



**US Army Corps  
of Engineers** ®  
New Orleans District

# Engineering Documentation Report

## EDR-OD-02

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**MLG to MLLW Vertical Datum Conversion**

### **Calcasieu River and Pass**

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**Appendix A-** Independent Technical Review (ATR) Certification

## LIST OF ACRONYMS

- CEPD: Comprehensive Evaluation of Project Datums
- EDR: Engineering Documentation Report
- FEIS: Final Environmental Impact Statement
- HQUSACE: Headquarters office of the United States Army Corps of Engineers
- MLG: Mean Low Gulf datum, as a historic reference
- MLLW: Mean Lower Low Water datum
- CEMVN: US Army Corps of Engineers, New Orleans District
- NAVD88: North American Vertical Datum of 1988
- National Geodetic Survey (NGS)
- NOAA: National Oceanic and Atmospheric Administration
- OPUS: Online Positioning User Service
- SGU: Stream Gaging Unit
- USACE: United States Army Corps of Engineers

## 1. Introduction

The U.S. Army Corps of Engineers (USACE), New Orleans District (CEMVN) is converting the vertical datum for all coastal navigation projects from Mean Low Gulf (MLG) to Mean Lower Low Water (MLLW) in accordance with USACE (2014), memorandum directing conversion from HQUSACE. This memorandum describes new policy for federal navigation projects where the decision documents supporting project authorization and the project authorization in law do not reference the Mean Lower Low Water (MLLW) datum.

According to the Memorandum “Navigation Projects Compliance with Vertical Datum Guidance” dated October 24, 2014:

“For federal navigation projects where the MLLW depth differs from the depths stated in the project authorization, an Engineering Documentation Report (EDR) shall be prepared in accordance with reference 1.d, paragraph 8.3 for each project and posted on a navigation home page for each district. The EDR will be of limited scope to document the datum change only.”

The Calcasieu River and Pass Project is currently authorized and maintained to (-) 42 ft. MLG in the bar channel, and (-) 40 ft. MLG from the Gulf of Mexico to Lake Charles, LA. Additionally, the 1977 Calcasieu River Final Environmental Impact Statement (FEIS) authorizes the project to have an advance maintenance dredging of 2 ft (-42.0 ft. MLG’) to avoid frequent redredging and to ensure the reliability of maintaining the project’s authorized depth.

This report documents the conversion from MLG to the NOAA-maintained MLLW for this project, and provides details on how this relationship was determined and will be applied.

A brief description of the primary datums referenced in this report are:

- The North American Vertical Datum of 1988 (NAVD88) is a geodetic datum that is defined and maintained by the National Geodetic Survey (NGS). This datum is typically used for surveying (in addition to design and construction) and can be related to other datums as needed, to ensure project datums are referenced as required.
- Mean Lower Low Water (MLLW) is a tidal datum that is defined and maintained by the National Oceanic and Atmospheric Administration (NOAA). This tidal datum is defined as the average of the lowest of the two daily low water heights observed over the National Tidal Datum Epoch (which spans a 19 year period).
- Mean Low Gulf (MLG) is a local, legacy terrestrial datum that was originally defined as 0.78’ (Low Tide) below local mean sea level as observed at the Biloxi gage in 1899 in the Gulf of Mexico. It has been used as a navigation (and construction) reference datum in coastal waterways such as the Gulf Intracoastal Waterway (GIWW) and the Calcasieu River and Pass navigation channel.

## 2. Project Summary

The Calcasieu River and Pass, LA project is a federal deep draft navigation project, providing deep draft access to the Port of Lake Charles, and various facilities located along the Calcasieu River.

Construction, operation, and maintenance of the general navigation features of the Calcasieu River and Pass, Louisiana Project at Calcasieu and Cameron Parishes in Southwest Louisiana, was authorized by Section 1 of the River and Harbor Act of 1937, Public Law 75-392; as modified by Section 2 of the Rivers and Harbors Act of 1945, Public Law 79-14; Section 2 of the River and Harbor Act of 1946, Public Law 79-525; Section 107 of the River and Harbor Act of 1960, Public Law 86-645; Sections 201 and 310 of the Flood Control Act of 1965, Public Law 89-298, October 27, 1965 (with Section 201 authorizing construction, operation and maintenance of the navigation project at Devil's Elbow, pursuant to a later resolution adopted by the House Committee on Public Works on December 15, 1970, and a resolution adopted by the Senate Committee on Public Works on December 27, 1970); and Section 5081 of Water Resources Development Act of 2007, Public Law 110-114.

The project consists of an approach channel having a depth of 42 feet below Mean Low Gulf level over a bottom width of 800 feet from the 42 foot depth in the Gulf of Mexico to the jettied channel; a channel between the jetties varying in depth from 42 to 40 feet at the seaward end and shoreline, respectively; over a bottom width of 400 feet; a channel 40 feet deep over a bottom width of 400 feet from the shoreline mile 0, to the wharves of the port of Lake Charles mile 34.1; enlargement of the existing turning basin at mile 29.6 to a depth of 40 feet; and a mooring basin about mile 3 having a width of 350 feet, a length of 2,000 feet, and a depth of 40 feet; extension of the existing ship channel at a depth of 35 feet below Mean Low Gulf level over a bottom width of 250 from the wharves of the Port of Lake Charles, mile 34.1, to the vicinity of the bridge on U.S. Highway No. 90, mile 36.0, and a turning basin of the same depth at the upper end having a width of 750 feet and a length of 1,000 feet; and maintenance of the existing channel 12 feet deep and 200 feet wide from the ship channel to Cameron, Louisiana, via the old channel of the Calcasieu River.

The Devil's Elbow project is located in Calcasieu Parish in the vicinity of Lake Charles, Louisiana. The plan of improvement consists of enlarging 2.3 miles of the existing industrial channel to a 40 foot depth over a bottom width of 400 feet, a 1/2 mile eastward extension of the enlarged channel, and the construction of a 1,200 foot by 1,400 foot turning basin south of the extended channel at its landward end. The Calcasieu River at Coon Island, Louisiana project consists of deepening and widening to -40 feet by 200 feet for a distance of 6,943 feet, the existing turning basin to -40 feet by 750 feet by 1,000 feet.

The Calcasieu River consists of three routinely dredged reaches to allow for navigation. The first reach is the approach channel (bar channel) in the Gulf of Mexico to the jettied channel, which is dredged annually. The inland reaches from Mile 0 to Mile 36 are dredged annually, alternating between the lower (Mile 5 to Mile) 17 and upper (Mile 17 to Mile 36) reaches each year to include Devil's Elbow and Coon Island. The datum conversion documented in this EDR relates to all reaches of the Calcasieu River and Pass, LA Operations and Maintenance project.





### 3. Vertical Datum Conversion Process

The datum relationships in this report were determined to bring the Calcasieu River and Pass project into compliance with the requirements outlined in ER 1110-2-8160, Policies for Referencing Project Elevation Grades to Nationwide Vertical Datums, and EM 1110-2-6056, Standards and Procedures for Referencing Project Elevation Grades to Nationwide Vertical Datums. These policy documents define the requirement for referencing datums on coastal navigation projects. The following EM excerpt addresses the requirement to establish the relationship to MLLW for projects that are defined to a legacy datum, such as MLG (page 4-2):

*"USACE projects that are still defined relative to non-standard or undefined legacy datums (e.g., Mean Low Gulf (MLG), Gulf Mean Tide, MSL, NGVD, MLW, COEMLW, etc.) should have technically valid transforms to the NOAA MLLW chart/tidal datum for the area. In isolated cases, the legacy datum may be retained as the reference grade provided its relationship to NOAA MLLW datum is accurately defined based on current gage data at the project site. In such projects, depth data furnished to NOAA and other project users must indicate the primary reference gage, along with the tidal datum epoch period and the relationship between the legacy datum, NOAA MLLW, and NAVD88. Legacy "Low Water" datums must be periodically updated for sea level change and regional subsidence using similar computational techniques established by NOAA for coastal waters." (Reference 7)*

The relationships have been defined between the MLG legacy project datum and MLLW and NAVD88 as described in the EM. These datum relationships were used to define a MLLW-MLG conversion value, which converts the currently maintained MLG elevations to MLLW depths.

#### 3.1 Project Datum

The River and Harbor Act of 1960 specified MLG as the project datum for the Calcasieu River and Pass project. MLG is a local, legacy terrestrial datum that was originally defined as 0.78' (Low Tide) below local mean sea level as observed at the Biloxi gage in 1899 in the Gulf of Mexico. As discussed in EM-1110-2-6056 (Reference 5), most USACE civil projects are, in effect, referenced to a local vertical datum. Many local datums are based on unknown, or perhaps archaic origins. Most hydraulic-based river datums and MSL/MLLW tidal datums are actually local datums when they are not properly modeled or kept updated. MLG was intended to represent the low water level of the Gulf of Mexico, and was defined by District memorandum in 1944 as being 0.78 feet below local mean sea level. At that time, mean sea level was defined by the Sea Level Datum of 1929 (SLD29). SLD29 was created by the US Coast and Geodetic Survey (USC&GS) as the datum to adjust all vertical control to in North America. SLD29 was believed to be a "mean sea level" datum although mean sea level was not the same at each gage. Mean sea level was not developed using the same epoch or period of record at each of the gages. Each gage was, in effect, a "local mean sea level" (LMSL) reference datum. However, over time, with sea level rise and other factors, it was no longer considered a "mean sea level" datum. In 1973, the name of SLD29 was changed to the National Geodetic Vertical Datum of 1929 (NGVD29) because it no longer represented sea level (Reference 5). However, the assumed equivalency of NGVD29 to mean sea level was predominant in both government and academic

texts published well after the 1973 redefinition and MLG for this project continued to be locally interpreted as 0.78 ft. below NGVD29. The MLG datum thus became disassociated from sea level.

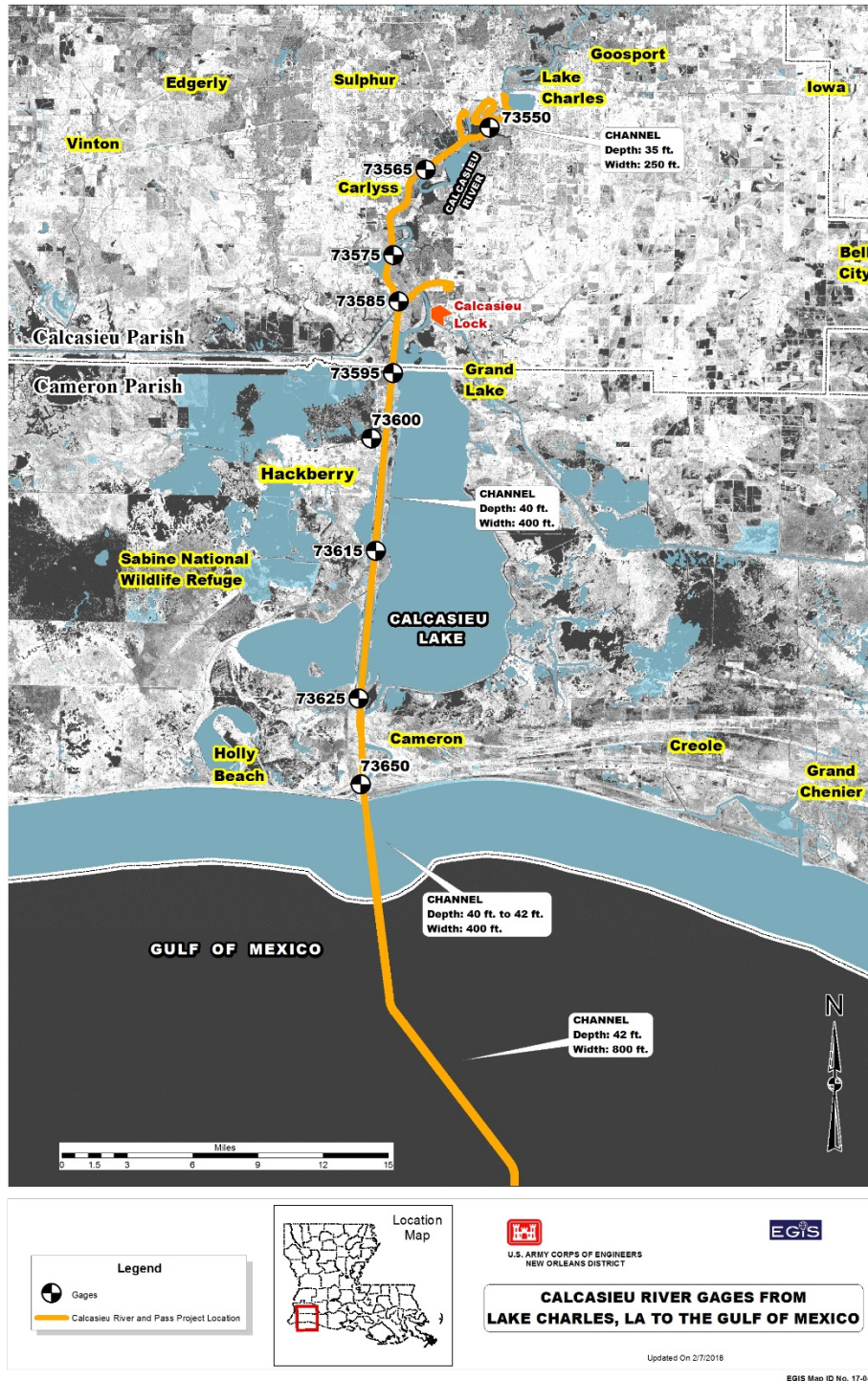
The relationship between reference datums is often complex given they can deviate spatially over a region, due to a variety of reasons. They may also have temporal deviations due to land subsidence or uplift, sea level changes, project reconstruction, periodic readjustments to the datum origin, or to redefined points on the reference surface. This is particularly true for this project due to subsidence in the region. The Survey Section Stream Gaging Unit (SGU) has maintained a series of gages along Calcasieu River, which were set and maintained to NGVD29 until they were reset to NAVD88 in 2013. The original reference to NGVD29 was maintained in order to determine MLG relationships for each gage. The project was thus constructed and had historically been maintained to a legacy local terrestrial datum that was disassociated from mean sea level.

### **3.2 Methodology for Establishing Conversion Value**

In 2010 and 2012 CEMVN performed surveys as part of the Comprehensive Evaluation of Project Datums (CEPD) effort to establish the relationship between MLG, MLLW, and NAVD88 for this area. This required surveying the Stream Gaging Unit (SGU) gages and NOAA gages in the vicinity. The datum relationships were defined and were documented via the CEPD reporting database. In 2013, NGS published an update to NAVD88 (the 2009.55 epoch) and a new geoid model (GEOID12A). These updates changed the resulting NAVD88 elevations in this area, so new gage surveys were required to reestablish datum relationships on both sets of gages.

In 2013 several surveys were performed to update the datum relationships (MLG, MLLW, NAVD88) within this project area. SGU recommended and established consensus for resetting the SGU gages to NAVD88, and maintaining the local MLG references by establishing offset values to the SGU gages.

In October 2013 the SGU gages along Calcasieu River were reset to the most up to date NAVD88 reference, NAVD88 (2009.55) (See Map 2). Additional gages were also added along the channel to provide more control for surveys / dredging. The MLG and MLLW offset values were determined for each gage and were supplied for use on the navigation project. These references are currently included in the navigation specifications to define MLG for this contract area.



**MAP 2- Calcasieu River Gages**

The 2013 datum analysis performed for Calcasieu River and Pass resulted in the determination of NAVD88 (2009.55/OPUS), MLLW (1983-2001) and MLG relationships. These relationships were used to define the MLG to MLLW conversion value, and the current relationships between these datums and NAVD88.

The MLLW and NAVD88 datum relationships will have to be periodically updated to incorporate future sea level rise and local subsidence, as well as other factors that may affect these datums (i.e. geoid models, epoch updates).

Of note, these periodic updates will not change the MLG to MLLW conversion value. This value will remain constant, which will allow dredging templates to rise over time along with MLLW (due to sea level rise).

After the datum analysis was completed in 2013 all gages along this channel that are maintained by the USACE MVN SGU were reset to NAVD88 (2009.55/OPUS). Gage correction values were defined for each gage to adjust gage readings to MLLW (1983-2001) and MLG. These corrections will be considered valid until a new datum analysis for future MLLW adjustments are performed.

The MLLW-NAVD88 relationships were determined at three tide stations published by the National Oceanic and Atmospheric Administration (NOAA):

- Lake Charles (Station 8767816)
- Bulk Terminal (Station 8767961), and
- Calcasieu Pass (Station 8768094).

These stations are located near USACE gages 73550, 73565 and 73650, respectively, so these relationships are referenced at the USACE gages. These MLLW – NAVD88 relationships are referenced to the 1983-2001 National Tidal Datum epoch.

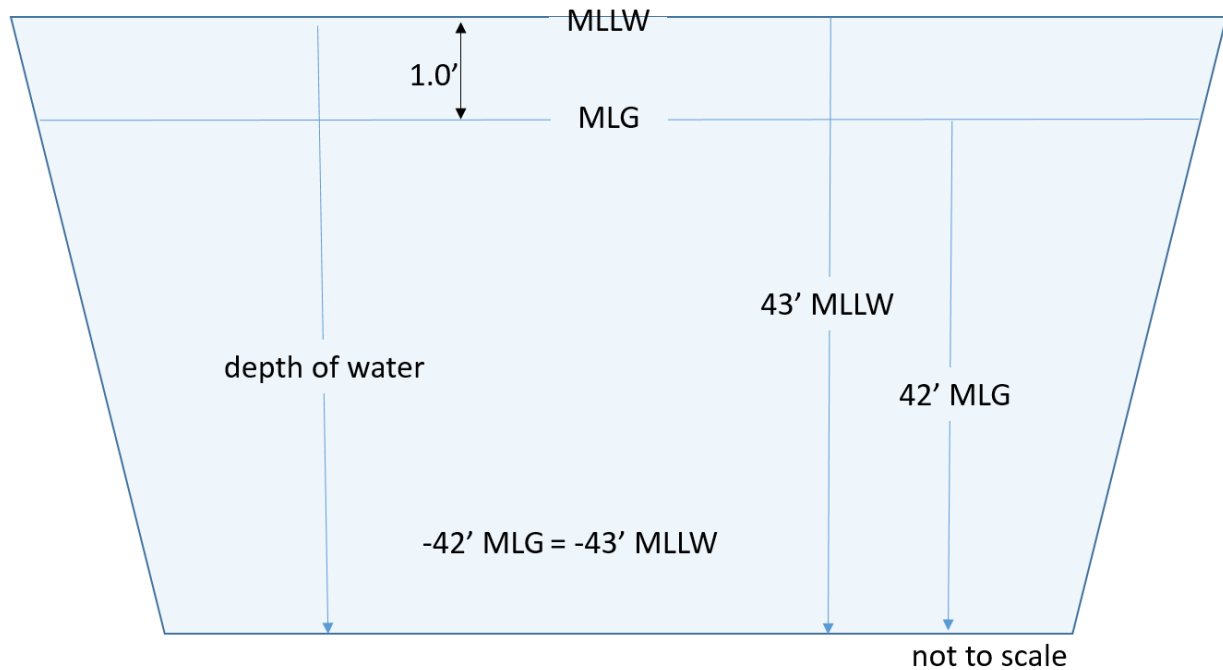
The MLG – NAVD88 relationships were determined based on surveys of staff gages that were previously set to MLG.

## 4. Project Conversion

This section reports the actual conversion from MLG to MLLW for the Calcasieu River project. The MLG to MLLW conversion value has been defined as:

$$0.0 \text{ ft MLLW} = 1.0 \text{ ft MLG}$$

**FIGURE 1**  
**Datum Conversion Definition Sketch**



This conversion value will be used to define MLG for this area, by directly referencing MLLW and applying this conversion value to determine MLG. This conversion value has been determined by referencing the national tidal datum epoch of 1983-2001, but this same value will be held with future updates to MLLW. This is discussed further in Section 4.6.

### 4.1. Datum Offsets for Calcasieu River and Pass Project

Table 1 provides the datum offsets at the gages that are currently used by USACE MVN Operations Division to maintain the Calcasieu River. All gages were set to NAVD88 (2009.55) or NAVD88 (OPUS) using GEOID12A in 2013.

**TABLE 1- Datum Relationships for Calcasieu River Gages**

Gage ID	Gage Name	River Mile	Datum Relationships
73550	Lake Charles	33.3	0.0' NAVD88 = 0.6' MLLW = 1.6' MLG
73565	Rose Bluff Cutoff	29.7	0.0' NAVD88 = 0.6' MLLW = 1.6' MLG
73575	Moss Lake	25.0	0.0' NAVD88 = 0.8' MLLW = 1.8' MLG
73585	Devil's Elbow	22.7	0.0' NAVD88 = 0.8' MLLW = 1.8' MLG
73595	Day Marker 86	19.4	0.0' NAVD88 = 0.9' MLLW = 1.9' MLG
73600	Hackberry	16.5	0.0' NAVD88 = 1.0' MLLW = 2.0' MLG
73615	Long Point (DM 72)	11.2	0.0' NAVD88 = 1.1' MLLW = 2.1' MLG
73625	St John Island (DM 57)	4.4	0.0' NAVD88 = 1.2' MLLW = 2.2' MLG
73650	Cameron	0.5	0.0' NAVD88 = 1.3' MLLW = 2.3' MLG

**NOTES:**

1. MLLW is referenced to the 1983-2001 national tidal datum epoch.
2. Gages 73625 and 73650 are set to NAVD88 (2009.55). The remaining gages are set to NAVD88 (OPUS) using GEOID12A.

Table 2 provides the gage datum offsets for the gages currently used by USACE MVN Operations Division to maintain the Calcasieu River. All gage readings are referenced to NAVD88, but the datum offsets provided in this table can be used to adjust these gage readings to MLG or MLLW (1983-2001).

**TABLE 2- Datum Offsets for Calcasieu River Gages**

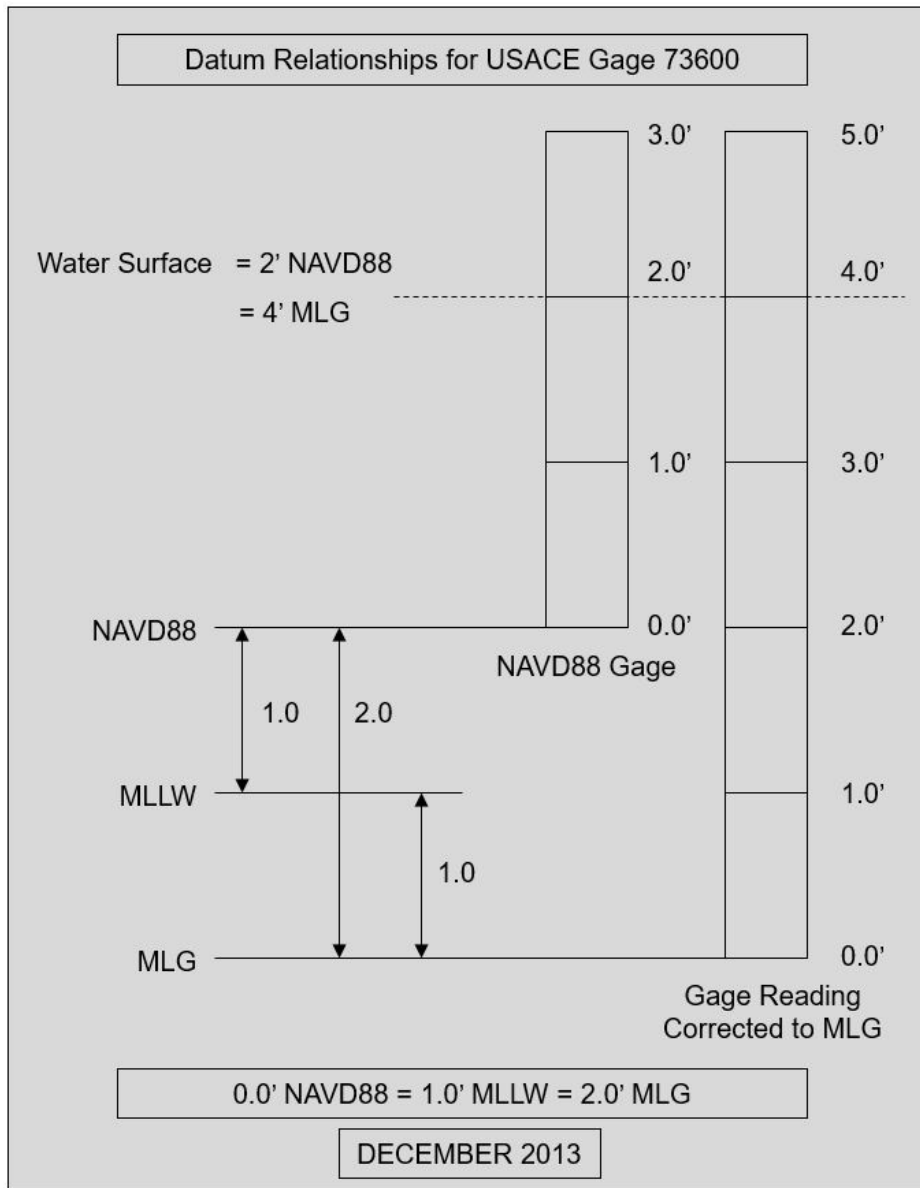
Gage ID	Gage Name	Gage Datum Offsets		Latitude	Longitude
		Gage Datum / MLG	Gage Datum / MLLW		
73550	Lake Charles	1.6	0.6	30 12 47.11	093 15 25.04
73565	Rose Bluff Cutoff	1.6	0.6	30 11 03.85	093 18 19.33
73575	Moss Lake	1.8	0.8	30 07 36.80	093 19 44.51
73585	Devil's Elbow	1.8	0.8	30 05 46.04	093 19 28.12
73595	Day Marker 86	1.9	0.9	30 02 53.36	093 19 40.50
73600	Hackberry	2.0	1.0	30 00 20.37	093 20 01.88
73615	Long Point (DM 72)	2.1	1.1	29 55 45.64	093 20 18.78
73625	St John Island (DM 57)	2.2	1.2	29 49 50.49	093 20 58.88
73650	Cameron	2.3	1.3	29 46 33.73	093 20 52.36

**NOTE:** The gage datum offsets can be added to the raw gage readings to adjust them to the specified datum.

## 4.2. Datum Offsets for Gage 73600

Figure 2 shows the datum relationships that were determined for USACE gage 73600. The NAVD88- MLG and NAVD88-MLLW relationships are valid as of the date of this report.

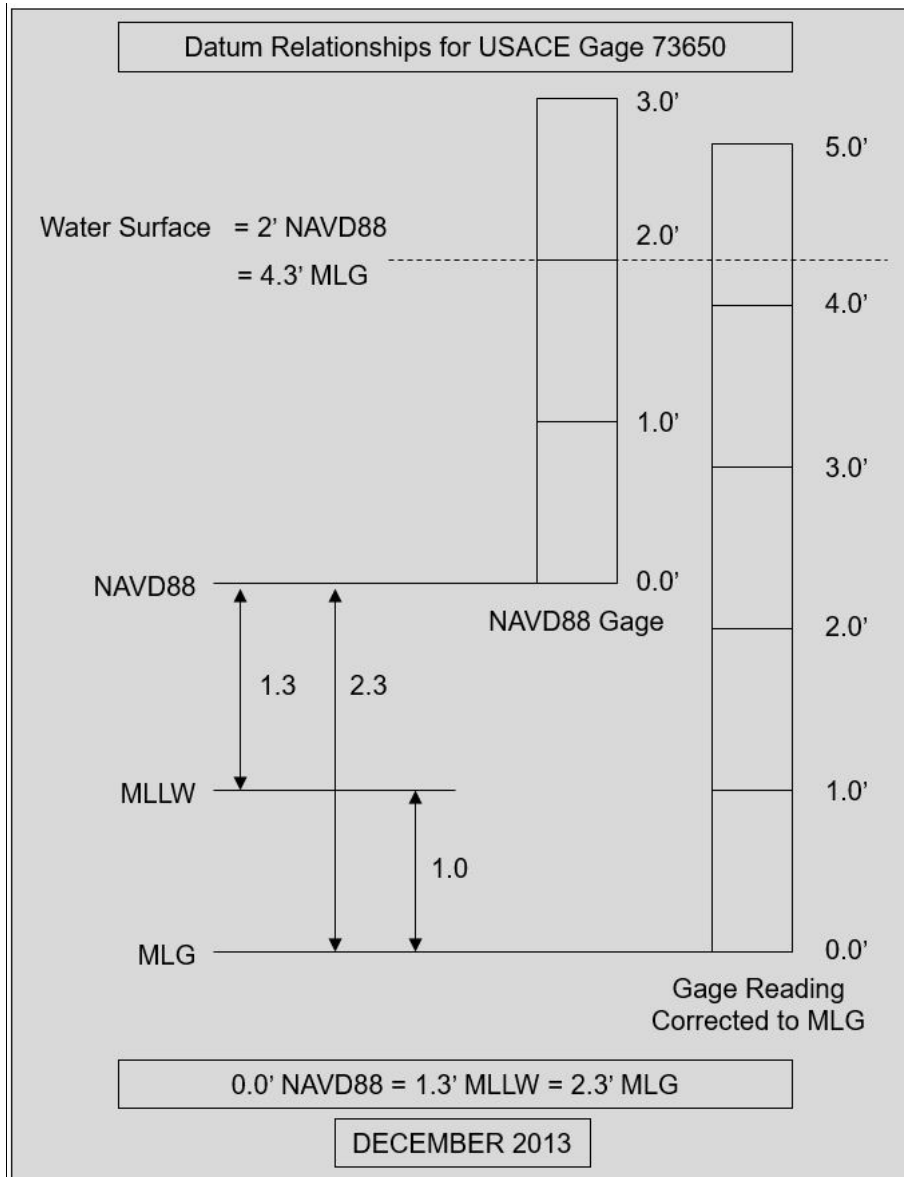
**FIGURE 2**  
**Datum Offsets for USACE Gage 73600**  
**(Applied to a water surface reading)**



### 4.3. Datum Offsets for Gage 73650

Figure 3 shows the datum relationships that were determined for USACE gage 73650. The NAVD88-MLG and NAVD88-MLLW relationships are valid as of the date of this report.

**FIGURE 3**  
**Datum Offsets for USACE Gage 73650**  
**(Applied to a water surface reading)**

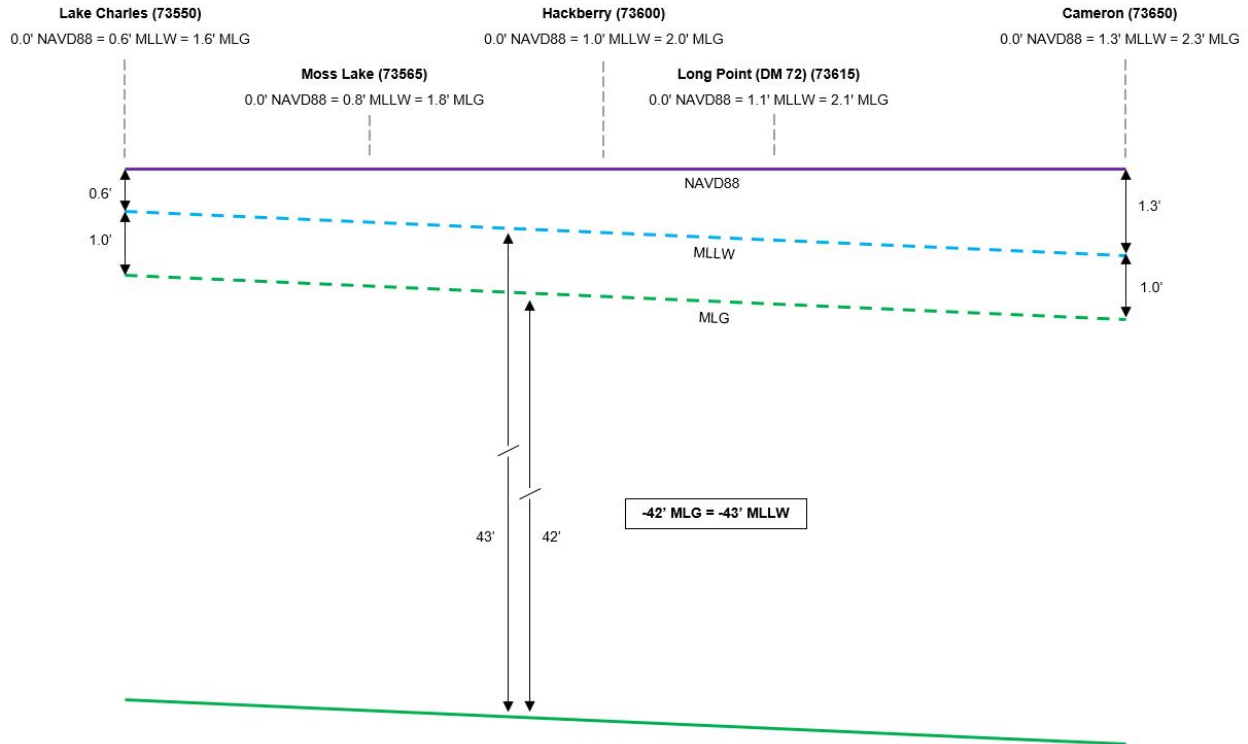




#### 4.4. Datum Offset Chart

The following chart (Figure 4) shows the MLG/MLLW/NAVD datum offsets for Calcasieu River gages:

**FIGURE 4**  
**Datum Offset Chart**



Due to regional subsidence and global sea-level rise, the elevations of the referenced benchmarks and the tidal datum values at the referenced gages (as well as the datum relationships) are time dependent and subject to change. Therefore, the information contained in this report shall be updated on a regular basis and/or as new information becomes available.

#### 4.5. Documents to be Updated

Project documents that must be updated to reflect the MLLW values are:

- Dredging templates
- Plans and specifications
- Channel condition survey data posted on web page

## 4.6. Future Updates to MLLW/NAVD88

The MLLW-NAVD88 datum offsets defined in this report are time dependent and will have to be regularly verified/updated. EM 1110-2-6065 indicates that the periodic reassessments of controlling elevations and datum relationships should be performed at least every five years. These reassessments will not change the MLLW-MLG conversion value, only the MLLW-NAVD88 relationships that will be used to define MLLW for the Calcasieu River.

## 4.7 Summary

This conversion value will be considered absolute and documents current practices. It will not be redefined for Calcasieu River gages. Use of this relationship will be a no-impact change to current dredging practices, as it has been determined using the currently used relationship to MLG in the Calcasieu River and Passes. However, the relationship between MLLW and NAVD88 will need to be periodically updated to incorporate the future sea level rise and local subsidence.

Dredging design templates and other associated documents are now updated to directly reference MLLW depths, and the relationship to MLG will be included as a note. Providing the MLG relationship will allow users to relate these project documents back to authorization language as needed.

## REFERENCES

1. Comprehensive Evaluation of Project Datums (CEPD) Final Report – Appendix 3, Calcasieu River and Pass. Date: 23 April 2012.
2. USACE, 1999. ER 1110-2-1150: Engineering and Design for Civil Work Projects, 31 August 1999.
3. USACE, 2007. EC 1110-2-6065: Engineering and Design, Comprehensive Evaluation of Project Datums, Guidance for a Comprehensive Evaluation of Vertical Datums on Flood Control, Shore Protection, Hurricane Protection, and Navigation Projects, 1 July 2007.
4. USACE, 2009. EC 1110-2-6070: Engineering and Design, Comprehensive Evaluation of Project Datums, Guidance for a Comprehensive Evaluation of Vertical Datums on Flood Control, Shore Protection, Hurricane Protection, and Navigation Projects, 1 July 2009.
5. USACE, 2010. EM 1110-2-6056: Engineering and Design, Standards and Procedures for Referencing Project Elevation Grades to Nationwide Vertical Datums, 31 December 2010.
6. USACE, 2014. Navigation Project Compliance with Vertical Datum Guidance. Memorandum from HQUSACE. Dated 24 October 21014.

7. ER 1110-2-8160, Policies For Referencing Project Elevation Grades To Nationwide Vertical Datums
8. NOAA, 2014. NOAA Technical Report NOS CO-OPS 068, Implementation of Procedures for Computation of Tidal Datums in Areas with Anomalous Trends in Relative Mean Sea Level

All related supporting documentation may be found in ProjectWise:

pw:\\COE-MVNPWP01NOL.mvn.ds.usace.army.mil:CEMVN01\Documents\Civil Works\CALC - Calcasieu\Calcasieu River & Pass Navigation\Engineering Documentation Report\

[Engineering Documentation Report](#)

pw://COE-MVNPWP01NOL.mvn.ds.usace.army.mil:  
CEMVN01/Documents/P{8c46bee1-3136-4f27-886b-377ccb158c1f}/