



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

Engineering Documentation Report

EDR-OD-06

Mississippi River Outlets Vicinity of Venice, LA

Tiger Pass Mississippi River to the Gulf of Mexico

MLG to MLLW Vertical Datum Conversion

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LIST OF ACRONYMS

CO-OPS: Center for Operational Oceanographic Products and Services

DM: Daymark

EDR: Engineering Documentation Report

EM: Engineer Manual

ER: Engineer Regulation

HQUSACE: US Army Corps of Engineers Headquarters Office

GIWW: Gulf Intracoastal Waterway

LMSL: Local Mean Sea Level

MLG: Mean Low Gulf datum

MLLW: Mean Lower Low Water datum

MLW: Mean Low Water

MSL: Mean Sea Level

MVN: Mississippi Valley Division, New Orleans District

NAVD 88: North American Vertical Datum of 1988

NGS: National Geodetic Survey

NGVD 29: National Geodetic Vertical Datum of 1929

NTDE: National Tidal Datum Epoch

NOAA: National Oceanic and Atmospheric Administration

OCS: Office of Coast Survey

SLD 29: Sea Level Datum of 1929

USACE: US Army Corps of Engineers

USC&GS: US Coast and Geodetic Survey

1 Introduction

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

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

This report documents the conversion from the legacy, unmaintained MLG datum to the National Oceanic and Atmospheric Administration (NOAA) maintained MLLW tidal datum for Tiger Pass from the Mississippi River to the end of the Tiger Pass Channel in the Gulf of Mexico. This report provides details on how this relationship was determined and will be applied.

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

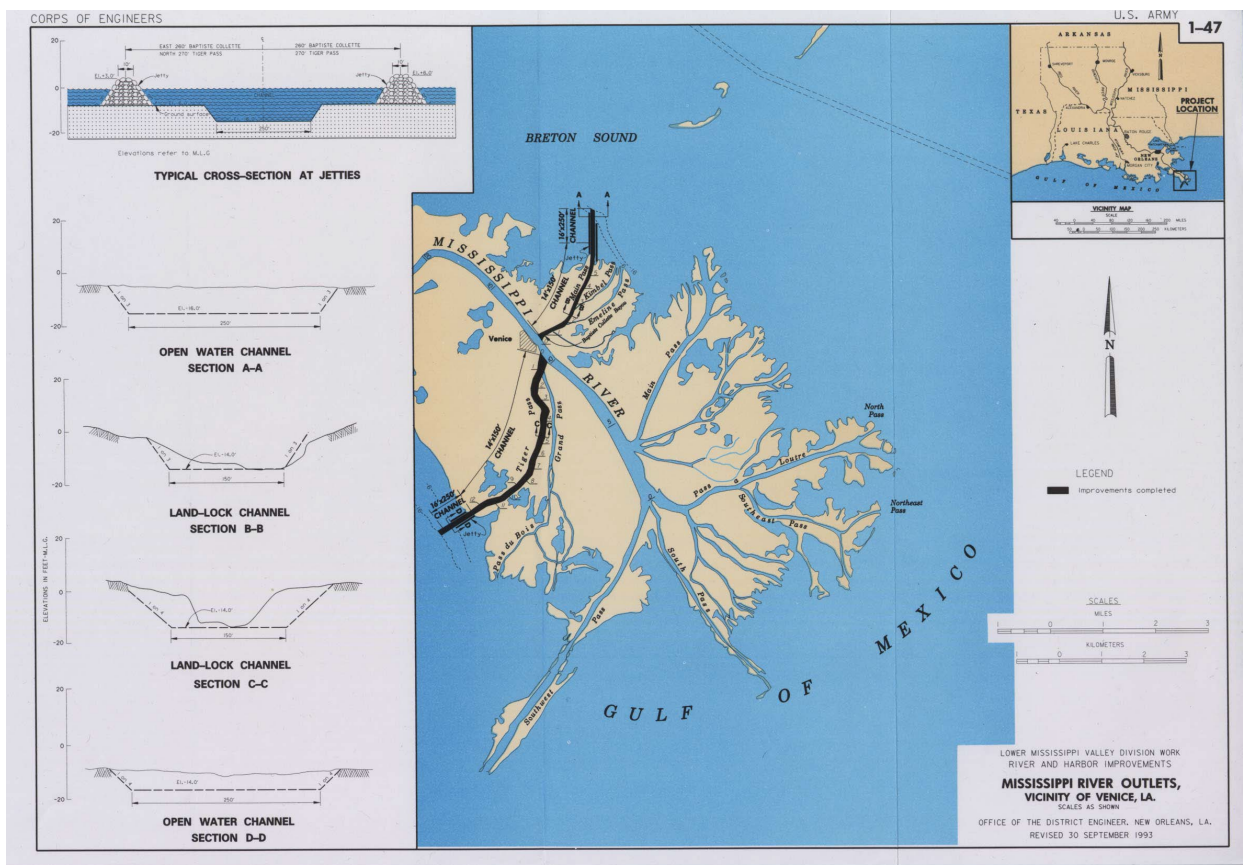
- The North American Vertical Datum of 1988 (NAVD 88) is a geodetic datum that is defined and maintained by the National Geodetic Survey (NGS). This datum is typically used for surveying (in addition to design and construction) and can be related to other datums as needed, to ensure project datums are referenced as required.
- Mean Lower Low Water (MLLW) as defined by the U.S. Department of Commerce and maintained by NOAA is the reference for project channel depths under the Rivers and Harbors Appropriation Act of 1915 and subsequent River and Harbor Acts.
- Mean Low Gulf (MLG) is a local, legacy terrestrial datum that was originally defined relative to local mean sea level as observed in 1899 at a Biloxi, MS gage 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 coastal portion of the Mississippi River navigation channel.

2 Project Summary

The River and Harbor Act of 1968, approved 13 August 1968 (House Document 361, 90th Congress, 2nd Session), provides for additional navigation outlets from the Mississippi River in the vicinity of Venice, Louisiana, by enlargement of the existing channels of Baptiste Collette Bayou and Tiger Pass to provide channels 14 feet deep (Mean Low Gulf) over a bottom width of 150 feet, with entrance channels in open water 16 feet deep over a bottom width of 250 feet. Jetties, to the 6-foot depth contour, are authorized if and when justified to reduce the cost of maintenance dredging.

The enlargement of Grand and Tiger Passes began in March 1978 and was completed in October 1978. Construction of the Tiger Pass jetty was completed in March 1979.

Tiger Pass extends from the Mississippi River to the Gulf of Mexico. The Tiger Pass channel maintenance ends at the minus 16-foot depth contour at approximately 5 miles into the Gulf of Mexico.



MAP 1- Mississippi River Outlets including Tiger Pass

3 Vertical Datum Conversion Process

The datum relationships provided in this report brings Tiger Pass of the “Mississippi River Outlets” project into compliance with the requirements outlined in Engineer Regulation (ER) 1110-2-8160, Policies for Referencing Project Elevation Grades to Nationwide Vertical Datums, and Engineer Manual (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 relation 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., MLG, Gulf Mean Tide, MSL, NGVD, MLW, 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 NAVD 88. 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.”

The datum relationship between MLG, MLLW, and NAVD 88 was defined in accordance with EM 1110-2-6056. This datum relationship was used to determine the MLG-MLLW conversion value. See Section 4 for the relationship and conversion value.

3.1 Project Datum

Tiger Pass was completed in 1979 and its maintenance was authorized by the River and Harbor Act of 1968. Since that time, MLG has been the project datum for the entire project. As discussed in EM-1110-2-6056, some USACE Civil Works projects are, in effect, referenced to a local vertical datum. Many local datums are based on arbitrary, unknown, or perhaps archaic origins. Most hydraulic-based river datums and MSL/MLLW tidal datums are local datums when they are not properly modeled or kept updated. Mean Low Gulf was intended to represent the low water level of the Gulf of Mexico and it was defined in 1944 by New Orleans District Memorandum as being 0.78 ft below local mean sea level. At that time, Mean Sea Level (MSL) was defined by the Sea Level Datum of 1929 (SLD 29). SLD 29 was created by the U.S. Coast and Geodetic Survey (USC&GS) as the standard vertical control datum for North America. SLD 29 was believed to be a MSL based datum, although MSL values were not consistent at the various gage locations. MSL values were not developed using the same epoch or period of record at each of the gages, so each gage was, in effect, a “local mean sea level” reference datum.

However, over time, with sea level rise and other factors, SLD 29 was no longer considered a MSL datum. In 1973, the name of SLD 29 was changed to the National Geodetic Vertical Datum of 1929 (NGVD 29) because it no longer represented sea level¹. However, the assumed equivalency of NGVD 29 to MSL was predominant in both government and academic texts published well after the 1973 redefinition. MLG for this project continued to be locally interpreted as 0.78 ft below NGVD 29. 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. The relationships 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 the magnitude of subsidence in the region.

The U.S. Army Corps of Engineers, New Orleans District, Stream Gaging team has maintained gages at Venice, LA, Daymark 17, and Daymark 10 which are currently referenced to NAVD 88.

3.2 Methodology for Establishing Conversion Value

EDR-OD-01, November 2016, defined the NAVD 88, MLLW (2007-2011) and MLG relationships for the Southwest Pass gages including the Venice Gage (01480) which is located on the Mississippi River at the head of Grand Pass which is also the beginning of the maintained Tiger Pass Navigation Channel. The datum relationship for the Venice Gage was updated in May 2020 based on MLLW (2012-2016). Therefore the Venice Gage MLLW to NAVD 88 relationship of 0.53 ft is held at the beginning of the maintained Tiger Pass Navigation Channel, Station 0+00, located at the head of Grand Pass.

Other MLLW values on the downstream end of Tiger Pass were provided by NOAA's online *VDatum*², a web-based version of NOAA's *VDatum* (Vertical Datum Transformation) program, a software tool developed jointly by NGS, Office of Coast Survey (OCS), and CO-OPS. *VDatum* utilizes a geospatial dataset of MLLW values defined on a 5 ft horizontal grid. These grid values are only assigned within geographic polygons defined as valid tidal areas as determined by *VDatum*. At approximate Tiger Pass Station 650+00, at the downstream end of the South Jetty and where Tiger Pass joins the open water of the Gulf of Mexico, *VDatum* defines the MLLW to NAVD 88 relationship as being 0.05 ft higher such that 0.00 ft MLLW equals 0.05 ft NAVD 88.

¹ National Geodetic Vertical Datum of 1929 (NGVD 29): <https://www.ngs.noaa.gov/datums/vertical/national-geodetic-vertical-datum-1929.shtml>

² Online Vertical Transformation Tool: July 2016, <https://vdatum.noaa.gov/vdatumweb/>

Since *VDatum* values are based upon proximity to NOAA Tide Stations and calculated based on open water between the tide station and the area of interest, *VDatum* values may become more suspect in constricted waterways such as inlets or canals where tidal flow is interrupted by geographical features. It is for this reason that the head of Tiger Pass is in an area defined as “not a valid tidal area” according to *VDatum*.

Therefore, the decision was made to hold the MLLW values of 0.53 ft NAVD 88 at the Venice Gage and 0.05 ft NAVD 88 at Station 650+00. The MLLW values between these two stations are interpolated at a constant slope and the portion of the Tiger Pass Channel past Station 650+00 is an extension of that same slope. This results in an ending value (-0.02 ft) that is only 0.04 ft less than the published *VDatum* value at that location (+0.02 ft). The graphic representation of the slope can be seen in Figure 6.

The legacy MLG and MLLW were compared to determine a relationship between MLG and MLLW. They were found to be roughly 3.0 ft apart at the point of least separation. Therefore, a calibration value of 3.0 ft is determined to be valid for Tiger Pass as:

$$\mathbf{0.0\text{ ft MLLW} = 3.0\text{ ft MLG}}$$

MLLW, and subsequently MLG, is determined to be a constant slope for the entire Tiger Pass Channel. MLLW, and subsequently MLG, for the entire channel is defined and will continue to be defined by a constant slope between the MLLW value of the Mississippi River at the Venice Gage and the MLLW value defined by *VDatum* at Station 650+00.

The MLLW values currently in use by *VDatum* are based on the modified National Tidal Datum Epoch (NTDE) of 2002-2006. With each new modified NTDE, NOAA analyzes the change in Local Mean Sea Level (LMSL) from the 2002-2006 epoch to the current epoch. If the change in LMSL is less than the Maximum Cumulative Uncertainty of 17.1 cm for the transformational grid, then the *VDatum* MLLW values are not updated. Therefore, even though the modified NTDE for *VDatum* is reported as 2002-2006, we will consider the derived MLLW values as being referenced to the 2012-2016 modified NTDE.

The MLLW and NAVD 88 datum relationships will continue 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 model changes, epoch updates).

Of note, these periodic updates will not change the MLLW to MLG conversion value of 3.0 ft. This value will remain constant, which will allow dredging templates to rise over time along with changes to MLLW due to sea level rise and other factors.



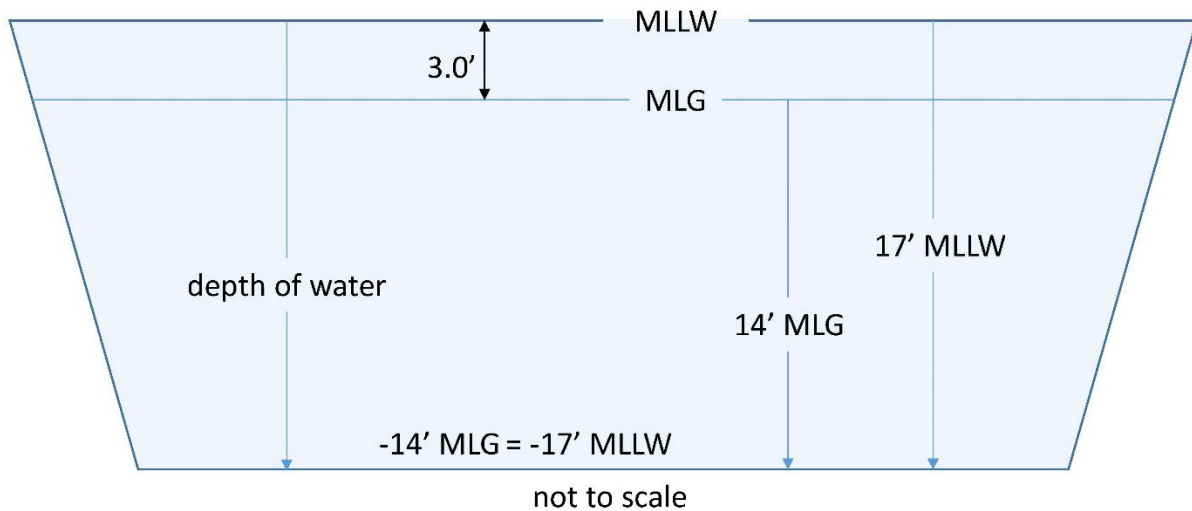
MAP 2- Tiger Pass from the Mississippi River to the Gulf of Mexico

4 Datum Conversion

This section reports the actual conversion from MLG to MLLW for Tiger Pass. The MLG to MLLW conversion value has been defined as:

$$0.0 \text{ ft MLLW} = 3.0 \text{ ft MLG}$$

**FIGURE 1:
Datum Conversion Definition Sketch
Tiger Pass**



This conversion value of 3.0 feet will be used to define MLG for this area, by directly referencing the MLLW value and adding 3.0 feet to result in a MLG value. This conversion value has been determined by referencing the Modified National Tidal Datum Epoch of 2012-2016 and will be held with future updates to MLLW. This conversion value is discussed further in Section 3.2 of this report.

4.1 Datum Offsets for Tiger Pass Gages

Table 1 provides the datum offsets at the gages that are currently used by the USACE New Orleans District, Operations Division to maintain Tiger Pass.

TABLE 1- Datum Offsets Relative to NAVD 88

Datum Offsets to NAVD 88					
Gage ID	Gage Name	NAVD 88	Gage Datum	MLLW	MLG
01480	Venice Gage	0.00'	0.00'	-0.53'	2.47'
01535 (DM17)	Daymark 17	0.00'	0.18'	-0.13'	2.87'
01535 (DM10)	Daymark 10	0.00'	0.00'	-0.08'	2.92'

NOTES: These MLLW values are calculated based upon a constant slope defined by the MLLW value of the Mississippi River at the head of Tiger Pass and the MLLW value obtained from VDatum at Station 650+00. The MLLW values are referenced to the 2012-2016 modified NTDE.

TABLE 2- Datum Offsets Relative to Gage Datum

Datum Offsets to Gage Datum					
Gage ID	Gage Name	Gage Datum	NAVD 88	MLLW	MLG
01480	Venice Gage	0.00'	0.00'	-0.53'	2.47'
01535 (DM17)	Daymark 17	0.00'	-0.18'	-0.31'	2.69'
01535 (DM10)	Daymark 10	0.00'	0.00'	-0.08'	2.92'

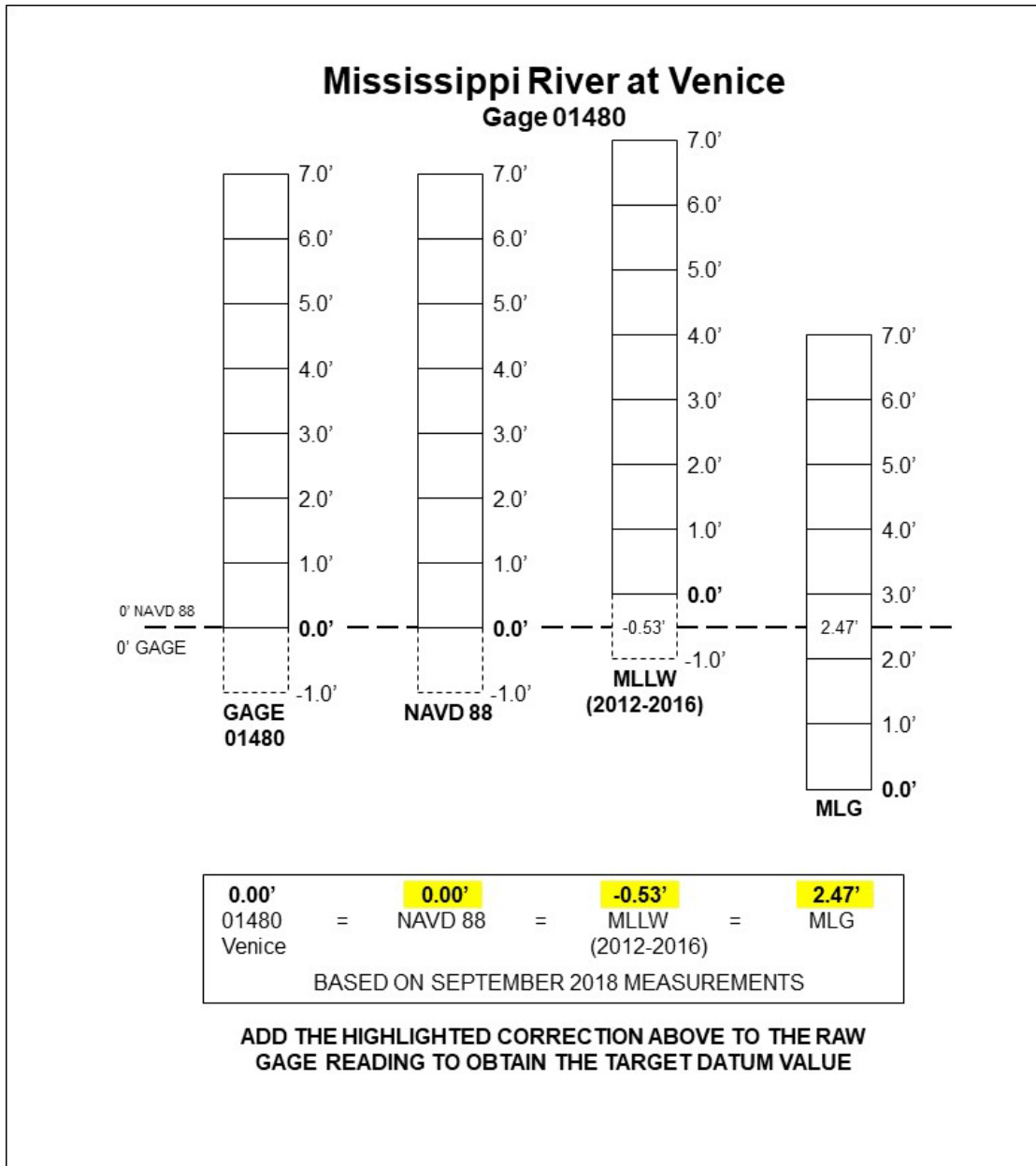
NOTES: These MLLW values are calculated based upon a constant slope defined by the MLLW value of the Mississippi River at the head of Tiger Pass and the MLLW value obtained from VDatum at Station 650+00. The MLLW values are referenced to the 2012-2016 modified NTDE.

The offsets supplied in this table can be added to the raw gage readings to adjust them to the specified datum.

4.2 Datum Offsets for Gage 01480

Figure 2 shows the datum relationships that were determined for the USACE Gage 01480. The NAVD 88 - MLG and NAVD 88 - MLLW relationships are valid as of September 2018.

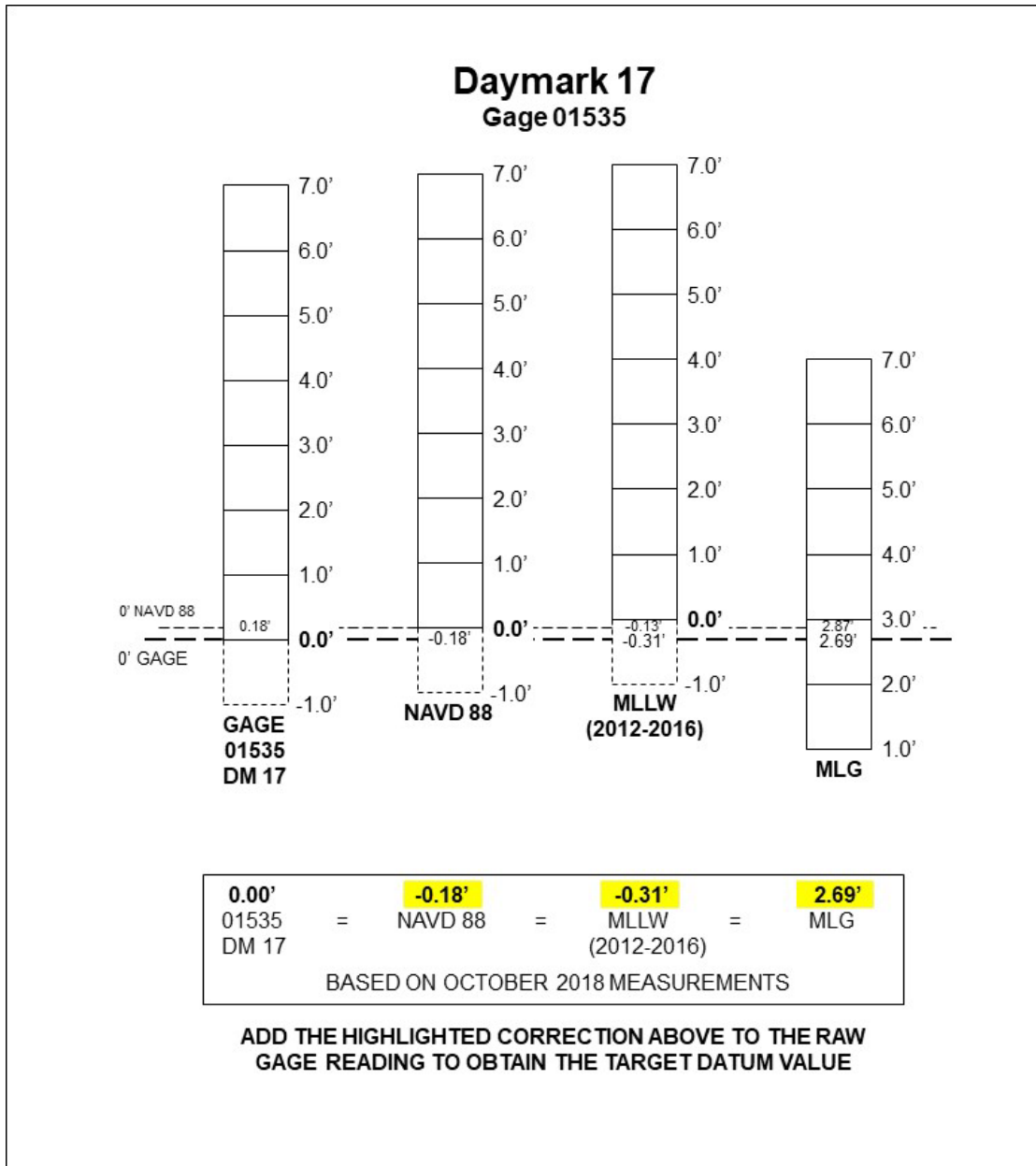
**FIGURE 3:
Datum Offsets for USACE Gage 01480**



4.3 Datum Offsets for Gage 01535, Daymark 17

Figure 2 shows the datum relationships that were determined for the USACE Gage 01535, Daymark 17. The NAVD 88 - MLG and NAVD 88 - MLLW relationships are valid as of October 2018.

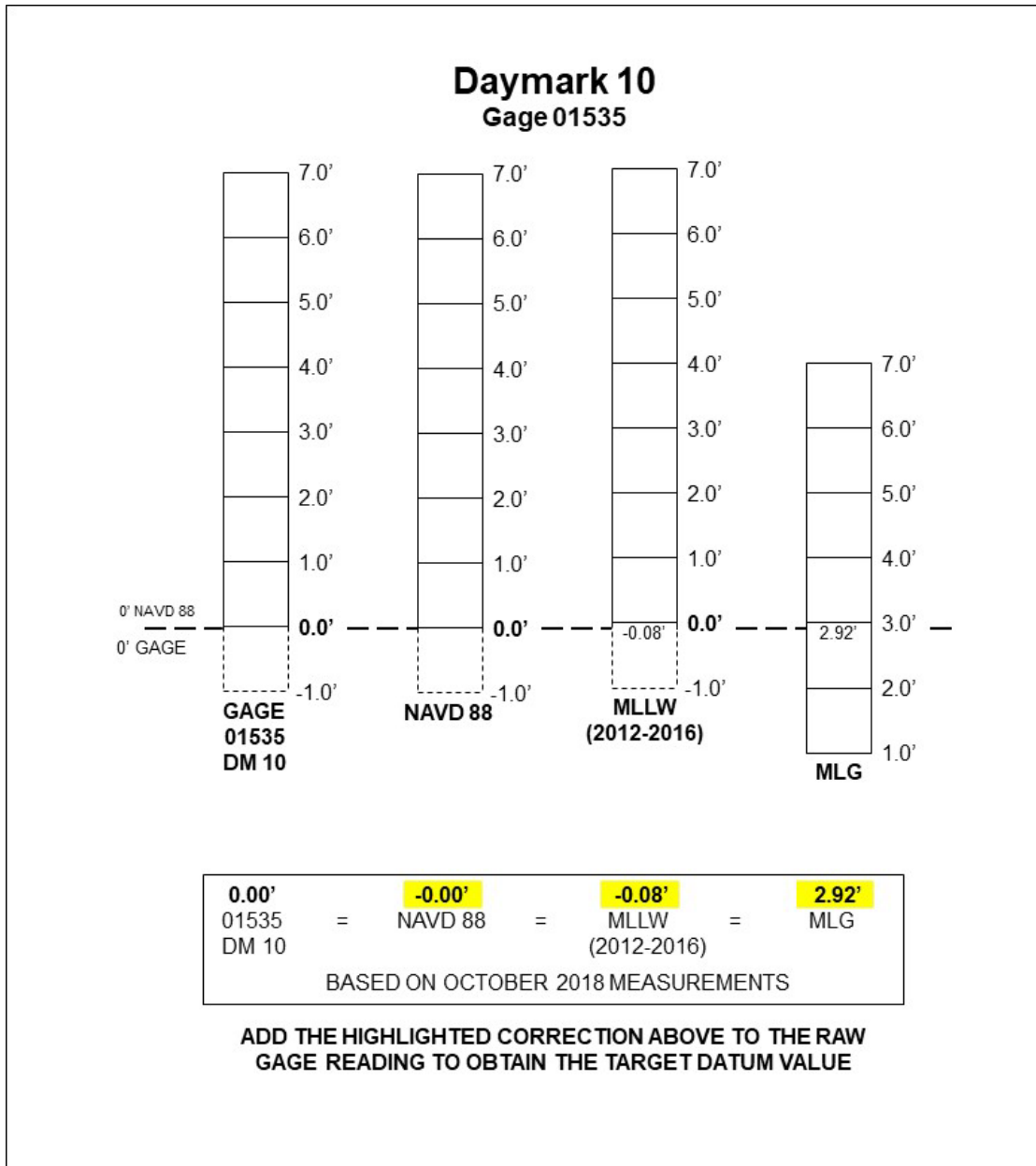
**FIGURE 4:
Datum Offsets for USACE Gage 01535, DM 17**



4.4 Datum Offsets for Gage 01535, Daymark 10

Figure 3 shows the datum relationships that were determined for the USACE Gage 01535, Daymark 10. The NAVD 88 - MLG and NAVD 88 - MLLW relationships are valid as of October 2018.

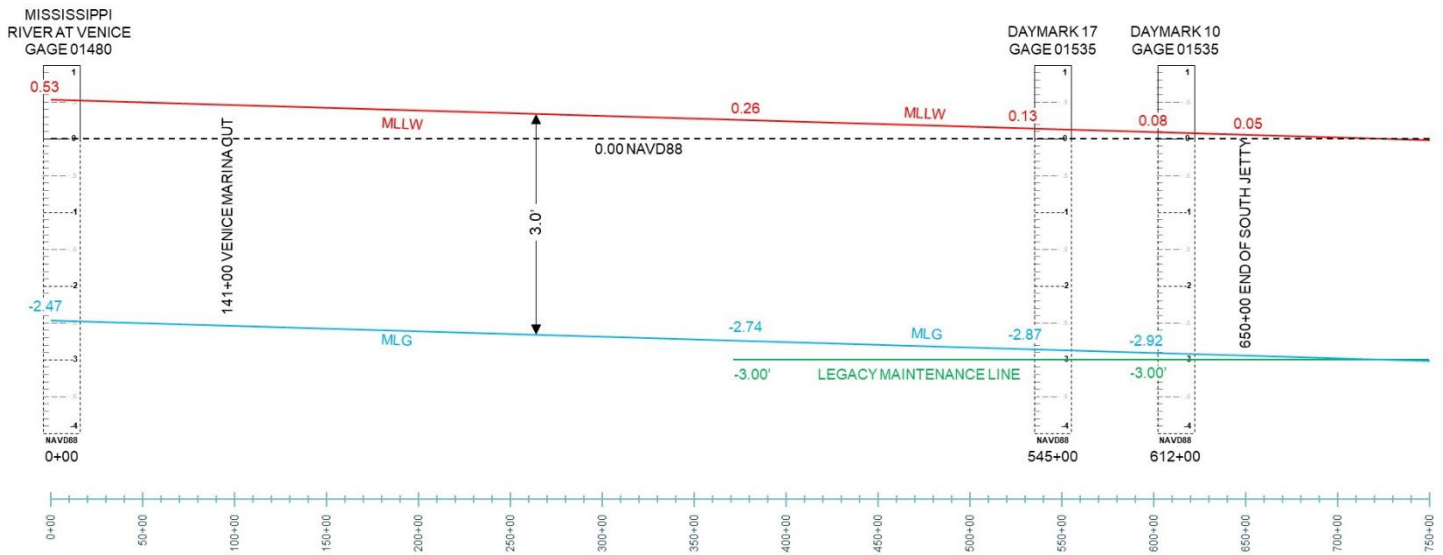
**FIGURE 5:
Datum Offsets for USACE Gage 01535, DM 10**



4.5 Datum Offset Chart

The following chart (Figure 4) shows the MLG/MLLW/NAVD 88 datum offsets for the Tiger Pass gages from the Mississippi River to Breton Sound.

**FIGURE 6:
Datum Offset Chart
Tiger Pass**



1. MLLW value at the head of channel (Station 0+00) is 0.53' NAVD 88 which based upon the MLLW value of the Mississippi River at Venice Gage.
2. MLLW value of 0.05' at the end of the South Jetty (Station 650+00) is based upon the VDatum MLLW value at that location.
3. MLLW value for Tiger Pass is interpolated as a constant slope between those two points.
4. MLG is offset 3.0' below MLLW for all of Tiger Pass.

Due to regional subsidence and global sea-level rise, the elevations of 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.

5 Future Updates to MLLW-NAVD 88

The MLLW-NAVD 88 datum offsets defined in this report are time dependent and will have to be regularly verified/updated. The 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 of 3.0 ft. They will only change the MLLW-NAVD 88 relationships that will be used to define MLLW for Tiger Pass.

It is anticipated that in 2023, NOAA will publish an updated National Tidal Datum Epoch for the period of observations from 2017 to 2021, which will require an update of the Tiger Pass MLLW-NAVD 88 relationship and a corresponding update of the relationship to MLG.

6 Summary

The MLLW-MLG conversion value is considered absolute and will not be redefined for Tiger Pass. However, the relationship between MLLW and NAVD 88 will need to be periodically updated to incorporate the future sea level rise and local subsidence.

Dredging design templates and other associated documents shall be updated to directly reference and utilize MLLW depths, and the relationship to MLG shall 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. USACE, 2014. Navigation Project Compliance with Vertical Datum Guidance. Memorandum from HQUSACE. 24 October 2014.
2. Rivers and Harbors Appropriation Act of 1915, Chapter 142, Section 5.1644, Laws Relating to Improvement of Rivers and Harbors.
3. River and Harbor Act of 1968, Public Law 90-483, Section 101, Navigation.
4. USACE, 2009. ER 1110-2-8160: Policies for Referencing Project Elevation Grades to Nationwide Vertical Datums. 01 March 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, 2019. EDR-OD-01, Revision 2: Mississippi River, Venice, Louisiana to the Gulf of Mexico (Vicinity of Southwest Pass), 24 June 2019
7. Online Vertical Transformation Tool, NOAA and the National Ocean Service: July 2016, <https://vdatum.noaa.gov/vdatumweb/>

All related supporting documentation may be found on the MVN ProjectWise server at:

pw:\\PWINT-CPC.EIS.DS.USACE.ARMY.MIL:CEMVN01\Documents\Civil Works\MROV - Mississippi River Outlets - Vicinity of Venice\Tiger Pass\MLG-to-MLLW Engineering Documentation Report\