Tides and Tide Datums

New York State Association of Professional Land Surveyors

Conference
January 2019
Presented by
Peter Borbas, PLS, PP

- NY and NJ licensed professional surveyor and NJ professional planner
- Past President of the Geographic and Land Information Society
- Past Chairman of the
  American Congress on Surveying and Mapping
- Past Chairman of the
  New Jersey Society of Professional Land Surveyors GIS/LIS Committee
- Serving on the advisory boards for the surveying degree programs at
  Paul Smiths College and the New Jersey Institute of Technology

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I wish to sincerely thank

Dr. Joshua Greenfeld
Professor Emeritus
New Jersey Institute of Technology
for his continuing guidance,
and contribution to this program

As well as NOAA and NGS for many of the photos and text content included here;
and the terrific tools and support they give us!!!
Introduction and Audience

- Who are we and why are we here?
- Learn something new
- To benefit others
- Provide more services
- Reduce liability
- Teach others
- Increase revenue and profits
- What else, why are you here?
Workshop Outline

Introductions
Examples
Understanding Tides
Glossary for our discussion
Types of Tides
Datums
Tide Stations
Datum Determination
Laws Pertaining to Tides
Datum Conversions
Determining Land Boundaries
Resources
Vdatum
Examples

Harlem River

Liberty Island

Egg Harbor
The Tide Phenomenon

The word **TIDE**

is a generic term used to define the alternating rise and fall in sea level with respect to the land.
The Main Factors Instigating Tides Are:

- Gravitational attraction of the moon and the sun.
- Configuration of the coastline
- Local depth of the water
- Ocean-floor topography
- Hydrographic influences
- Meteorological influences (including extreme conditions)

The Factors Could Impact the Tides

Magnitude and/or Time of Arrival
Tidal bulge due to inertia

Tidal bulge due to gravity

Moon’s gravitational pull

Moon
A Lack of Understanding

- Betio Island in the Tarawa atoll 1943
- Lowest tide of the year was unexpected
- Landing craft (Higgins boats) could not pass the reef only the LVT’s could cross or Marines waded in to the beach
- Not understanding the tides meant LOSS OF LIFE
Marine battle planners had expected the normal rising tide to provide a water depth of 5 feet, the Higgins boats had a 4 foot draft.

This particular day the ocean experienced a neap tide, and the tide did not rise.

Some said “the ocean just sat there“.

The mean depth was 3 feet.
Plum Island New York
Superstorm Sandy
Surveyor Schappell Studying the Shifting Sands after Sandy
Glossary

**HAT**- Highest Astronomical Tide
The elevation of the highest predicted astronomical tide expected to occur at a specific tide station over the National Tidal Datum Epoch

**MHHW**- Mean Higher High Water
The average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

**MHW**- Mean High Water
The average of all the high water heights observed over the National Tidal Datum Epoch.

For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.
**DTL**- Diurnal Tide Level
The arithmetic mean of mean higher high water and mean lower low water.

**MTL**- Mean Tide Level
The arithmetic mean of mean high water and mean low water.

**MSL**- Mean Sea Level
The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch. Shorter series are specified in the name; e.g. monthly mean sea level and yearly mean sea level.
**MLW**- Mean Low Water
The average of all the low water heights observed over the National Tidal Datum Epoch.
For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

**MLLW**- Mean Lower Low Water
The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.
For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.
**LAT**- Lowest Astronomical Tide
The elevation of the lowest astronomical predicted tide expected to occur at a specific tide station over the National Tidal Datum Epoch.

**GT**- Great Diurnal Range
The difference in height between mean higher high water and mean lower low water.

**MN**- Mean Range of Tide
The difference in height between mean high water and mean low water.

**DHQ**- Mean Diurnal High Water Inequality
The difference in height of the two high waters of each tidal day for a mixed or semidiurnal tide.

**DLQ**- Mean Diurnal Low Water Inequality
The difference in height of the two low waters of each tidal day for a mixed or semidiurnal tide.
**HWI**- Greenwich High Water Interval
The average interval (in hours) between the moon's transit over the Greenwich meridian and the following high water at a location.

**LWI**- Greenwich Low Water Interval
The average interval (in hours) between the moon's transit over the Greenwich meridian and the following low water at a location.

**Max Tide**- Highest Observed Tide
The maximum height reached by a rising tide. The high water is due to the periodic tidal forces and the effects of meteorological, hydrologic, and/or oceanographic conditions.

**Min Tide**- Lowest Observed Tide
The minimum height reached by a falling tide. The low water is due to the periodic tidal forces and the effects of meteorological, hydrologic, and/or oceanographic conditions.
Station Datum- A fixed base elevation at a tide station to which all water level measurements are referred. The datum is unique to each station and is established at a lower elevation than the water is ever expected to reach. It is referenced to the primary bench mark at the station and is held constant regardless of changes to the water level gauge or tide staff. The datum of tabulation is most often at the zero of the first tide staff installed.

National Tidal Datum Epoch- The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., mean lower low water, etc.) for tidal datums.
Station Datum- A fixed base elevation at a tide station to which all water level measurements are referred. The datum is unique to each station and is established at a lower elevation than the water is ever expected to reach. It is referenced to the primary bench mark at the station and is held constant regardless of changes to the water level gauge or tide staff. The datum of tabulation is most often at the zero of the first tide staff installed.

National Tidal Datum Epoch- The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., mean lower low water, etc.) for tidal datums.
Types of Tides

Tides are caused by **gravitational pull** of the moon and the sun.

Some locations have **diurnal tides**: one high tide and one low tide per day.

Most locations have **semidiurnal tides**: the tide cycles through a high and low twice each day with one of the two high tides being higher than the other and one of the two low tides being lower than the other.
**Mixed tide** - Two considerably unequal higher high and lower high waters and/or higher low and lower low waters that occur during a tidal day.

For example: transitional tide areas, along parts of the Gulf Coast of Florida and along the west coast. 

![Tidal Diagram](image)

Datum

Tidal Period

Tidal Period
Neap Tides

Spring Tide

First Quarter

Full Moon

New Moon

Third Quarter

To Sun

SUN
Tides During a Lunar Cycle

Day of the Lunar Cycle

Tide Height (ft)

High

Low
Tide Terminology

Tidal Period

Tidal Day

Higher

High Water

Lower

High Water

Tidal Rise

Tidal Range

Tidal Range

Tidal Range

Tidal Amplitude = ½ Range

Datum
Vertical Datums

- Assumed
- Project Site Specific
- Tidal
- Mean Sea Level
- NGVD29
- NAVD88
- What else?
See what our friends at the National Geodetic Survey at NOAA have to say about NGVD29 and NAVD88


"Mean sea level was held fixed at the sites of 26 tide gauges, 21 in the U.S.A. and 5 in Canada. The datum is defined by the observed heights of mean sea level at the 26 tide gauges and by the set of elevations of all bench marks resulting from the adjustment. A total of 106,724 km of leveling was involved, constituting 246 closed circuits and 25 circuits at sea level."

"The datum (was) not mean sea level, the geoid, or any other equipotential surface. Therefore it was renamed, in 1973, the National Geodetic Vertical Datum on 1929." (Geodetic Glossary, pp. 56)

The North American Vertical Datum of 1988 (NAVD 88) is the vertical control datum established in 1991 by the minimum-constraint adjustment of the Canadian-Mexican-U.S. leveling observations. It held fixed the height of the primary tidal bench mark, referenced to the new International Great Lakes Datum of 1985 local mean sea level height value, at Father Point/Rimouski, Quebec, Canada.
**Mean Sea Level** – The average height of the surface of the sea for all stages of the tide over a 19 year period.

**Mean Sea Level Datum** - A determination of mean sea level that has been adopted as a standard datum for heights or elevations.

An example could be the Sea Level Datum of 1929. You need to know what years the MSL was determined. People tend to use the term loosely and incorrectly. Frequently, people incorrectly refer to MSL as the 1929 adjustment or NGVD29.
Heights and Elevations are they different!

- Heights: a vertical measurement (Borbas)

- Elevations: A vertical distance from a datum (ASCE)
TM is the Time Meridian, it is the reference meridian used to calculate time.
An epoch is a 19-year tidal cycle used to calculate datums.

The present National Tidal Datum Epoch (NTDE) is 1983 through 2001.

Tidal datums in certain regions with anomalous sea level changes such as Alaska and the Gulf of Mexico are calculated on a Modified 5-Year Epoch.
NOAA San Francisco Tide Station, in operation for more than 150 years. Before computers were used to record water levels (especially tides), special "tide houses" sheltered permanent tide gauges. Housed inside was the instrumentation—including a well and a mechanical pen-and-ink (analog) recorder—while attached outside was a tide or tidal staff. Essentially a giant measuring stick, the tide staff allowed scientists to manually observe tidal levels and then compare them to readings taken every six minutes by the recorder. Tide houses and the data they recorded required monthly maintenance, when scientists would collect the data tapes and mail them to headquarters for manual processing.
The Battery Tide Station
Turkey Point
Hudson River
Ulster County
The Old
Before computers, special "tide houses" were constructed to shelter permanent water level recorders, protecting them from harsh environmental conditions. In this diagram, we can see how the analog data recorder is situated inside the house with the float, and the stilling well located directly beneath it. Attached to one of the piers' pilings is a tidal staff. This device would allow scientists to manually observe the tidal level and then compare it to the readings taken by the analog recorder.
The New

Similar in design to older tide houses, newer tide station enclosures are designed to protect sensitive electronics, transmitting equipment, and backup power and data storage devices. The older stilling well has been replaced with an acoustic sounding tube and the tidal staff with a pressure sensor. The new field equipment is designed to operate with the highest level of accuracy with a minimum of maintenance, transmitting data directly back to NOAA headquarters for analysis and distribution.
WATER LEVEL DETERMINATION FOR TRANSPORTATION PROJECTS:
MEAN HIGH WATER MANUAL

FINAL REPORT
November 2009

Submitted by
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Surveying Program Coordinator
New Jersey Institute of Technology
Newark, NJ 07102-1982

NJDOT Research Project Manager
Mr. Robert Saso

In cooperation with
New Jersey
Department of Transportation
Bureau of Research
and
U.S. Department of Transportation
Federal Highway Administration
State of New Jersey
Department of Transportation

Mean High Water Manual

Prepared by Technical Survey Unit
2008
Datums and Boundaries

- High Seas
- Exclusive Economic Zone
- Territorial Sea
- Contiguous Zone
- Legal Continental Shelf
- 12 n. mi.
- 200 n. mi.
- Mean higher high water
- Mean high water
- Mean low water
- Chart Datum
- Mean Lower low water
- Sounding
- Longshore bar
- Inshore bar
- Trough
- Baseline
- Mean Lower low water line
- Mean lower low water line
- State Owned Tidelands
- State Owned Uplands
- AL, AK, CA, CT, FL, MD, MS, NJ, NY, NC, OR, RI, SC, WA
- Privately Owned Uplands
- Ordinary (Summer) berm
- Storm (Winter) berm
- Crest of berm
- Natural Resources Boundary.
3 Marine Leagues (9 n. mi.) for the States of Texas and Florida in the Gulf of Mexico and for the Commonwealth of Puerto Rico.
Interpolating MHWL elevations

There is no tide station at my project site

Interpolate between two tide stations

(White board example)
Tidal Datums (from NOAA)

In general, a datum is a base elevation used as a reference from which to reckon heights or depths.

A tidal datum is a standard elevation defined by a certain phase of the tide.

Tidal datums are used as references to measure local water levels and should not be extended into areas having differing oceanographic characteristics without substantiating measurements.

In order that they may be recovered when needed, such datums are referenced to fixed points known as bench marks.

Tidal datums are also the basis for establishing privately owned land, state owned land, territorial sea, exclusive economic zone, and high seas boundaries.
Benchmarks

- Common network and reference systems
- Coordinate systems and datums
Access to the National Spatial Reference System

- NGS/NOAA Benchmarks
- NGS CORS
- New York DOT Real Time Network
- Pennsylvania/KeyNet VRS
- New Jersey Delaware SmartNet
NGS developing GIS Tools and Datasets for Display and Analysis of Survey Data

NOAA's National Geodetic Survey (NGS) is in the process of developing new Geographic Information System (GIS) software tools for display and analysis of NGS survey data. The tools convert the output from NGS GPS processing, survey control network adjustment, and geodetic leveling adjustment software into an attribute-rich standard GIS data format. The intent is to make these tools part of the popular Web-based NGS Geodetic Toolkit. In addition, NGS is beginning to provide some of its products in standard widely-used GIS data formats. For more information, contact Michael Dennis.
News Item

National Geodetic Survey

Survey Mark Datasheets
GPS Data (CORS)
GPS Data (Real-Time)
Aerial Images (Storm)
Aerial Images (Coast)
Aeronautical Data
Antenna Calibration Data
NGS Data Explorer
GEOID (12A, 09, 06, 03, 99)
Gravity Data
Orbit Data
NGS orthomosaics and lidar
Shoreline Data
Storm Imagery (Irene)
Storm Imagery (Joplin)
Storm Imagery (Tuscaloosa)

NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education | Search

Developing GIS Tools for Survey Data

The National Geodetic Survey (NGS) is in the process of developing Geographic Information System (GIS) software tools for display and control of NGS survey data. The tools convert the output from NGS GPS network adjustment, and geodetic leveling into an attribute-rich standard GIS data format. The tools are part of the popular Web-based NGS Geodetic Data Explorer.

Michael Dennis

Website Owner: National Geodetic Survey / Last modified by NGS.webmaster Jan 20 2012
Thursday, November 18, 2010

NGS Developing GIS Tools for Survey Data

NOAA's National Geodetic Survey (NGS) has developed a set of GIS tools to assist the surveying community in their work. These tools are available on the NGS GIS Tools and Applications website.

The primary tool is GEOID12A Toolkit, which contains a suite of software designed to transform geodetic coordinates into latitude and longitude. The toolkit also includes the NGS GPS DEM and the NGS GPS GEOD12A dataset. The NGS GIS Tools and Applications website currently contains five tools for display and adjustment:

- Adjust Leveling (LOCUS)
- Geodetic Tool Kit
- Process GPS data (OPUS)
- Coordinate Transformation
- Datum Transformation (NADCON)
- Vertical Conversions (VDATUM)
- Download PC Software

NGS Geodetic Survey / Last modified by NGS.webmaster Jan 20 2012

For more information, contact Michael Dechellis, national geodetic survey program manager.
NGS developing Analysis of Survey Data

NOAA's National Geodetic Survey is working on the development of an analysis tool for survey data. This tool will allow for the processing and adjustment of survey data, enabling users to analyze and visualize the results. The goal is to make the process more efficient and accessible to a broader audience.

Surveys
- Active Geodetic Control (CORS)
- Adjust Leveling (LOCUS)
- Survey Mark Datasheets
- Process GPS data (OPUS)
- Calibration Base Lines (CBLs)
- Geodetic Control Subcommittee (FGCS)
- User-submitted Survey Projects (Bluebooking)
- DTM of the popular Web-based tool for geodetic leveling
- GRAV-D
- Geoid Slope Validation Survey of 2011
- Height Modernization
- Leveling
- Mark Recovery

Height Modernization
NAD 83(2011) epoch 2010.00 coordinates on passive control

Publications
Survey Project Proposal Form
Thursday, January 19, 2012

NGS developing GIS Tools for Survey Data Analysis

NOAA's National Geodetic Survey (NGS) is developing new Geographic Information System (GIS) software tools for display and analysis of survey data. The survey control network adjustment software allows conversion of survey data into an attributed standard GIS data format. The intent is to make these tools part of the Web-based NGS Geodetic Toolkit. In addition, NGS is beginning to provide some of its products in a standard, widely used GIS data format.

Michael Dennis
NGS Workshop, Conference and Training Opportunities

There are several ways to learn more about or receive training on NGS products and tools.

Workshops/Conferences
If you would like to attend a conference or workshop, click here to see if there is one scheduled for your area. If you would like to inquire about scheduling a workshop, click here to see if there is a State Advisor in your state. If so, he or she can assist you. If there is not a State Advisor in your state, or if you would like more information about the NGS Workshop program, please contact Erika Little, erika.little@noaa.gov, or 540-373-1243.

Training Classes
If you would like to learn about upcoming classes offered at NGS’ Corbin Training Center, located just south of Fredericksburg, VA, click here to see the upcoming schedule of classes. This page also lists web-based classes. All classes are free of charge.

Online Learning Resources
To see a list of online learning resources, click here.
NYSNet is a spatial reference network of continuously operating Global Positioning System (GPS) reference stations (CORS) throughout New York State that can be used for differential GPS applications. Depending on equipment and
Reference System Datum

**Horizontal:**


Users must take special note that CORS defined in NAD83 (2011) use absolute antenna calibrations. Absolute values should be used when processing data with CORS coordinates in NAD 83(2011) EPOCH 2010.0

When surveying on local coordinates systems, including prior adjustments of NAD83, the user must determine the appropriate connections to these coordinate systems.

**Vertical:**
Heights produced from this network are related to the reference ellipsoid for NAD83, GRS80. NYSDOT CORS are not directly connected to the North American Vertical Datum of 1988 (NAVD88), an orthometric height system.

NGS does produce GEOID models for transforming heights between ellipsoidal and orthometric heights. Users should be aware of the accuracy of these models. Depending upon required survey accuracy, the user must determine required connections to local vertical datum, including NAVD88.

NA2011 yields ellipsoid heights that are inconsistent with GEOID09; therefore, GEOID12B should be used if transforming ellipsoidal heights to NAVD88 heights.
NYSNet Real Time Network (RTN)

Real Time Corrections
Real time corrections are available from NYSNet under the following conditions:
• Connections to the network must be made using the internet.
• User authentication will make use of NTRIP (Networked Transport of RTCM via Internet Protocol): A secure means (login, password required) of transmitting correction data via TCP/IP. For some real time products, rovers must send in NMEA position.
• Data files will be in RTCM and CMR+ formats.

For further access to the RTN, you must register on this website.

Real Time GNSS Data Accuracy
Accuracy is dependent upon equipment and procedures. NYSDOT recommends testing the accuracy of all RTN products at each project site. Testing should include connections to local coordinate systems and datums.

Real Time GNSS Data Reliability
The NYSNet RTN is dependent upon a real time data stream through the NYSDOT information technology network. If the network connection to a particular site is down, the RTK processing software can deliver data from the next nearest site. Data from partner sites are dependent upon connections through the internet.

RTN Antenna Phase Center Offsets
The real time correction messages from this network are transformed to the ARP of the reference station antenna using the NGS absolute antenna calibration file. Rover users should use a NULL antenna definition for the reference station antenna type. This results in the rover not needing to know the actual antenna type of the reference stations.
Definition of the Waters of the State
(Taken the Environmental Council of the States)
New York (ENV Section 15-0107)

"Waters" shall be construed to include lakes, bays, sounds, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Atlantic Ocean within the territorial limits of the State of New York, and all other bodies of surface or underground water, natural or artificial, inland or coastal, fresh or salt, public or private, which are wholly or partially within or bordering the state or within its jurisdiction.
U.S. Geological Survey Hudson River salt-front data—
Yesterdays salt-front location at high-slag tide was
73 river miles above the Battery at New York City.

River Mile: 73 on 09/30/2015
NOAA Measuring Stations
The Battery, NY - Station ID: 8518750

Established: May 24, 1920
Time Meridian: 0° E
Present Installation: Sep 11, 1989
Date Removed: N/A
Water Level Min (ref MLLW): -4.29 ft. Feb 02, 1976
Mean Range: 4.53 ft.
Diurnal Range: 5.06 ft.
Latitude: 40° 42' N
Longitude: 74° 0.8' W
NOAA Chart#: 12335
Met Site Elevation: 6.4 ft. above MSL

Today's Tides (LST)

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<th>Time</th>
<th>Type</th>
<th>Level</th>
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<tbody>
<tr>
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<tr>
<td>8:02 AM</td>
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<td>1:47 PM</td>
<td>high</td>
<td>3.9 ft</td>
</tr>
<tr>
<td>8:32 PM</td>
<td>low</td>
<td>0.6 ft</td>
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Tidal datums at THE BATTERY, NEW YORK HARBOR based on:

LENGTH OF SERIES: 19 YEARS
TIME PERIOD: January 1983 - December 2001
TIDAL EPOCH: 1983-2001
CONTROL TIDE STATION:

Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

HIGHEST OBSERVED WATER LEVEL (09/12/1960) = 3.052
MEAN HIGHER HIGH WATER (MHHW) = 1.541
MEAN HIGH WATER (MHW) = 1.443
NORTH AMERICAN VERTICAL DATUM-1988 (NAVD) = 0.847
MEAN SEA LEVEL (MSL) = 0.783
MEAN TIDE LEVEL (MTL) = 0.753
MEAN LOW WATER (MLW) = 0.063
MEAN LOWER LOW WATER (MLLW) = 0.000
LOWEST OBSERVED WATER LEVEL (02/02/1976) = -1.307

Bench Mark Elevation Information In METERS above:

<table>
<thead>
<tr>
<th>Stamping or Designation</th>
<th>MLLW</th>
<th>MHW</th>
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<tr>
<td>NO 7 1975</td>
<td>4.468</td>
<td>3.025</td>
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<td>NO 3</td>
<td>4.276</td>
<td>2.833</td>
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<td>NO 6 1975</td>
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<td>BM</td>
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<td>4.277</td>
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<td>851 8750 TIDAL 749</td>
<td>5.690</td>
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<td>R 340 1952</td>
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<td>1.404</td>
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Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

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<th>Datum</th>
<th>Elevation</th>
<th>Note</th>
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<td>BENCHMARK NO 7 1975</td>
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<td>(3.621 NAVD88)</td>
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<tr>
<td>HIGHEST OBSERVED WATER LEVEL (09/12/1960)</td>
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Bench Mark Elevation Information In METERS above:

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<td>4.276</td>
<td>2.833</td>
</tr>
</tbody>
</table>
Station ID: 8518750
Name: THE BATTERY, NEW YORK HARBOR NY
NOAA Chart: 12335
USGS Quad: NEW JERSEY CITY
Latitude: 40° 42.0' N  (40.70060)
Longitude: 74° 0.9' W (-74.01420)

To reach the tidal bench marks from New Jersey, take exit 14-C on the New Jersey Turnpike for the Holland Tunnel to Manhattan, then take the Downtown exit to Broadway. Proceed south on Broadway to its end at The Battery. Turn onto State Street and proceed on State Street for 0.3 km (0.2 mi) to the U.S. Coast Guard Inspection Office. The bench marks are located in the area around Battery Park. The tide gage and staff are located on the pier behind the Inspection Office.

TIDAL BENCH MARKS

PRIMARY BENCH MARK STAMPING: NO 7 1975
DESIGNATION: 851 8750 TIDAL 7
MONUMENTATION: Tidal Station disk
AGENCY: National Ocean Survey (NOS)
SETTING CLASSIFICATION: Loading dock
LATITUDE: 40° 42.2' N (40.70344)
LONGITUDE: 74° 0.9' W (-74.01464)

The primary bench mark is a disk set in a concrete loading dock, 68.6 m (225 ft) east of the SW corner of the Coast Guard Building, 13.87 m (45.5 ft) SW of the westernmost corner of a blue brick guard house, 0.91 m (3.0 ft) SW of the south corner of the building, and 0.82 m (2.7 ft) above ground.
The NGS Data Sheet

See file dsdata.pdf for more information about the datasheet.

PROGRAM = datasheet95, VERSION = 8.12.5.2
1 National Geodetic Survey, Retrieval Date = DECEMBER 15, 2018
AB6736 TIDAL BM - This is a Tidal Bench Mark.
AB6736 DESIGNATION - 851 8750 TIDAL 7
AB6736 PID - AB6736
AB6736 STATE/COUNTY - NY/NEW YORK
AB6736 COUNTRY - US
AB6736 USGS QUAD - JERSEY CITY (1981)
AB6736
AB6736
AB6736

*CURRENT SURVEY CONTROL

| AB6736* NAD 83(1986) POSITION- 40 42 00. | (N) 074 00 53. | (W) SCALED |
| AB6736* NAVD 88 ORTHO HEIGHT - 3.621 (meters) | 11.88 (feet) ADJUSTED |
| AB6736 GEOID HEIGHT - -31.892 (meters) | GEOID12B |
| AB6736 DYNAMIC HEIGHT - 3.620 (meters) | 11.88 (feet) COMP |
| AB6736 MODELED GRAavity - 980,249.8 (mgal) | NAVD 88 |
| AB6736 VERT ORDER - FIRST CLASS II |

The horizontal coordinates were scaled from a topographic map and have an estimated accuracy of +/- 6 seconds.

The orthometric height was determined by differential leveling and adjusted by the NATIONAL GEODETIC SURVEY in September 1996.

Significant digits in the geoid height do not necessarily reflect accuracy. GEOID12B height accuracy estimate available here.

This Tidal Bench Mark is designated as VM 291 by the CENTER FOR OPERATIONAL OCEANOGRAPHIC PRODUCTS AND SERVICES.
Station ID: 8518750
Name: THE BATTERY, NEW YORK HARBOR NY
NOAA Chart: 12335
USGS Quad: NEW JERSEY CITY
LATITUDE: 40° 42.0' N (40.70060)
Longitude: 74° 0.9' W (-74.01420)

TIDAL BENCHMARKS

BENCHMARK STAMPING: NO 3
DESIGNATION: 8518750 TIDAL 3

MONUMENTATION: Tidal Station disk
AGENCY: US Coast and Geodetic Survey (USC&GS)
VM#: 287
IDB PID#: KV0584
OPUS PID#: KV0584
SETTING CLASSIFICATION: Concrete wall
LATITUDE: 40° 42.2' N (40.70378)
LONGITUDE: 74° 1.0' W (-74.01656)

The bench mark is a disk set in the north end of a low concrete wall surrounding the Castle Clinton National Monument, 61.36 m (201.3 ft) SW of the face of the John Ericsson Statue, 23.80 m (78.1 ft) NW of the NW corner of the marble base of the monument - The Immigrants, and 20.76 m (68.1 ft) north of the main entrance to the castle.
Interpolating MHWL elevations

There is no tide station at my project site

Interpolate between two tide stations

(White board example)

Beacon to Turkey Point 21.7 miles

Beacon to Rhinecliff 16.3 miles

Rhinecliff to Turkey Point 5.4 miles
Shared Solution

PID: KV0584
Designation: 851 8750 TIDAL 3
Stamping: NO 3
Stability: May hold commonly subject to ground movement
Setting: Footings of small/medium structures
Mark: G
Condition: 
Description: LOCATED IN THE BOROUGH OF MANHATTAN AT BATTERY PARK, THE BENCH MARK IS SET IN THE NORTH END OF A LOW CONCRETE WALL SURROUNDING THE CASTLE CLINTON NATIONAL MONUMENT, 61.36 M (201.31 FT) SW OF THE FACE OF THE JOHN ERICSSON STATUE, 23.80 M (78.08 FT) NW OF THE NW CORNER OF THE MARBLE BASE OF THE MONUMENT - THE IMMIGRANTS, AND 20.76 M (68.11 FT) NORTH OF THE MAIN ENTRANCE TO THE CASTLE.
Observed: 2018-10-02T11:54:00Z
Source: OPUS - page5 1603.24

<table>
<thead>
<tr>
<th>REF_FRAME</th>
<th>NAD_83(2011)</th>
<th>EPOCH: 2010.0000</th>
<th>SOURCE: NAVD88 (Computed using GEOF12B)</th>
<th>UNITS: m</th>
<th>SET PROFILE</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAT: 40° 42' 13.42159&quot; ± 0.015 m</td>
<td>UTILITY:</td>
<td>NORTING: 4506333.992m 59638.528m</td>
<td>SPC 3104(NY L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LON: -74° 0' 59.38816&quot; ± 0.011 m</td>
<td>EASTING:</td>
<td>X: 1333320.782</td>
<td>583084.017m 298605.833m</td>
<td></td>
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<tr>
<td>ELL HT: -28.470</td>
<td>CONVERGENCE: 0.64142500&quot; -0.0107889&quot;</td>
<td>Y: -4654900.045</td>
<td>0.64142500&quot; -0.0107889&quot;</td>
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<tr>
<td>ORTHO HT: 3.421</td>
<td>POINT SCALE: 0.99968496</td>
<td>Z: 4137518.018</td>
<td>0.99999815</td>
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<tr>
<td></td>
<td>COMBINED FACTOR: 0.99968942</td>
<td></td>
<td>1.00000262</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONTRIBUTED BY

richard.girard

Center for Operational Oceanographic Products and Services

Map Satellite

Get directions: To here (nearest road)
Tide Predictions at 8518750, The Battery NY
From 2018/12/11 12:00 AM LST/LDT to 2018/12/12 11:59 PM LST/LDT

Height in feet (MLLW)

Predictions: 0.52 ft.
Welcome to VDatum!

VDatum is a free software tool being developed jointly by NOAA’s National Geodetic Survey (NGS), Office of Coast Survey (OCS), and Center for Operational Oceanographic Products and Services (CO-OPS). VDatum is designed to vertically transform geospatial data among a variety of tidal, orthometric and ellipsoidal vertical datums - allowing users to convert their data from different horizontal/vertical references into a common system and enabling the fusion of diverse geospatial data in desired reference levels.

Important: Transformation Uncertainties in the ‘Louisiana/Mississippi - Eastern Louisiana to Mississippi Sound’ Regional Model, have been found to range from 20 to 50 cm in particular locations from the Mississippi River Delta north to Lake Pontchartrain. These issues most likely can be attributed to subsidence, newly established datums, and changes to the understanding of NAVD88 based on new versions of the GEOID. The VDatum Team is currently looking at resolving these uncertainties.
Features

VDatum software is written in Java, so it runs on Mac OS X, Unix, VMP, and Windows.

Where available and uncertainties are established, VDatum supports the conversions among following:

- **Coordinate Systems:** Geographic, UTM, State Plane Coordinates (SPC), and geocentric (ECEF)

- **Horizontal Datums:** NAD27, NAD83(1986), and NAD83(HARN); and ellipsoidal datums such as of ITRF, WGS84, and NAD83 serializations

- **Vertical Datums:**
  - **Ellipsoidal Datums:** NAD83, WGS84, ITRF88, ITRF89, ITRF90, NEOS 90, PNEOS 90, ITRF91, ITRF92, SIO/MIT 92, ITRF93, ITRF94, ITRF96, ITRF97, IGS97, ITRF2000, IGS00, IGb00, ITRF2005, IGS05, ITRF2008, IGS08, WGS84(transit), WGS84(G730), WGS84(G873), WGS84(G1150), WGS84(G1674), NAD83(PACP00), NAD83(MARP00)
  - **Orthometric Datums:** NAVD88, NGVD29, PRVD02, VIVD09, ASVD02, GUVD04, NMVD03, HAWAII EGM2008, EGM1996, and EGM1984
  - **Tidal Datums:** MLLW, MLW, LMSL, DTL, MTL, MHW, LWD, and MHHW
  - IGLD85

- **GEOID models:** GEOID12B, GEOID12A, GEOID09, GEOID06 (Alaska only), GEOID03, GEOID99, and GEOID96

- **EGM models:** EGM2008, EGM1996, and EGM1984

- **xGEOID models:** xGEOID16b (BETA), and xGEOID17b (BETA)

- **Supported file format:** text(ASCII), LiDAR(.LAS, *.LAZ) version 1.0, 1.1, 1.2 and 1.4 with Classification, ESRI ASCII Raster(.ASC), ESRI 3D shapefile, and GeoTIFF (on Windows OS)

- **NOAA VDatum APIs:** Provide API for Tidals
# Online Vertical Datum Transformation

Integrating America's Elevation Data

## Horizontal Information

<table>
<thead>
<tr>
<th>Source</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coor. System: Geographic (Longitude, Latitude)</td>
<td>Projected State Plane Coordinates (Easting, Northing)</td>
</tr>
<tr>
<td>Unit:</td>
<td>foot (U.S. Survey) (US_ft)</td>
</tr>
<tr>
<td>Zone:</td>
<td>NY E - 3101</td>
</tr>
</tbody>
</table>

## Vertical Information

<table>
<thead>
<tr>
<th>Source</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Frame: NAVD 88</td>
<td>NAVD 88</td>
</tr>
<tr>
<td>Unit: meter (m)</td>
<td>foot (U.S. Survey) (US_ft)</td>
</tr>
<tr>
<td>Height</td>
<td>Sounding</td>
</tr>
<tr>
<td>GEOID model: GEOID09</td>
<td>GEOID model: GEOID09</td>
</tr>
</tbody>
</table>

## Point Conversion

### ASCII File Conversion

```
Input

Longitude:  
Latitude:  
Height:  

Convert  
Reset  
DMS  

Output

Easting:  
Northing:  
Height:  

Vertical Uncertainty:
```

### Conversion Options

- Drive to on map
- Reset Map
- to DMS
Internet Exercise

NOAA Tide Station

NOAA Vdatum
For a review of
Riparian and Littoral Law in
New York State

See NYSAPLS Presentation by
Laura Ayers, Esq.
At the NYSAPLS website
Key Take Aways

- Can the tide affect my project, and my clients?
- Where can I get tide data?
- What responsibilities do I have???
- What did I learn that I did not know before that can help me? What value can I add to my services?
- What surprised me?
- What was my ahh hah?
- ?
- ?
You have just given up 90 minutes of your total life here on earth!

Thank you for the privilege of allowing me to share it with you.

Now go on and make that 90 minutes mean something to someone.

Peter Borbas
peter.borbas@borbas.com
Office 973-316-8743