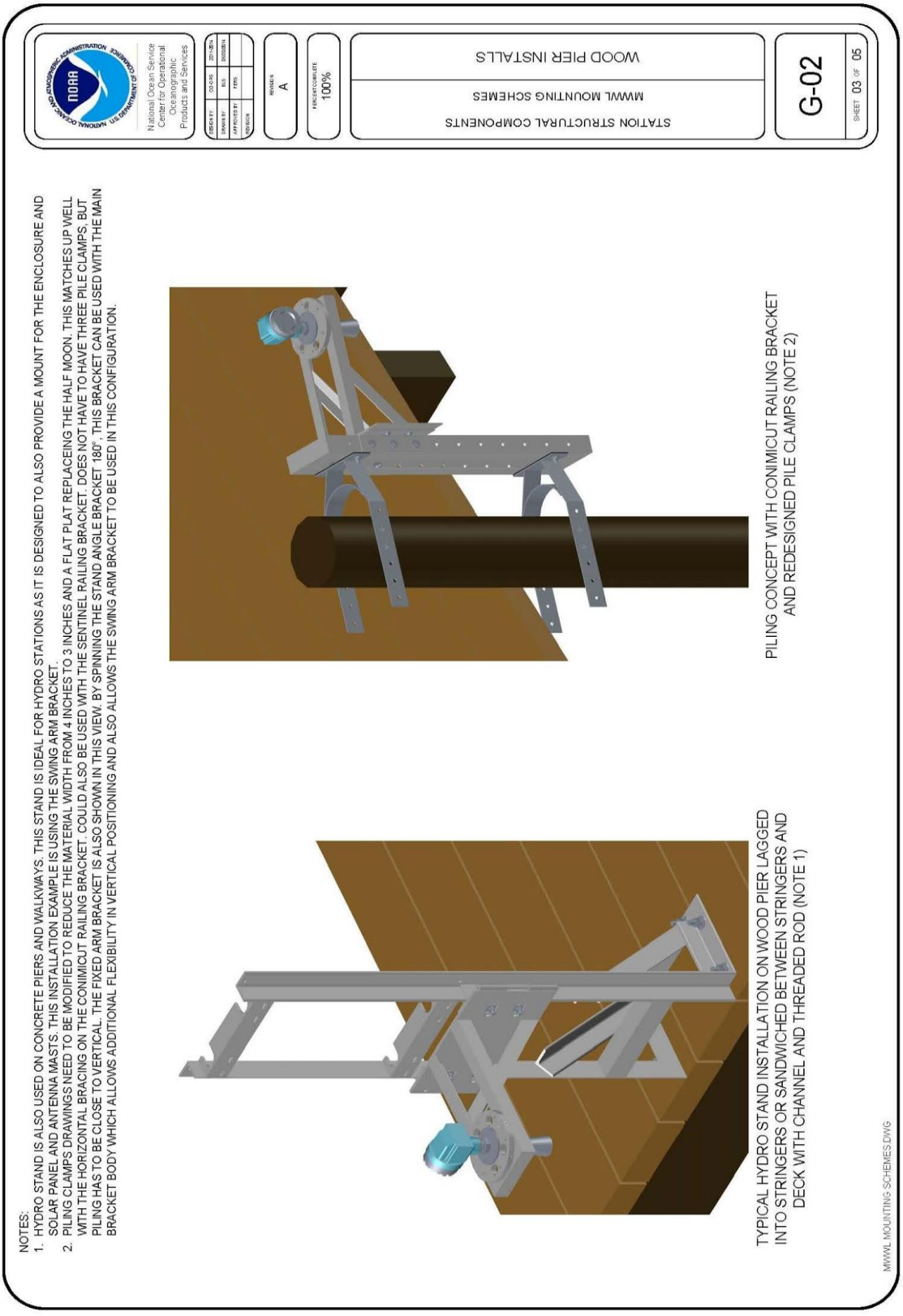
STATION STRUCTURAL COMPONENTS
MWWL MOUNTING SCHEMES
TYPICAL MWWL BRACKETS

G-01

SHEET 02 OF 05

MWWL MOUNTING SCHEMES.DWG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STATION STRUCTURAL COMPONENTS
MWWL MOUNTING SCHEMES
WOOD PIER INSTALLS
G-02
SHEET 03 OF 05
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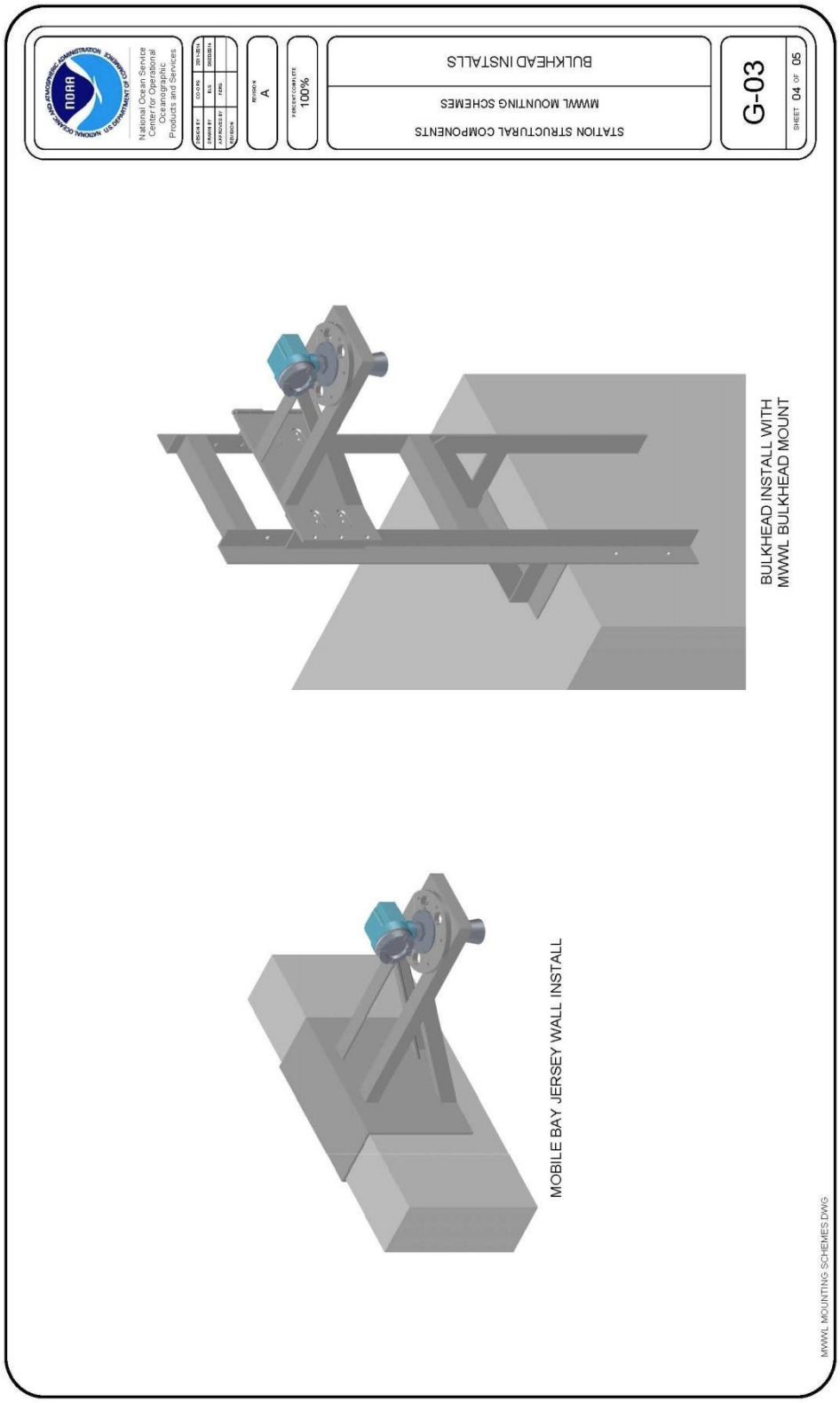
NOTES:
1. HYDRO STAND IS ALSO USED ON CONCRETE PIERS AND WALKWAYS. THIS STAND IS IDEAL FOR HYDRO STATIONS AS IT IS DESIGNED TO ALSO PROVIDE A MOUNT FOR THE ENCLOSURE AND SOLAR PANEL AND ANTENNA MASTS. THIS INSTALLATION EXAMPLE IS USING THE SWING ARM BRACKET.
2. PILING CLAMPS DRAWINGS NEED TO BE MODIFIED TO REDUCE THE MATERIAL WIDTH FROM 4 INCHES TO 3 INCHES AND A FLAT PLAT REPLACEING THE HALF MOON. THIS MATCHES UP WELL WITH THE HORIZONTAL BRACING ON THE CONIMICUT RAILING BRACKET. COULD ALSO BE USED WITH THE SENTINEL RAILING BRACKET. DOES NOT HAVE TO HAVE THREE PILE CLAMPS, BUT PILING HAS TO BE CLOSE TO VERTICAL. THE FIXED ARM BRACKET IS ALSO SHOWN IN THIS VIEW. BY SPINNING THE STAND ANGLE BRACKET 180°, THIS BRACKET CAN BE USED WITH THE MAIN BRACKET BODY WHICH ALLOWS ADDITIONAL FLEXIBILITY IN VERTICAL POSITIONING AND ALSO ALLOWS THE SWING ARM BRACKET TO BE USED IN THIS CONFIGURATION.
PILING CONCEPT WITH CONIMICUT RAILING BRACKET AND REDESIGNED PILE CLAMPS (NOTE 2)
TYPICAL HYDRO STAND INSTALLATION ON WOOD PIER LAGGED INTO STRINGERS OR SANDWICHED BETWEEN STRINGERS AND DECK WITH CHANNEL AND THREADED ROD (NOTE 1)
MWWL MOUNTING SCHEMES.DWG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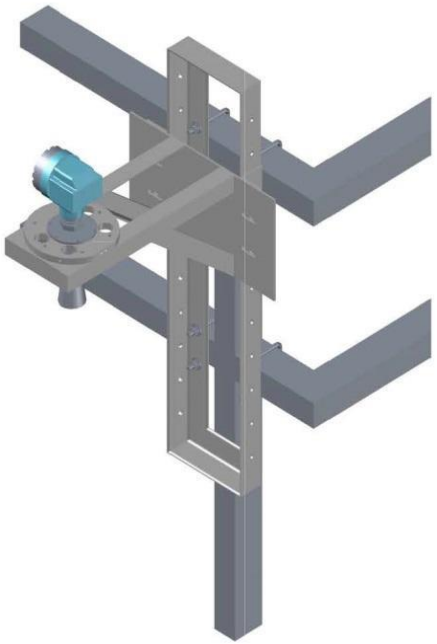
STATION STRUCTURAL COMPONENTS
MWWL MOUNTING SCHEMES
BULKHEAD INSTALLS
G-03
SHEET 04 OF 05
BULKHEAD INSTALL WITH
MWWL BULKHEAD MOUNT
MOBILE BAY JERSEY WALL INSTALL
MWWL MOUNTING SCHEMES.DWG

NOTES:
1. THE PROPOSED SENTINEL RAILING INSTALLATION SHOWN IS USING A MWWL RAILING BRACKET AND FIXED ARM BRACKET.
2. THE MWWL RAILING BRACKET COULD USE THE FIXED ARM OR SWING ARM BRACKET.
3. THIS DESIGN IS ADAPTABLE TO DIFFERENT SIZE RAILINGS.



SENTINEL INSTALLATION USING
MWWL RAILING BRACKET

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DRAWN BY	BLG	05/05/2014
APPROVED BY	TERS	
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STATION STRUCTURAL COMPONENTS
MWWL MOUNTING SCHEMES

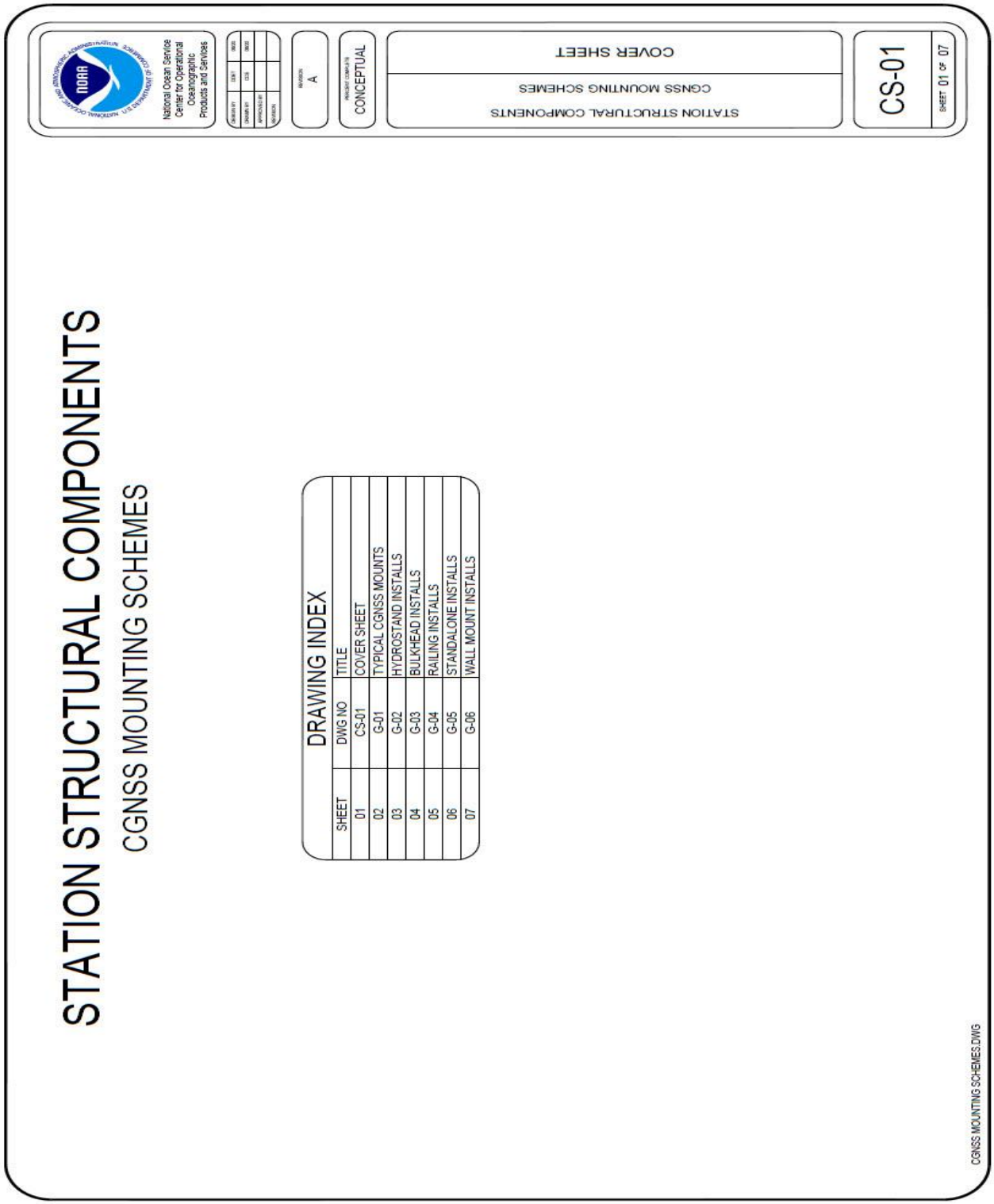
SENTINEL & RAILING INSTALLS

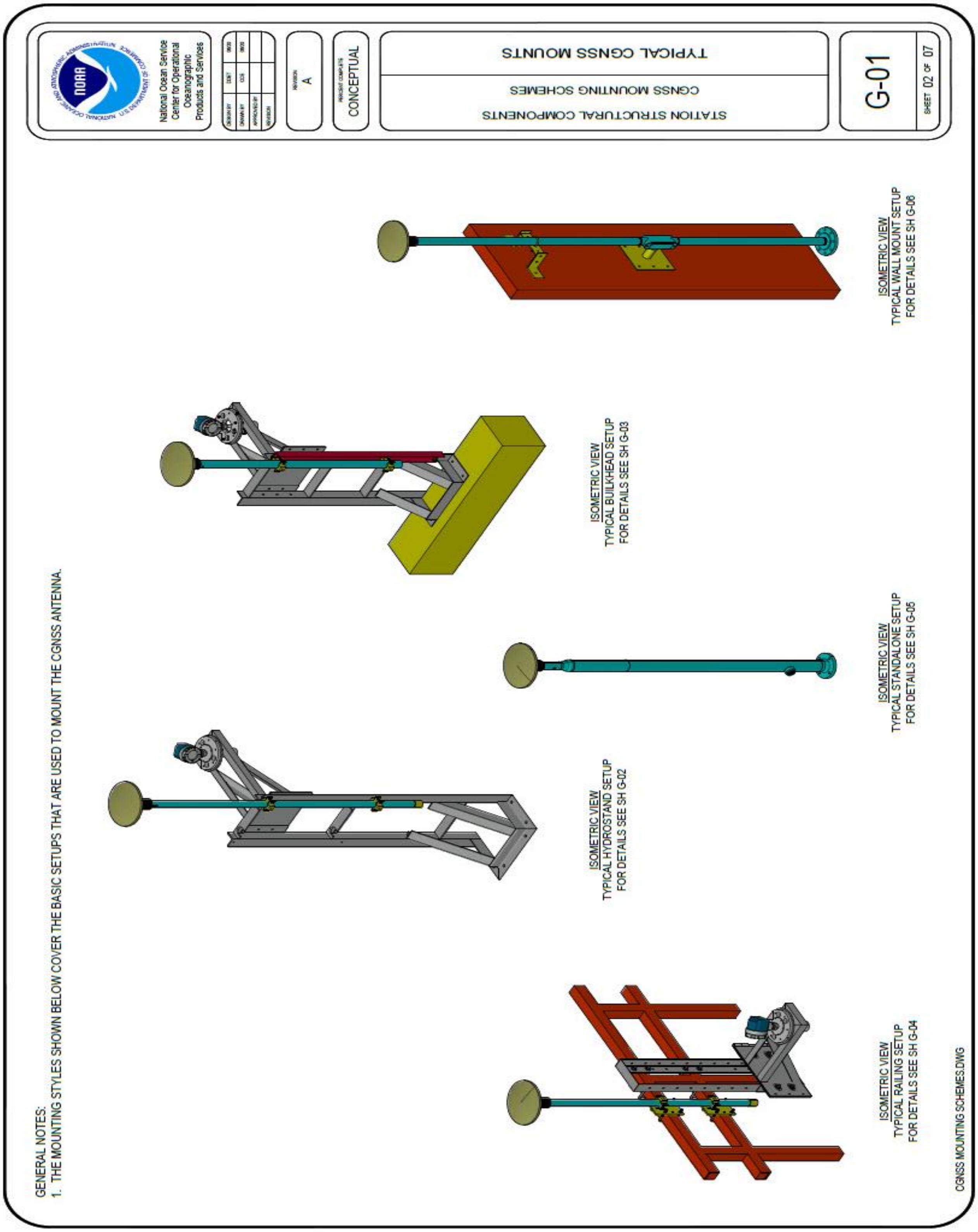
G-04

SHEET 05 OF 05

MWWL MOUNTING SCHEMES.DWG

Appendix G: cGNSS Antenna Mounting Schemes




GENERAL NOTES:
1. THE MOUNTING STYLES SHOWN BELOW COVER THE BASIC SETUPS THAT ARE USED TO MOUNT THE CGNSS ANTENNA.
ISOMETRIC VIEW
TYPICAL WALL MOUNT SETUP
FOR DETAILS SEE SH G-06
ISOMETRIC VIEW
TYPICAL BULKHEAD SETUP
FOR DETAILS SEE SH G-03
ISOMETRIC VIEW
TYPICAL STANDALONE SETUP
FOR DETAILS SEE SH G-05
ISOMETRIC VIEW
TYPICAL HYDROSTAND SETUP
FOR DETAILS SEE SH G-02
ISOMETRIC VIEW
TYPICAL RAILING SETUP
FOR DETAILS SEE SH G-04
CGNSS MOUNTING SCHEMES.DWG
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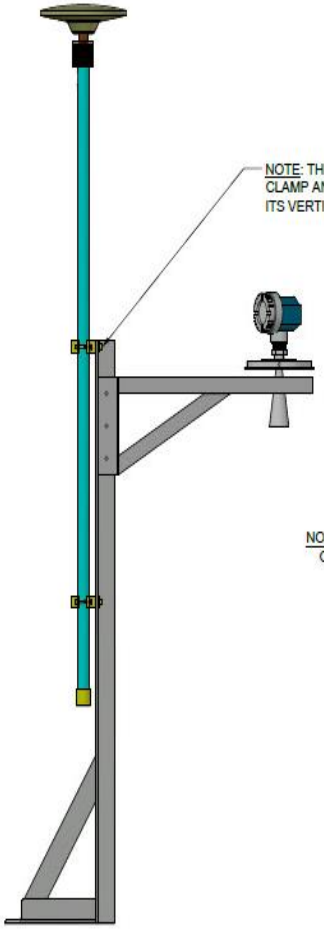
CONCEPTUAL
TYPICAL CGNSS MOUNTS
CGNSS MOUNTING SCHEMES
STATION STRUCTURAL COMPONENTS
G-01
SHEET 02 OF 07

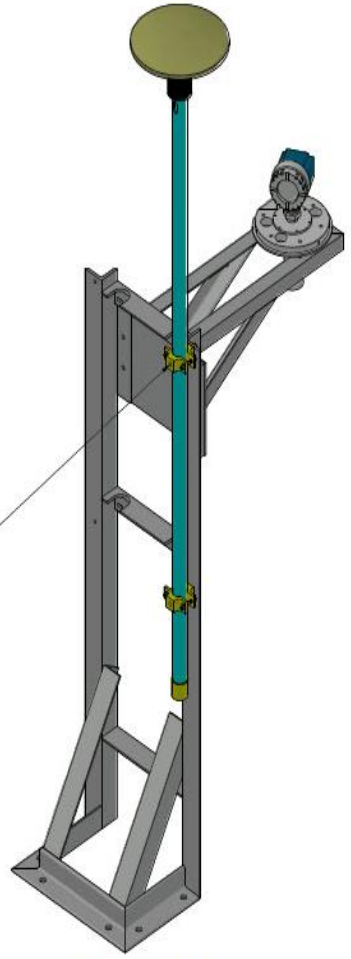
SHEET NOTES:

1. THE HYDROSTAND SETUP INVOLVES DRILLING OUT THE EXISTING Ø7/16 HOLES TO Ø1/2 IN THE HYDROSTAND. THE MAST CONSISTS OF EITHER A 2 NPS SCH 40 OR 1-1/2 NPS SCH 80, 6061-T6 PIPE WITH AN ADJUSTABLE MONUMENT FOR LEVELING THE ANTENNA.
2. THIS SETUP GENERALLY FOLLOWS SECTION 'B.4. ROOF-BASED MONUMENT' FROM THE NGS 'GUIDELINES FOR NEW AND EXISTING CORS' PUBLICATION, THE ANTENNA MAST (IN BLUE BELOW) IS SECURED WITH LOCKNUTS AND A PIN THAT PASSES THROUGH THE MAST AND HYDROSTAND. ANY DESIGN MODIFICATION SHALL NOT WEAKEN THESE CONNECTIONS.
3. THE CURRENT LEVELING TECHNIQUE IS TO REMOVE THE ANTENNA AND BRASS FITTING THEN PLACE A SURVEY BAR IN THE TOP OF THE MONUMENT. THEN A LEVELING ROD IS HELD AGAINST THE UNDERSIDE OF THE SURVEY BAR AND A LEVEL SHOT IS TAKEN. THE UNDERSIDE OF THE SURVEY BAR SHOULD BE AT THE SAME ELEVATION AS THE ANTENNA ARP.
4. FOR INSTALLATION EXAMPLE SEE DRAWING '8452660 NEWPORT GNSS, REV A'.



NOTE: THE ANTENNA MAST IS PINNED THROUGH THIS CLAMP AND THE HYDROSTAND, IN ORDER TO LOCK ITS VERTICAL POSITION WITH THE MWWL

ELEVATION VIEW
TYPICAL HYDROSTAND SETUP
CO-LOCATION OF CGNSS ANTENNA AND MWWL



NOTE: THE ANTENNA MAST IS PINNED THROUGH THIS CLAMP AND THE HYDROSTAND, IN ORDER TO LOCK ITS VERTICAL POSITION WITH THE MWWL

ISOMETRIC VIEW
TYPICAL HYDROSTAND SETUP
CO-LOCATION OF CGNSS ANTENNA AND MWWL

CGNSS MOUNTING SCHEMES.DWG

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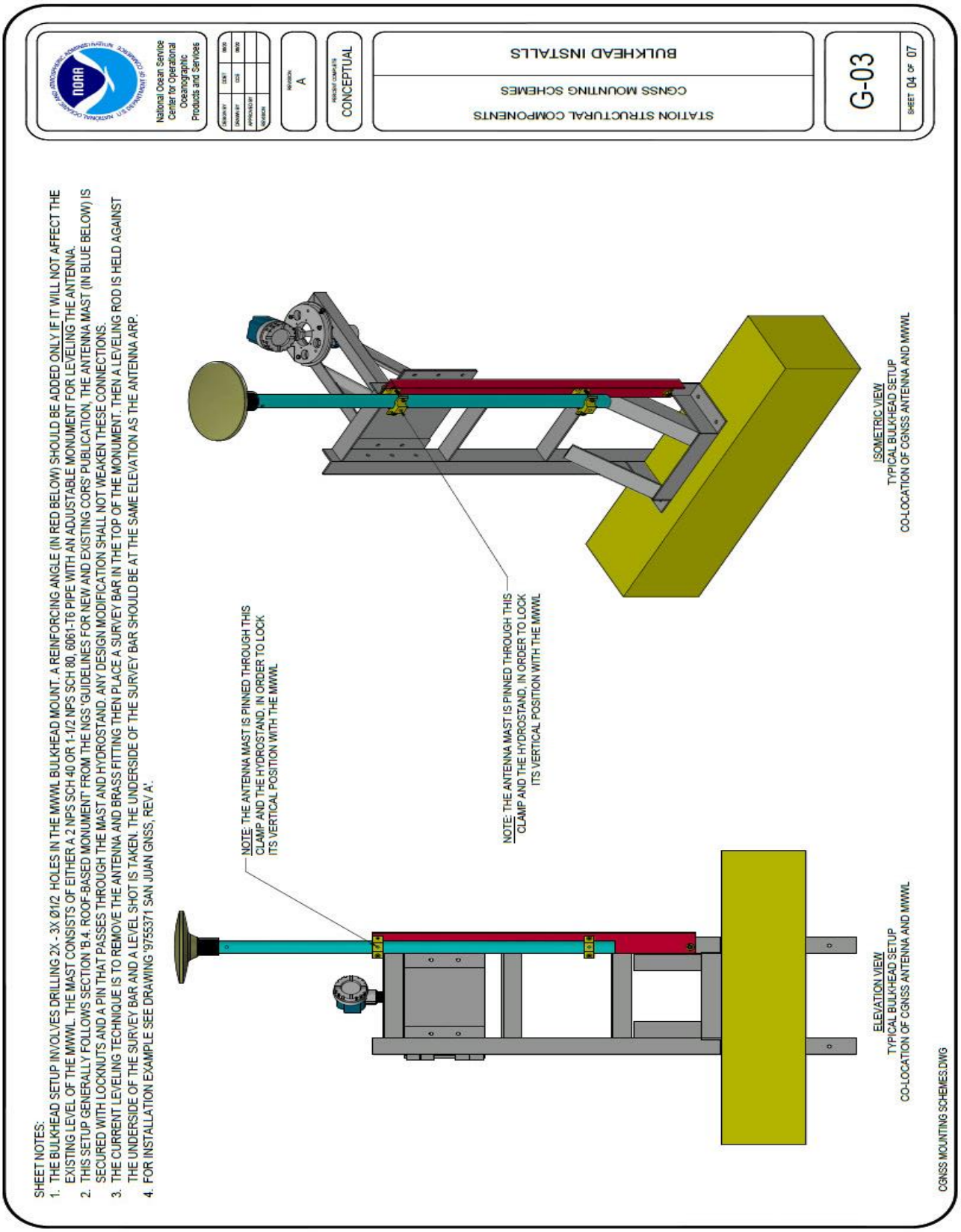
STATION STRUCTURAL COMPONENTS
CGNSS MOUNTING SCHEMES
HYDROSTAND INSTALLS

G-02

SHEET 03 OF 07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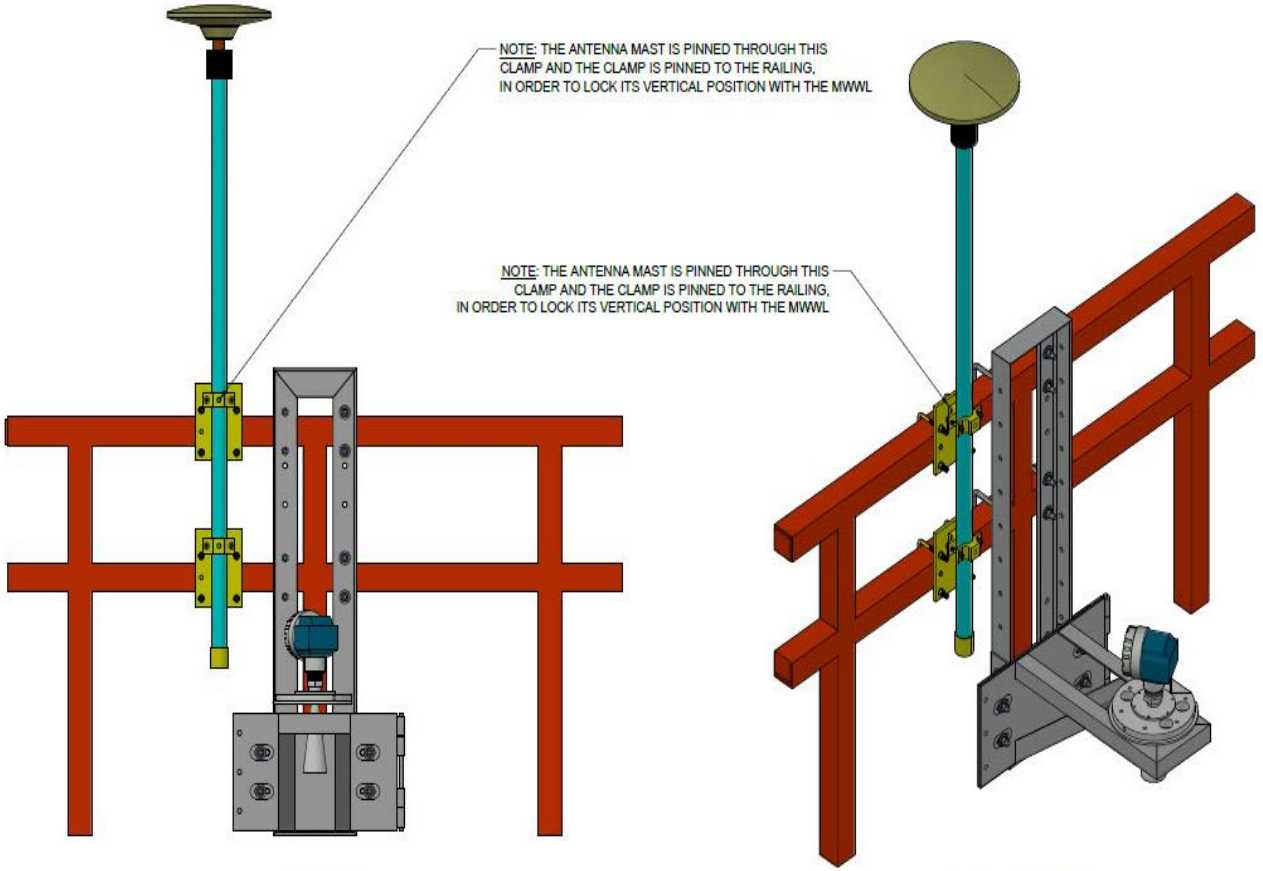
Products and Services
STATION STRUCTURAL COMPONENTS
CGNSS MOUNTING SCHEMES
BULKHEAD INSTALLS
G-03
SHEET 04 OF 07
A
CONCEPTUAL
SHEET NOTES:
1. THE BULKHEAD SETUP INVOLVES DRILLING 2X - 3X Ø1/2" HOLES IN THE MWWL BULKHEAD MOUNT. A REINFORCING ANGLE (IN RED BELOW) SHOULD BE ADDED ONLY IF IT WILL NOT AFFECT THE EXISTING LEVEL OF THE MWWL. THE MAST CONSISTS OF EITHER A 2 NPS SCH 40 OR 1-1/2 NPS SCH 80, 6061-T6 PIPE WITH AN ADJUSTABLE MONUMENT FOR LEVELING THE ANTENNA.
2. THIS SETUP GENERALLY FOLLOWS SECTION 'B.4. ROOF-BASED MONUMENT' FROM THE NGS 'GUIDELINES FOR NEW AND EXISTING CORS' PUBLICATION. THE ANTENNA MAST (IN BLUE BELOW) IS SECURED WITH LOCKNUTS AND A PIN THAT PASSES THROUGH THE MAST AND HYDROSTAND. ANY DESIGN MODIFICATION SHALL NOT WEAKEN THESE CONNECTIONS.
3. THE CURRENT LEVELING TECHNIQUE IS TO REMOVE THE ANTENNA AND BRASS FITTING THEN PLACE A SURVEY BAR IN THE TOP OF THE MONUMENT. THEN A LEVELING ROD IS HELD AGAINST THE UNDERSIDE OF THE SURVEY BAR AND A LEVEL SHOT IS TAKEN. THE UNDERSIDE OF THE SURVEY BAR SHOULD BE AT THE SAME ELEVATION AS THE ANTENNA ARP.
4. FOR INSTALLATION EXAMPLE SEE DRAWING '9755371 SAN JUAN GNSS, REV A'.
NOTE: THE ANTENNA MAST IS PINNED THROUGH THIS CLAMP AND THE HYDROSTAND, IN ORDER TO LOCK ITS VERTICAL POSITION WITH THE MWWL
NOTE: THE ANTENNA MAST IS PINNED THROUGH THIS CLAMP AND THE HYDROSTAND, IN ORDER TO LOCK ITS VERTICAL POSITION WITH THE MWWL
ISOMETRIC VIEW
TYPICAL BULKHEAD SETUP
CO-LOCATION OF CGNSS ANTENNA AND MWWL
ELEVATION VIEW
TYPICAL BULKHEAD SETUP
CO-LOCATION OF CGNSS ANTENNA AND MWWL
CGNSS MOUNTING SCHEMES.DWG

SHEET NOTES:

1. THE RAILING SETUP INVOLVES DRILLING 2X Ø1/4 HOLES IN THE RAILING TO PIN THE RAILING CLAMPS. THE RAILING CLAMPS MUST BE SECURED TO THE SAME RAILING SECTION AS THE MWWL. THE MAST CONSISTS OF EITHER A 2 NPS SCH 40 OR 1-1/2 NPS SCH 80, 6061-T6 PIPE WITH AN ADJUSTABLE MONUMENT FOR LEVELING THE ANTENNA.
2. THIS SETUP GENERALLY FOLLOWS SECTION 'B.4. ROOF-BASED MONUMENT' FROM THE NGS 'GUIDELINES FOR NEW AND EXISTING CORS' PUBLICATION, THE ANTENNA MAST (IN BLUE BELOW) IS SECURED WITH LOCKNUTS AND A PIN THAT PASSES THROUGH THE MAST AND RAILING CLAMPS. THE RAILING CLAMPS ARE SIMILARLY SECURED WITH LOCKNUTS AND A PIN THAT PASSES THROUGH THE RAILING CLAMPS AND RAILING. ANY DESIGN MODIFICATION SHALL NOT WEAKEN THESE CONNECTIONS.
3. THE CURRENT LEVELING TECHNIQUE IS TO REMOVE THE ANTENNA AND BRASS FITTING THEN PLACE A SURVEY BAR IN THE TOP OF THE MONUMENT. THEN A LEVELING ROD IS HELD AGAINST THE UNDERSIDE OF THE SURVEY BAR AND A LEVEL SHOT IS TAKEN. THE UNDERSIDE OF THE SURVEY BAR SHOULD BE AT THE SAME ELEVATION AS THE ANTENNA ARP.
4. FOR INSTALLATION EXAMPLE SEE DRAWING '8635027 DAHLGREN GNSS, REV A'.



ELEVATION VIEW
TYPICAL RAILING SETUP
CO-LOCATION OF CGNSS ANTENNA AND MWWL

ISOMETRIC VIEW
TYPICAL RAILING SETUP
CO-LOCATION OF CGNSS ANTENNA AND MWWL

CGNSS MOUNTING SCHEMES.DWG

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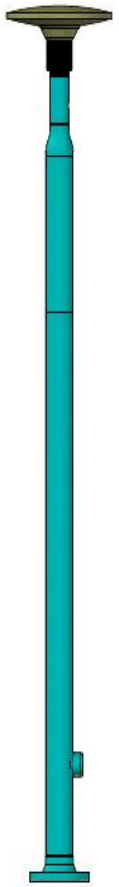
STATION STRUCTURAL COMPONENTS
CGNSS MOUNTING SCHEMES
RAILING INSTALLS

G-04

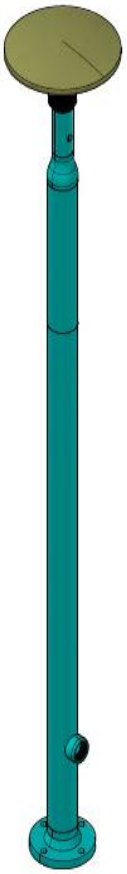
SHEET 05 OF 07

SHEET NOTES:

1. THE STANDALONE SETUP INVOLVES ANCHORING THE ANTENNA MAST TO A SOLID STRUCTURE (PIER, WHARF, ETC.), IDEALLY THE SAME STRUCTURE THAT SUPPORTS THE MWWL. THE MAST CONSISTS OF A 3 NPS SCH 40, SS316L PIPE WITH AN ADJUSTABLE MONUMENT FOR LEVELING THE ANTENNA.
2. THIS SETUP FOLLOWS SECTION 'B.4. ROOF-BASED MONUMENT' FROM THE NGS 'GUIDELINES FOR NEW AND EXISTING CORS' PUBLICATION, THE STAINLESS STEEL ANTENNA MAST (IN BLUE BELOW) IS BOLTED WITH LOCKNUTS AND EPOXY ANCHORS DIRECTLY TO THE MAIN PART OF THE BUILDING/STRUCTURE. ANY DESIGN MODIFICATION SHALL NOT WEAKEN THESE CONNECTIONS.
3. THE CURRENT LEVELING TECHNIQUE IS TO REMOVE THE ANTENNA AND BRASS FITTING THEN PLACE A SURVEY BAR IN THE TOP OF THE MONUMENT. THEN A LEVELING ROD IS HELD AGAINST THE UNDERSIDE OF THE SURVEY BAR AND A LEVEL SHOT IS TAKEN. THE UNDERSIDE OF THE SURVEY BAR SHOULD BE AT THE SAME ELEVATION AS THE ANTENNA ARP.
4. FOR INSTALLATION EXAMPLE SEE DRAWING '8729840 PENSACOLA GNSS, REV A'.



ELEVATION VIEW
TYPICAL STANDALONE SETUP
SEPARATION OF CGNSS ANTENNA AND MWWL



ISOMETRIC VIEW
TYPICAL STANDALONE SETUP
SEPARATION OF CGNSS ANTENNA AND MWWL

CGNSS MOUNTING SCHEMES.DWG

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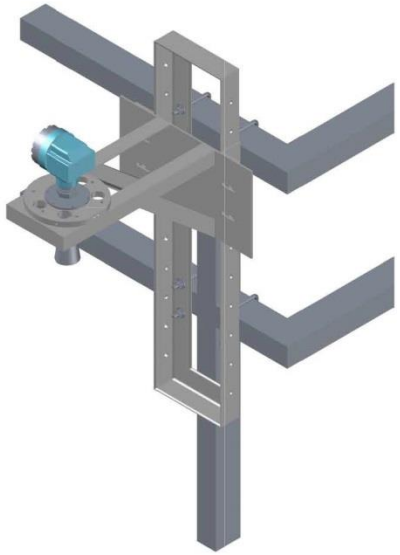
STATION STRUCTURAL COMPONENTS
CGNSS MOUNTING SCHEMES
STANDALONE INSTALLS

G-05

SHEET 06 OF 07

NOTES:
1. THE PROPOSED SENTINEL RAILING INSTALLATION SHOWN IS USING A MWWL RAILING BRACKET AND FIXED ARM BRACKET.
2. THE MWWL RAILING BRACKET COULD USE THE FIXED ARM OR SWING ARM BRACKET.
3. THIS DESIGN IS ADAPTABLE TO DIFFERENT SIZE RAILINGS.



SENTINEL INSTALLATION USING
MWWL RAILING BRACKET

National Ocean Service
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DESIGN BY	CO-OPS	2011/2014
DRAWN BY	BJS	09/30/2014
APPROVED BY	PERG	
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STATION STRUCTURAL COMPONENTS
MWWL MOUNTING SCHEMES

SENTINEL & RAILING INSTALLS

G-04

SHEET 05 OF 05

MWWL MOUNTING SCHEMES.DWG