



# Modernizing Water Level Vertical Control through cGNSS

*GNSS for Vertical Control at NOAA's National Water  
Level Observation Network (NWLON) Station*

USCG Civil GPS Service Interface Committee Meeting  
September 24-25, 2018  
Adria Schneck, CO-OPS



# National Water Level Observation Network (NWLON)

A network of 210 continuously operating water level stations throughout the United States.

## NWLON data supports:



Tide predictions, real-time data, and nowcast/forecast models that aid safe navigation and response to storms and oil spills



The nation's water level reference framework (tidal datums)



Production of nautical charts, shoreline and marine boundary determination



Understanding global/local sea level trends, nuisance flooding, and extreme water levels



Enhanced tsunami and storm surge warning systems



Restoration and coastal management projects

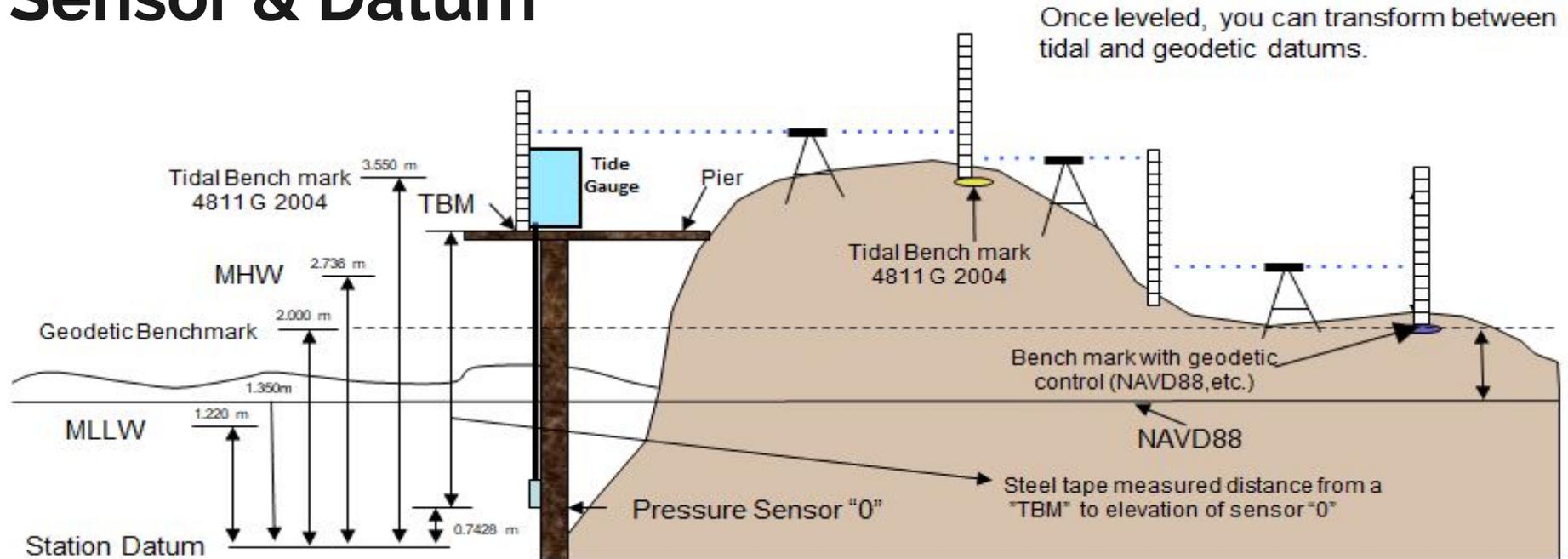




# Vertical Control Of Sensor & Datum

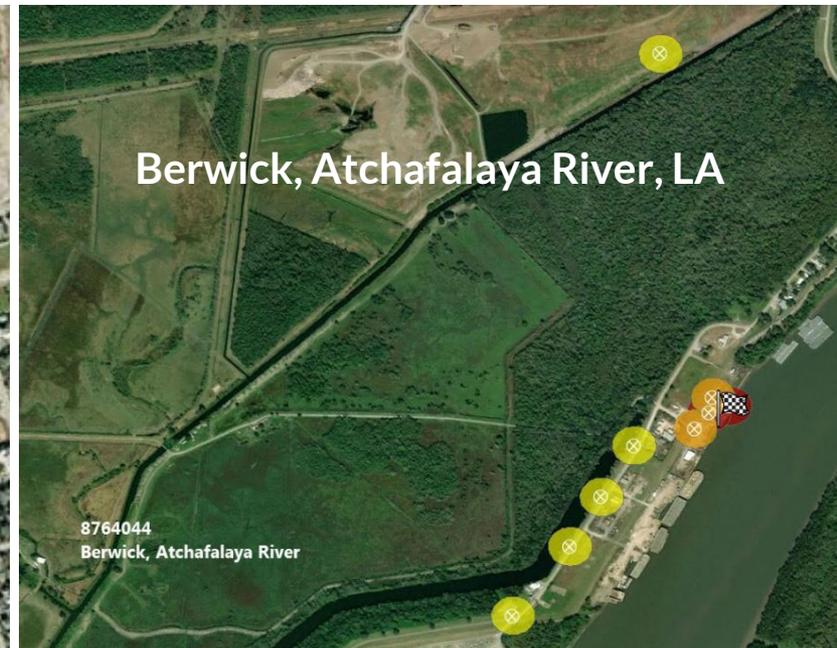
Vertical movement of the water level sensor relative to the local Station Datum must be  $< 1.2$  cm

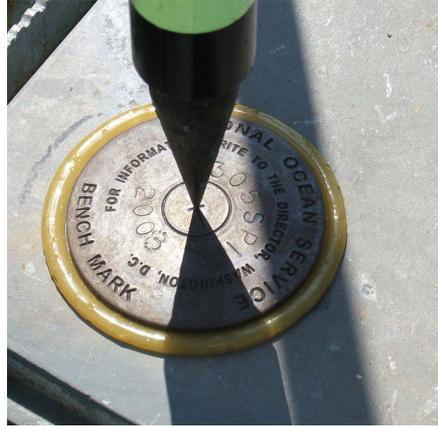
Vertical position of the Station Datum relative to geodetic control must be  $< 0.9$  cm



# Bench Mark Network

## Primary Means of Vertical Control





# Vertical Control Today

- Establish station datum
- Tidal bench mark network installation
- Periodic leveling surveys to tidal bench mark network in accordance with Federal Geodetic Data Committee (FGDC) standards to measure sensor elevation relative to land
- Connection to National Spatial Reference System (NSRS) wherever possible
  - Differential surveying
  - Campaign GPS observation ties
    - Each station has one GPS bench mark
    - One 4 hour observation every five years (annual w/ high RSL trends)

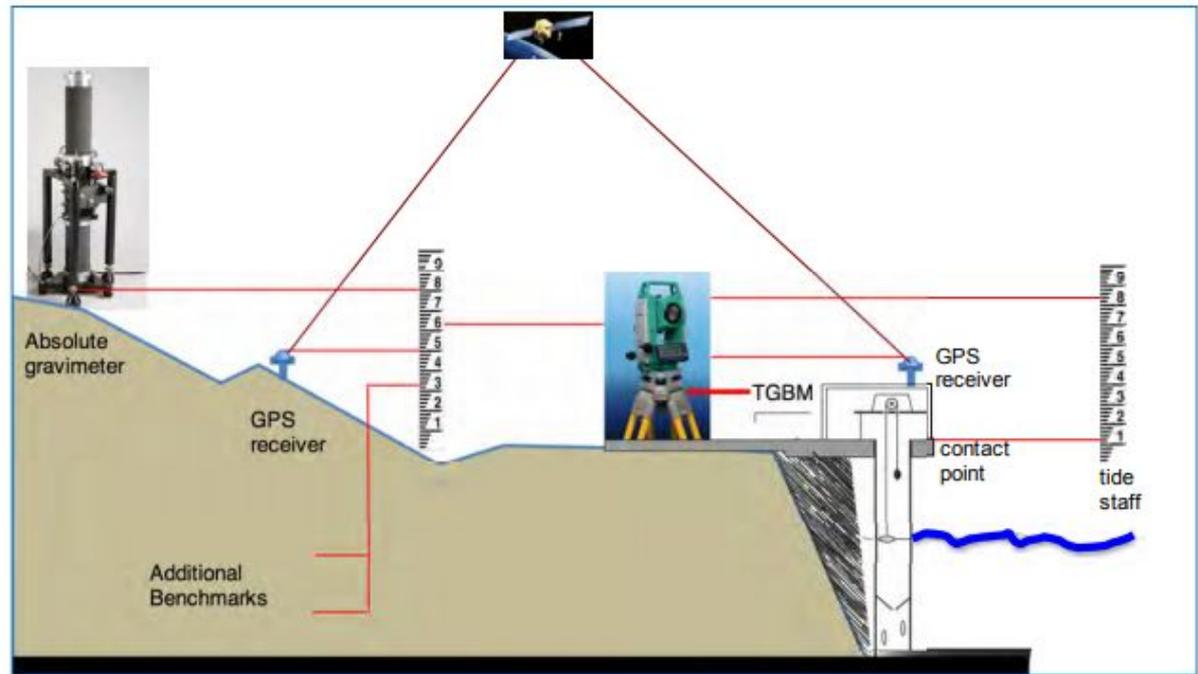
Initial incorporation of GNSS





Crescent City,  
CA

# Land Motion Stations with NWLON/CORS Collocation



**Figure 6.1** A schematic description of a tide gauge station together with a GNSS receiver for determination of the ellipsoidal height of the sea level measured by the gauge and for the monitoring of vertical land movements. Land movements are also shown being monitored in this figure with the use of an Absolute Gravity meter.

“All GLOSS sites must be equipped with Continuous GNSS antennas located as close to the gauge as possible, or connected to the gauge with a regularly maintained geodetic tie. CGNSS records support studies of vertical land movement and satellite altimeter calibration.”



# CO-OPS Strategic Vision for GNSS-Based Vertical Control

Leading the world in Earth system observation  
Global leader in water level observations

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# Team

## CO-OPS GNSS Working Group

- Developed Strategic Vision
- Held NOAA cGNSS Workshop with National Geodetic Survey (NGS), Office of Coast Survey and Office of Climate
- Developed draft implementation plan
- Is expanding it NGS membership
- Guiding path forward



Chung-Chu  
Teng



Nic Kinsman  
(NGS)



John  
Stepnoski



Jerry Hovis



Eric Breuer



Peter Stone



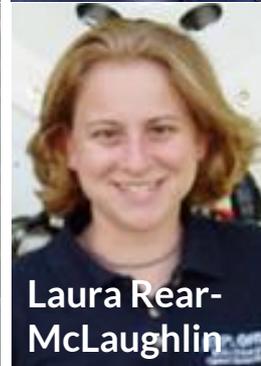
Mark Bailey



Greg Dusek



Manoj Samant



Laura Rear-  
McLaughlin



Louis Licate



George Story



Priority 1: Sensor Vertical Position

***Monitoring & accounting for vertical movement of water level sensors***

Goal 1.1: Implement GNSS as a means of measuring sensor stability for various timescales and in a range of environments.

Goal 1.2: Realize station datum by referencing the ellipsoid using GNSS.

Goal 1.3: Reduce check leveling at stations wherever possible.





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**Priority 2: Reference Framework Connection**

***Linking water level stations to national & global reference systems***

**Goal 2.1: Improve GNSS-based connections between water level datums and NSRS at all stations.**

**Goal 2.2: Increase spatial and temporal VDatum coverage and reduce VDatum transformation errors.**

**Goal 2.3: Increase stakeholder access to water level datums through improved connectivity across existing and new databases.**





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**Priority 3: Vertical Land Motion Component of Relative Sea Level Trends**

***Understanding the movement of land near water level stations***

**Goal 3.1: Support determination of the land and ocean components of relative sea level change at long-term NWLON stations using GNSS.**

**Goal 3.2: Investigate the resolution of regional and local variability in absolute sea level change.**

**Goal 3.3: Enhance utility of CO-OPS' suite of sea level products for stakeholders.**



# What's Next?



## Continue Installations

Continue working with Global Sea Level System (GLOSS) to co-locate cGNSS sensors at NWLON stations.

## Collaborate with NGS

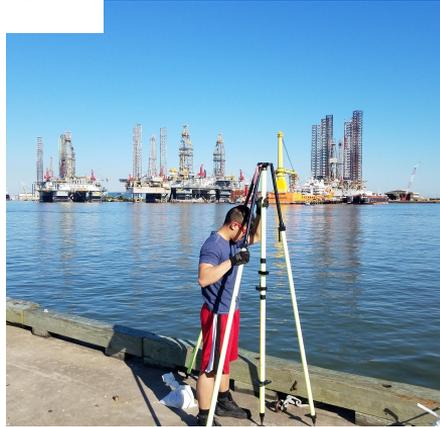
Strengthen partnership with NGS to align strategies and detail joint initiatives to move vision forward.



## Detail Implementation Plan

With close consultation with NGS, CO-OPS seeks to complete a detailed five-year implementation plan by the end of 2018.





# Vertical Control Future?

- Continuous monitoring of NWLON configuration stability
- Connections to the National Spatial Reference System (NSRS) everywhere:
  - Connections via cGNSS, where possible
  - Connections via static/campaign GNSS will be more comprehensive, systematic, & utilize longer occupations
- Targeted prioritization of geodetic leveling surveys
- Solutions for vertical control in offshore or unstable areas
- Increased participation in international collaboration on observing global sea level trends

A wide-angle photograph of a sunset over a body of water. The sky is filled with vibrant, colorful clouds in shades of orange, pink, and purple. The sun is low on the horizon, creating a bright glow. In the foreground, the dark silhouette of a pier or structure is visible on the right side. The water reflects the colors of the sky.

# Thank You