CHAPTER 7

Vertical Datums Applicable to Regulatory Permitting

7-1. Purpose and Applicability. This chapter provides general background information on reference elevation grades that may be cited on permit applications or mitigation site plans. ER 1110-2-8160 (*Policies for Referencing Project Elevation Grades to Nationwide Vertical Datums*) notes that vertical reference datums on permit applications should conform to accepted local and state requirements; thus, legacy or local reference datums will usually supersede requirements to reference projects to the NSRS (currently NAVD88) or NOAA NWLON tidal datums. Therefore, the technical guidance in this chapter is intended to cover only those permit applications or mitigation projects where the reference to a nationwide vertical NSRS or NWLON datum may be applicable.

7-2. Vertical Reference Datums Used in Regulatory Activities. Table 7-1 lists some of the reference datums that may be applicable to permitting or mitigation projects. These reference datums are also illustrated in Figures 7-1 and 7-2 and further described in subsequent sections. In tidal areas, established datum limits defined by NOAA are measured based on gage readings—e.g., MSL, MLW, MHW. Reference data at these gages may also be related to NSRS (NAVD88) datums. Limits defined by more subjective observations (OHWM, MHT) do not necessarily have hydraulic or tidal gage measurement definitions; however, OHWM or MHT points or contours on permit applications may have been surveyed relative to established NSRS (NAVD88) datums. Many permit applications reference water surface and excavation/fill elevations to superseded legacy orthometric datums (e.g., NGVD29) under the erroneous assumption this datum relates to the current epoch of LMSL.

7-3. Ordinary High Water Mark (OHWM) Determination. OHWM is a jurisdictional benchmark for administering the USACE regulatory program in navigable waterways under Section 10 of the Rivers and Harbors Appropriations Act of 1899 (33 U.S.C. 403) and Section 404 of the Clean Water Act of 1977 (33 U.S.C. 1344). The term "Ordinary High Water Mark" is defined in 33 CFR 328.3 (*Definitions of Waters of the United States*) to "mean that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."

a. OHWM interpretation. Various interpretations of OHWMs exist throughout CONUS, given the subjective site-dependent nature of the definition—e.g., estimated vegetation line limits. For example, a OHWM is also defined as "where the banks of a body of water are relatively steep, the OHWM is coordinate with the limit of the bed of the water; and that, only, is to be considered the bed which the water occupies sufficiently long and continuously to wrest it from vegetation and destroy its value for agricultural purposes."

Table 7-1. Vertical Datums used in Regulatory Permitting Authorities.

Authority [1]	Geographic Area	Activity	Typical Reference Datums
SECTION 10 Rivers & Harbor Act of 1899	Navigable Waters of United States	All work over, through, and under navigable waters (e.g., dredging, docks, beach renourishment)	Ordinary High Water Mark (OHWM) Mean High Tide (MHT) Mean Low Water (MLW)
SECTION 404 Clean Water Act of 1977	Waters of the United States, including Wetlands	Fill (e.g., roads, home sites, beach renourishment)	OHWM High Tide Line (HTL) Vegetation lines
SECTION 103 Marine Protection, Research & Sanctuaries Act	Ocean	Transportation of dredged material for the purpose of ocean disposal	Mean Sea Level (MSL) MLLW NAVD88

[1] References are listed in Section 7-12.

(1) When the river banks are low and flat, OHWM is considered "the point up to which the presence and action of the water is so continuous as to destroy the value of the land for agricultural purposes by preventing growth of vegetation."

(2) On navigable lakes and rivers the U.S. Government holds an easement for riparian lands up to the OHWM. Thus, it is essential that the OHWM demarcation line be referenced to reliable vertical datums—to include the NSRS (NAVD88). In controlled pools, the relationship between the OHWM and pool discharge controlling elevations should be related to a common and consistent reference datum.

b. Open water. Open water is defined as an area that, during a year with normal patterns of precipitation, has standing or flowing water for sufficient duration to establish an OHWM. Aquatic vegetation within the area of standing or flowing water is either non-emergent, sparse, or absent. Vegetated shallows are considered to be open waters. The term 'open water' includes rivers, streams, lakes, and ponds.

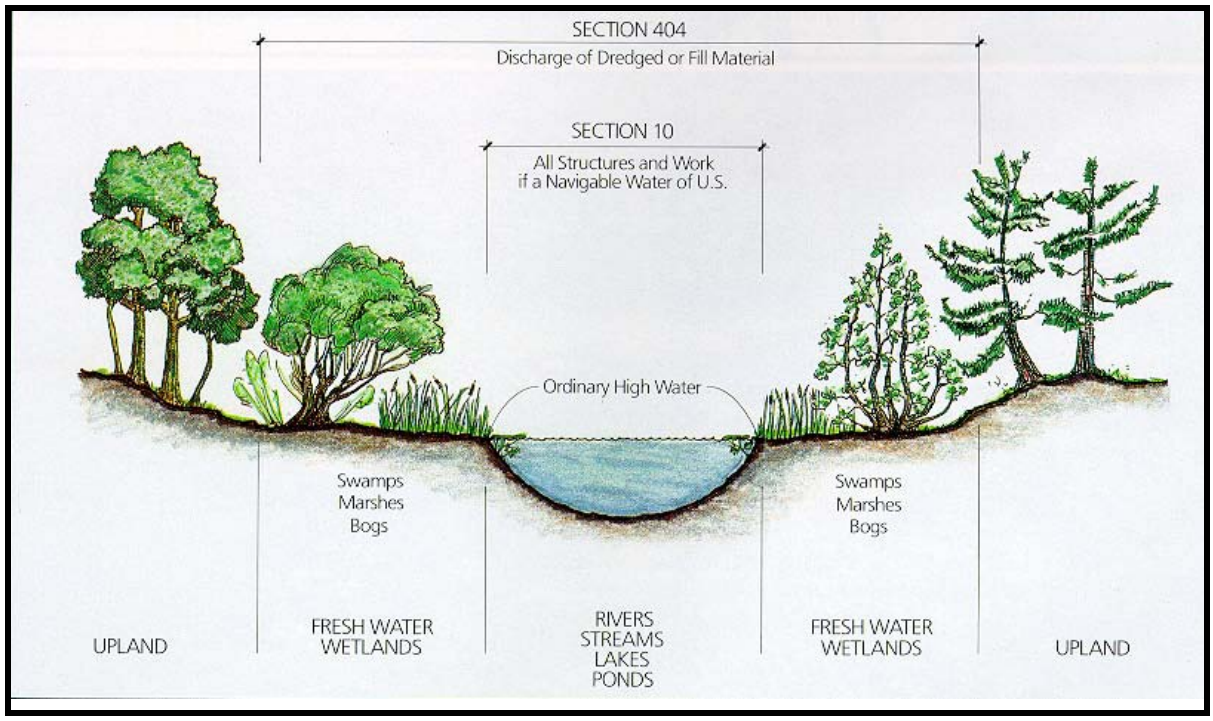

Figure 7-1. Regulatory datums for various permit authorities—inland rivers and lakes.

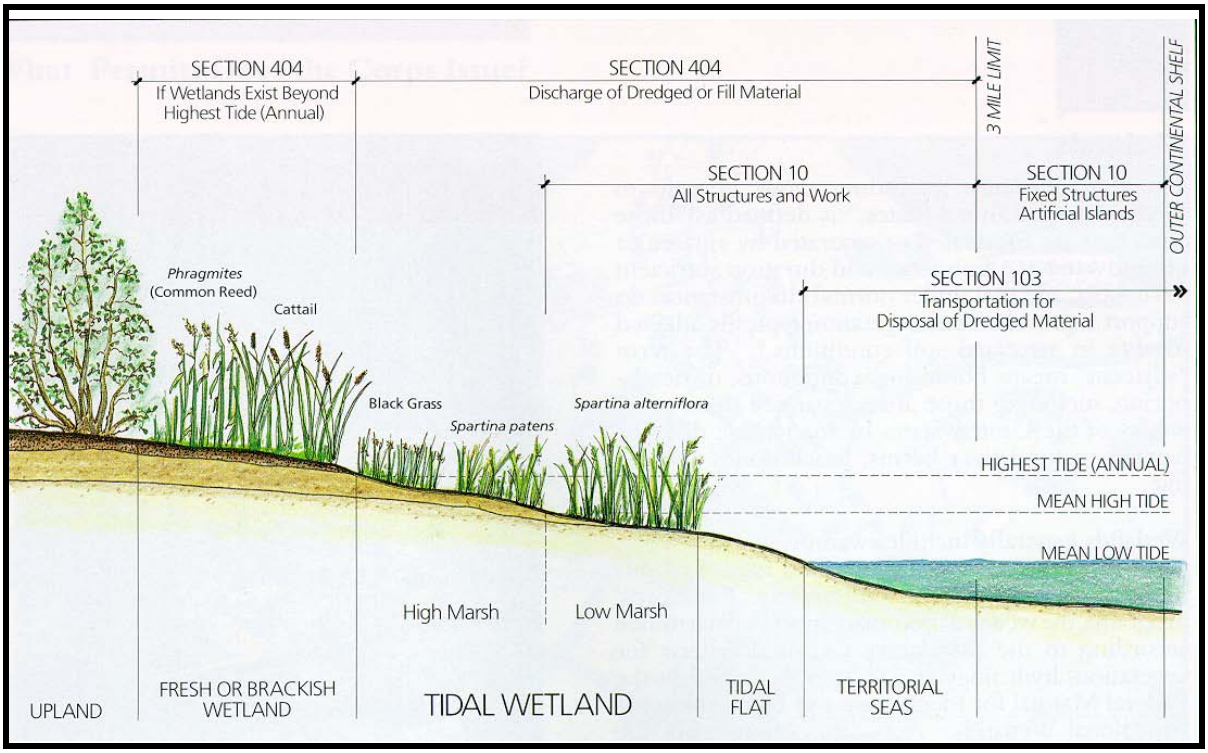

Figure 7-2. Regulatory datums for various permit authorities—tidal areas. In this figure "Highest Tide (Annual)" approximates HTL or MHWS, "Mean High Tide" approximates MHW, and "Mean Low Tide" approximates MLW.

c. Stream bed. A stream bed is defined as the substrate of the channel between the OHWMs. The substrate may be bedrock or inorganic particles that range in size form clay to boulders. Wetlands contiguous to the stream bed, but outside of the OHWMs, are not considered part of the stream bed.

d. Survey methods. Once OHWMs are delineated (staked out) in the field, various survey methods outlined in Chapter 3 may be used to control horizontal positions and elevations. RTK/RTN methods are usually the most efficient and provide adequate accuracy—typically less than ±0.2 ft relative to a nearby vertical reference PPCP—a gage or published NSRS bench mark. OHWM points will usually be marked with TBM hubs. Permanent marks (PBMs) will often be offset (set back) from the OHWM to higher ground, similar to erosion control lines or construction setback lines. Elevations will normally be referenced to NAVD88; however, legacy elevations or river/pool stages may be used. The horizontal location of OHWMs will normally be referenced to the local site plan (e.g., local boundary corners and structures). NAD83 coordinates may also be referenced on the site plan, either SPCS or geographical.

e. Example. Figure 7-3 is an example from a permit application that adequately references the proposed structure elevation to the local IGLD85 and NAVD88 datums at Lake Michigan. The relationship between the datums is clearly indicated on the drawing. Also shown is the established OHWM at the project site—in this case, differing federal and state OHWM determinations.

7-4. High Tide Line (HTL) and Related High Water Definitions. The high tide elevations depicted in Figure 7-2 are not consistently defined or measured throughout CONUS. High water tidal reference datums may be based on observed gage data, predicted tide models, or, in some cases, on visual estimates. Tidal datums based on reduced observations from federal or state gages are the most reliable and defensible. Predicted high tide levels based on NOAA models (TCARI, VDatum, etc.) would be next in reliability. Estimated tidal datum levels would be the most difficult to authenticate.

a. 33 CFR 328.3 definition of High Tide Line. The term "High Tide Line" (labeled as "Highest Tide Annual" in Figure 7-2) is defined in 33 CFR 328.3 as "... the line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The HTL may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The HTL encompasses spring high tides [MHWS] and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm."

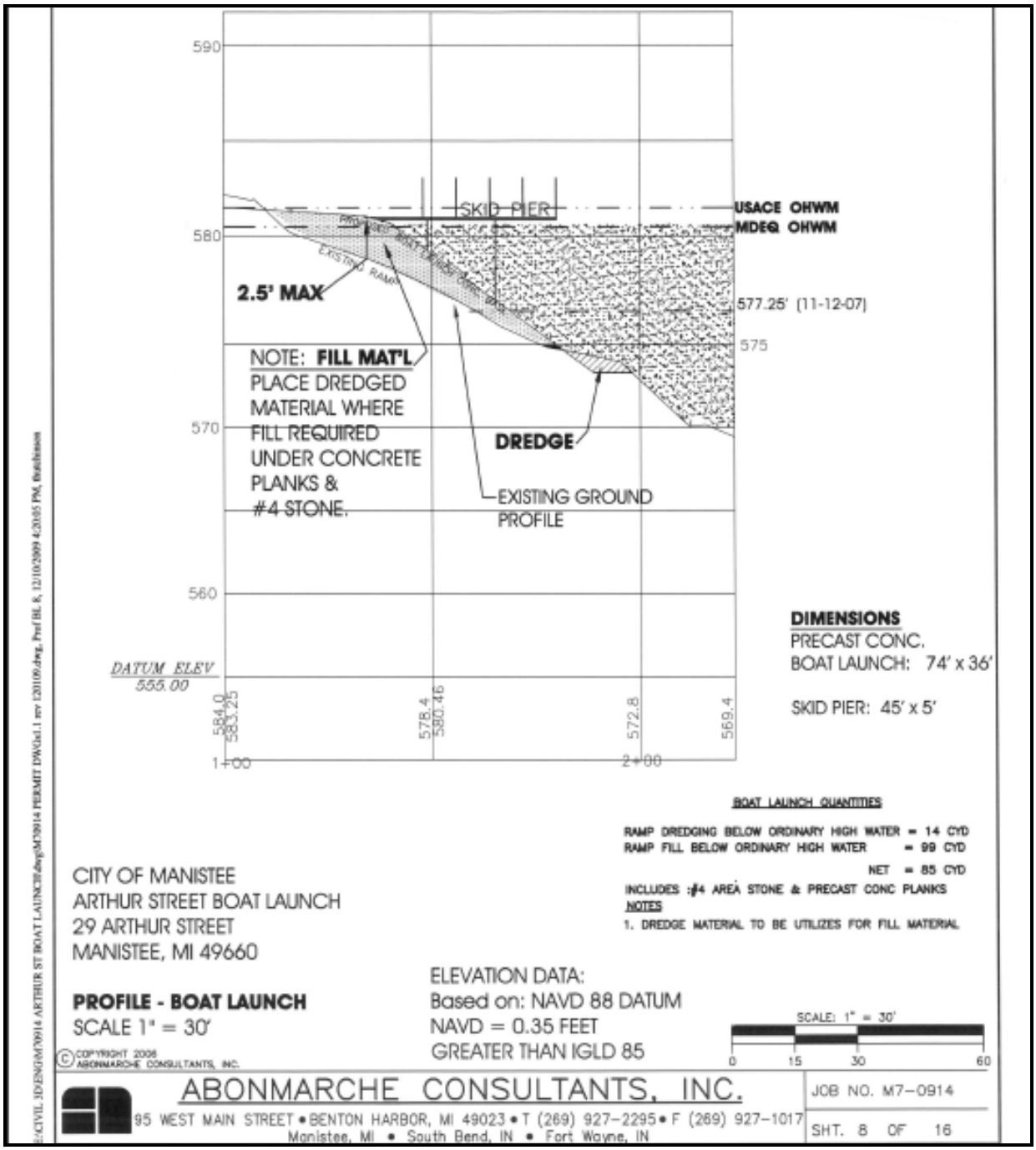

Figure 7-3. Federal (USACE) and State (Michigan Department of Environmental Quality) OHWM datums at Manistee, Michigan permit application site.
(USACE OHWM—elevation 581.5 ft).
Note that NAVD88 is 0.35 ft greater than IGLD85 (577.5 ft). (Detroit District)

(1) The preceding 33 CFR 328.3 definition implies High Tide Lines may be based on measured Spring Tides—i.e., Mean High Water Springs, or MHWS—at a local gage station.

33 CFR 328.3 notes "other high tides that occur with periodic frequency." These "other high tides" might be locally interpreted to include Mean High Water (MHW), Mean Higher High water (MHHW), or perhaps Highest Astronomical Tide (HAT). MHHW is below MHWS. HAT would represent the maximum tidal heights exclusive of storm surges. Local usage will determine which of these tidal datums should be used to define a permit limit on the shoreline. Regardless of the reference datum, it should be based on a firm mathematical computation from gage data, as illustrated for Spring High Water Tides (SHWT) below.

(2) It should be noted that MHW and MHHW datums are determined from all observed tides, including storm surge or other weather effects—the 33 CFR 328.3 definition excludes storm surge tides. By using mean values over a 19-year period, the effect of tides biased by weather effects (both extreme highs and extreme lows) are averaged out.

(3) Highest Astronomical Tide (HAT) is not based on observed gage data but is defined as the individual highest and lowest predicted tides over the NTDE 1983-2001 time period using the NOAA tide prediction procedures. NOAA predicted tides, including HAT, do not include daily and weekly weather effects in their elevations, but do include annual and semi-annual constituents that are driven by average seasonal changes in mean sea level.

b. Spring High Water Tides. Spring tides of increased range occur semimonthly as the result of the Moon being new or full. The spring range of tide is the average range occurring at the time of spring tides and is most conveniently computed from the harmonic constants. It is larger than the mean tide range (Mn) where the type of tide is either semi diurnal or mixed, and is of no practical significance where the type of tide is predominantly diurnal. The average height of the high waters of the spring tides is called Spring High Water Tides (SHWT) or Mean High Water Springs (MHWS), and the average height of the corresponding low waters is called Spring Low Water or Mean Low Water Springs (MLWS). Reference "*Tidal Datums and Their Applications*" (NOAA 2001).

(1) Historically, the international community, when it used Mean Low Water Springs (MLWS) as a chart datum, derives it by MLWS = Z0 - (M2 + S2), or the sum of the amplitudes of the semidiurnal (Z0) and solar M2 and S2 harmonic constituents below a mean value. Likewise, MHWS = Z0 + (M2 + S2). So high water spring tide datums are not based on tabulation of observations, but on harmonic analysis of observations.

(2) NOAA does not publish MHWS at its NWLON tide gage stations. However, they do publish the Spring Tide Ranges for selected prediction stations. The Spring Tide Range can be used to approximate the MHWS range by adding half the Spring Tide Range to the Mean Tide Level published for a gage station. This is only applicable for semi-diurnal tides—Spring Tide Ranges are not published for areas of diurnal tides (most of the Gulf of Mexico, etc.). In diurnal or mixed tide regions, the Highest Astronomical Tide (HAT) could be considered in lieu of MHWS because it can be determined the same way regardless of type of tide.

c. Mean High Water datum.. Mean High Water (MHW) is a reference for Section 10 boundaries— labeled as "Mean High Tide" in Figure 7-2. MHW datum is defined as the average

height of all high waters at a tide station referenced to a 19-year period—see Chapter 2. MHW datum is always below HTL.

d. Non-tidal wetland. A non-tidal wetland is defined as a wetland (i.e., a water of the United States) that is not subject to the ebb and flow of tidal waters. Non-tidal wetlands contiguous to tidal waters are located landward of the high tide line (e.g., the Spring High Tide Line).

e. Tidal wetland. A tidal wetland is a wetland (i.e., a water of the United States) that is inundated by tidal waters—reference 33 CFR 328.3. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Tidal wetlands are located channel ward of the high tide line (i.e., spring high tide line) and are inundated by tidal waters two times per lunar month, during spring high tides.

f. Tidal datum computations. Methods for determining tidal datums using water level gage comparison techniques are covered in state and federal publications. The primary source for most tidal datum computations is in the NOAA "*Computational Techniques for Tidal Datums Handbook Computational Techniques*" (NOAA 2003). This reference outlines methods for establishing tidal datums from gage observational data, including simultaneous comparison methods (e.g., Range-Ratio) used to transfer tidal datums from an established gage site to a remote project (permit) site. Typically, MHW datums are transferred using these simultaneous comparison methods. This NOAA manual does not cover establishment of an "Ordinary High Water Mark" (OHWM) since an OHWM demarcation is not always based on direct gage observations.

(1) The period of simultaneous gage comparisons is dependent on the distance from the site to the NWLON gage, the mean tide range, and local or individual state requirements. Simultaneous gage comparison periods of 3, 7, to 30 days are common in CONUS. Temporary staff gages may be used for short-term comparisons.

(2) Many coastal states have statutory and regulatory requirements for defining and observing new tidal datums at a project site. One example is in Florida Statutes, Chapter 177, Part II of the "*Florida Coastal Mapping Act of 1974*." Where these statues are applicable, surveyors portraying tidal elevations on permit drawings must have met the minimum technical standards prescribed in the statutes. For example, the Florida Department of Environmental Protection Chapter 177 statutes are relatively rigid regarding establishment of tidal datums, as extracted below. (Other coastal states have similar statutory or regulatory requirements.)

177.36 Work to be performed only by authorized personnel.--The establishment of local tidal datums and the determination of the location of the mean high-water line or the mean low-water line must be performed by qualified personnel licensed by the Board of Professional Surveyors and Mappers or by representatives of the United States Government when approved by the department.
177.37 Notification to department.--Any surveyor undertaking to establish a local tidal datum and to determine the location of the mean high-water line or the mean low-water

line shall submit a copy of the results thereof to the department [Department of Environmental Protection].within 90 days after the completion of such work, if the same is to be recorded or submitted to any court or agency of state or local government.

177.38 Standards for establishment of local tidal datums.--
(1) Unless otherwise allowed by this part or regulations promulgated hereunder, a local tidal datum shall be established from a series of tide observations taken at a tide station established in accordance with procedures approved by the department. In establishing such procedures, full consideration will be given to the national standards and procedures established by the National Ocean Service [NOAA CO-OPS].
(2) Records acquired at control tide stations, which are based on mean 19-year values, comprise the basic data from which tidal datums are determined.
(3) Observations at a tide station other than a control tide station shall be reduced to mean 19-year values through comparison with simultaneous observations at the appropriate control tide stations. The observations shall be made continuously and shall extend over such period as shall be provided for in departmental regulations.
(4) When a local tidal datum has been established, it shall be preserved by referring it to tidal bench marks in the manner prescribed by the department.

g. Survey procedures. Once a computed tidal datum at a site is established on a gage reference PBM, the MHW, MLW, or MHWS demarcation line can be staked out using total stations, differential levels, or RTK/RTN methods. On critical projects, the local gage PBMs should be set at stable locations for future reference and use in construction. Surveyed horizontal relationships between demarcation lines and PBMs to property corners are also normally required. CORS/OPUS techniques may be employed if a general NAD83 mapping reference is required—see Chapter 3.

7-5. Boundary Uncertainties Due to Water Level Datum Errors. The uncertainty in the value of a water level datum (e.g., MLW, MHW, OHWL, MTL) translates into a horizontal uncertainty of the location of a marine boundary when the datum line is surveyed to the land—reference "*Tidal Datums and Their Applications*" (NOAA 2001). Table 7-2 expresses the uncertainty in the marine boundary as a function of the slope (or grade) of the land. The greatest errors in the determination of a marine boundary occur for relatively flat terrain, which is characteristic of broad sections of the Atlantic and Gulf Coasts.

Table 7-2. Error in Position of Marine Boundary as a Function of the Slope of the Land given a 0.1 ft Vertical Datum Error. (Source: NOAA 2001)

Slope %	Degree of Slope (degrees)	Horizontal Error [1] (feet)
0.1	0.05	106
0.2	0.1	49
0.5	0.3	20
1.0	0.6	10
2.0	1	5
5.0	3	2
10.0	6	1
50.0	27	0.2
100.0	45	0.1

[1] error = 0.1 ft x cot (slope in degrees)

For example, a ±0.1 ft error in transferring a tidal datum from a gage to a project site on a 2% grade will equate to a ±5 ft horizontal error of the boundary demarcation line. This ± 0.1 ft "relative" uncertainty in a tidal datum does not include the regional (or global) uncertainty of the datum at the master gage. See Chapters 4 and 9 for discussions on the absolute and relative accuracies and uncertainties of tidal datums. If the tidal epoch at the project site has not been updated to the current epoch, then the error at this 2% grade site could be (+) 14 ft—14 ft landward given a 0.25 ft apparent sea level rise between epochs. The impact of these horizontal uncertainties (or biases) may or may not be significant, depending on the nature of a dredge or fill permit.

7-6. Section 10 Authority: Geographic and Jurisdictional Limits of Oceanic and Tidal Waters. Section 10 of the Rivers and Harbors Appropriations Act of 1899 (33 U.S.C. 403) requires approval prior to the accomplishment of any work or placement of any structure in navigable waters of the United States, or which affects the course, location, or condition of such waters with respect to navigable capacity. Typical activities requiring Section 10 permits include construction of piers, wharves, bulkheads, dolphins, marinas, ramps, floats intake structures, cable or pipeline crossings, and dredging and excavation. A Section 10 permit is required for all work, including structures, seaward of the "annual high water line" (e.g., MHW) in navigable waters of the United States, defined as waters subject to the ebb and flow of the tide, as well as a few of the major rivers used to transport interstate or foreign commerce. An example of a Section 10 project is shown in Figure 7-4.

a. Ocean and coastal waters. The navigable waters of the United States over which USACE regulatory jurisdiction extends include all ocean and coastal waters within a zone three

geographic (nautical) miles seaward from the baseline (The Territorial Seas). Wider zones are recognized for special regulatory powers exercised over the outer continental shelf. (See 33 CFR 322.3(b)).

(1) Baseline defined. Generally, where the shore directly contacts the open sea, the line on the shore reached by the ordinary low tides (e.g., MLW) comprises the baseline from which the distance of three geographic miles is measured. The baseline has significance for both domestic and international law and is subject to precise definitions. Special problems arise when offshore rocks, islands, or other bodies exist, and the baseline may have to be drawn seaward of such bodies.

(2) Shoreward limit of jurisdiction. Regulatory jurisdiction in coastal areas extends to the line on the shore reached by the plane of the mean (average) high water—i.e., Mean High Water (MHW). Where precise determination of the actual location of the line becomes necessary, it must be established by survey with reference to the available tidal datum, preferably averaged over a period of 18.6 years. Less precise methods, such as observation of the "apparent shoreline" which is determined by reference to physical markings, lines of vegetation, or changes in type of vegetation, may be used only where an estimate is needed of the line reached by the MHW.

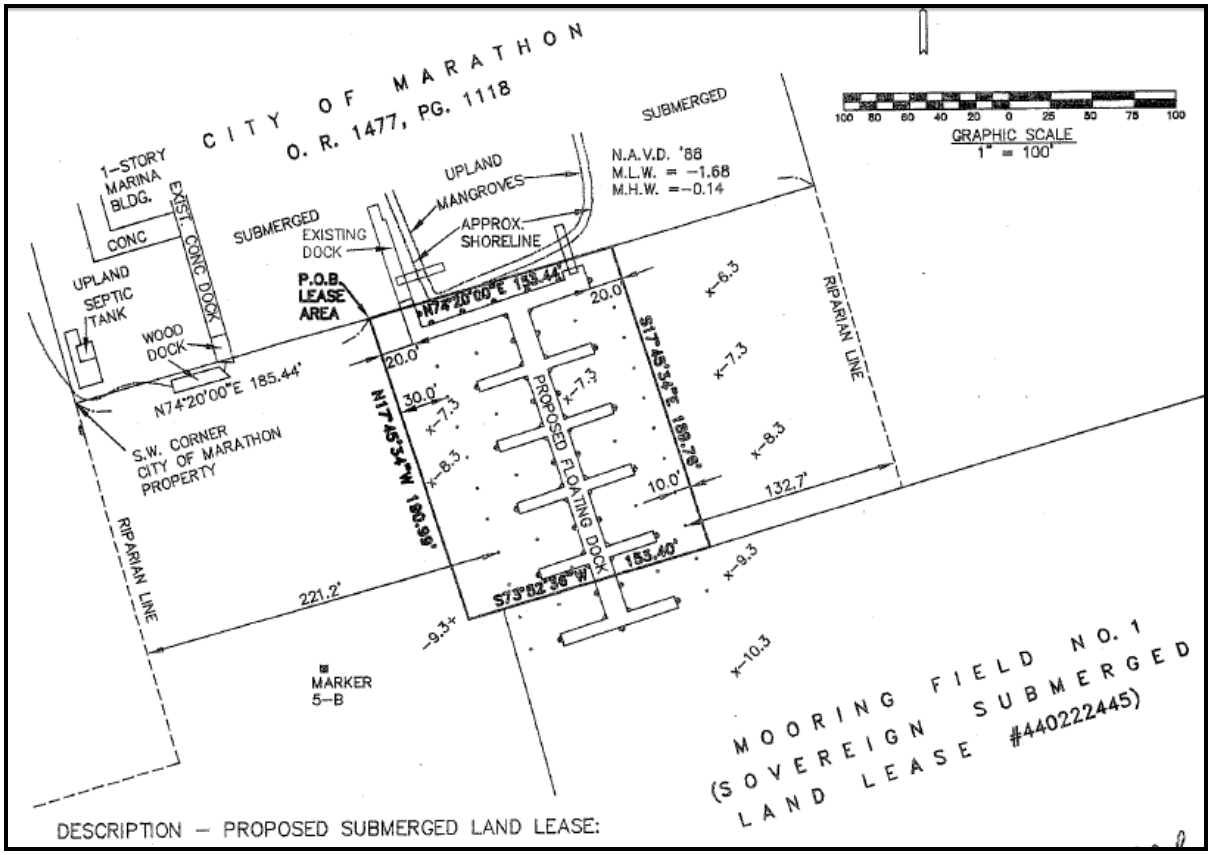

Figure 7-4. Example of Section 10 permit application with tidal datums and elevations referenced to NAVD88. (Jacksonville District)

b. Bays and estuaries. Regulatory jurisdiction extends to the entire surface and bed of all water bodies subject to tidal action. Jurisdiction thus extends to the edge of all such water bodies, even though portions of the water body may be extremely shallow, or obstructed by shoals, vegetation, or other barriers. Marshlands and similar areas are thus considered "navigable in law," but only so far as the area is subject to inundation by the mean high waters. The relevant test is therefore the presence of the mean high tidal waters, and not the general test described above, which generally applies to inland rivers and lakes.

c. Tidal datum computations. Methods for determining MHW tidal datums at remote sites using simultaneous comparison techniques were outlined in paragraph 7-4. Required tidal observation periods are highly site dependent—based on tide range and distance between the comparison gage and site.

7-7. Section 404 Authority: Limits of Jurisdiction—Dredged or Fill Material. Section 404 of the Clean Water Act of 1977 (33 U.S.C. 1344) regulates the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other U.S. waters. Jurisdictional boundaries relative to tidal and non-tidal waters are defined below. Typical activities requiring Section 404 permits include depositing of fill or dredged material in waters of the U.S. or adjacent wetlands, site development fill for residential, commercial, or recreational developments (see Figure 7-5), construction of revetments, groins, breakwaters, levees, dams, dikes, and weirs, and placement of riprap and road fills.

a. Territorial Seas. The limit of jurisdiction in the territorial seas is measured from the baseline in a seaward direction a distance of three nautical miles. (Reference 33 CFR 329.12)

b. Tidal Waters of the United States. The landward limits of jurisdiction in tidal waters:

(1) Extends to the "high tide line" (HTL), or

(2) When adjacent non-tidal waters of the United States are present, the jurisdiction extends to the limits identified in paragraph (c) of this section.

c. Non-Tidal Waters of the United States. The limits of jurisdiction in non-tidal waters:

(1) In the absence of adjacent wetlands, the jurisdiction extends to the OHWM, or

(2) When adjacent wetlands are present, the jurisdiction extends beyond the OHWM to the limit of the adjacent wetlands.

(3) When the water of the United States consists only of wetlands, the jurisdiction extends to the limit of the wetland.

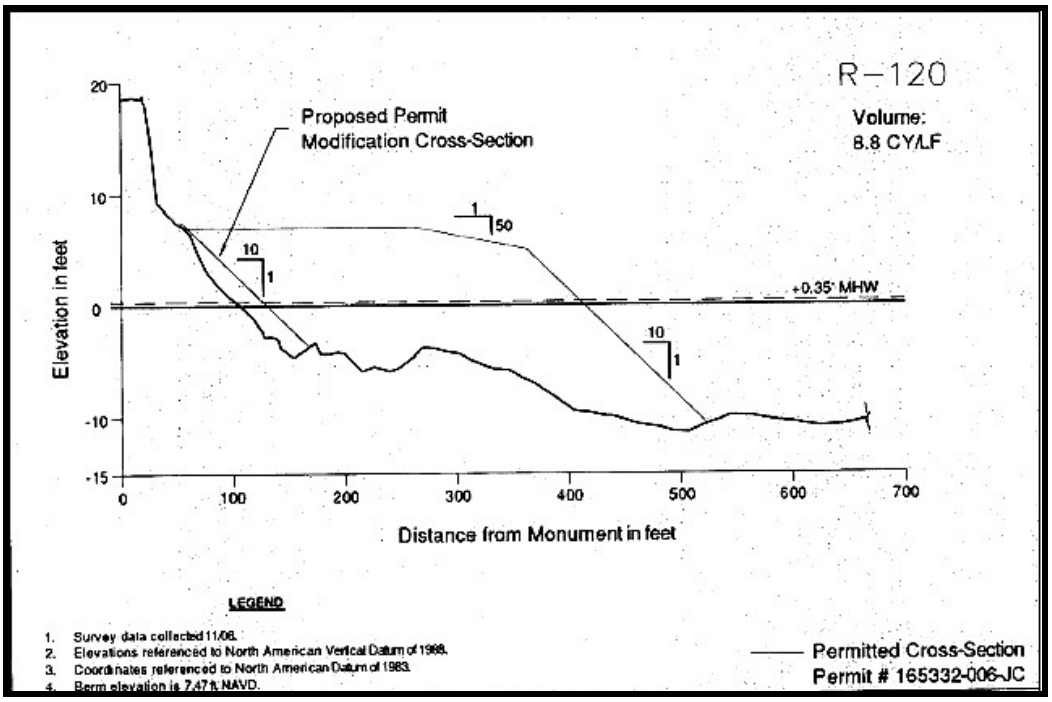

Figure 7-5. Sample Section 404 and Section 10 permit application—beach renourishment project. Cross-section and berm elevations are referenced to NAVD88. MHW relationship above NAVD88 is indicated. (The HTL is not indicated).

7-8. Section 103 Authority: Ocean Dumping of Dredged Material. Section 103 authority in the Marine Protection, Research and Sanctuaries Act (33 U.S.C. 1413), and related statutes, involves permits for ocean dumping in confined disposal sites. Vertical reference datums on these permits may be either orthometric or tidal. It is desirable that the datums be on the latest epochs and the orthometric-tidal relationship be specified. Section 103 permits can also involve a variety of site dependent parameters and restrictions. Those significant to geodetic datums involve dredge positioning/monitoring systems that record dredge/scow positions and changes in draft—e.g., the USACE "Silent Inspector" system. Currently many dredge control systems are positioned using RTK techniques. Thus, dredge draft and/or hopper drag arm elevations can be directly related to the orthometric, ellipsoidal, or tidal datum. Ocean disposal restrictions may involve both horizontal and vertical height restrictions, in addition to various turbidity and biologic criteria. Deep ocean sites (i.e., > 100 ft) may require periodic monitoring surveys to check for material dispersion.

7-9. Marine Boundaries in Coastal Areas Defined by Tidal Datums. The following material in this section is excerpted from NOAA 2001. It provides an overview of the marine boundaries defined by tidal datums in the various states.

a. General. Chart datum, MLLW, is the elevation of the baseline for many marine boundaries, including most which are recognized by the United Nations Convention on the Law of the Sea. However, baselines may differ in position for the purposes of different statutes. The

baselines (see Figure 7-6) usually consist of points or line segments on these tidal datum lines from which the marine boundaries are measured and constructed.

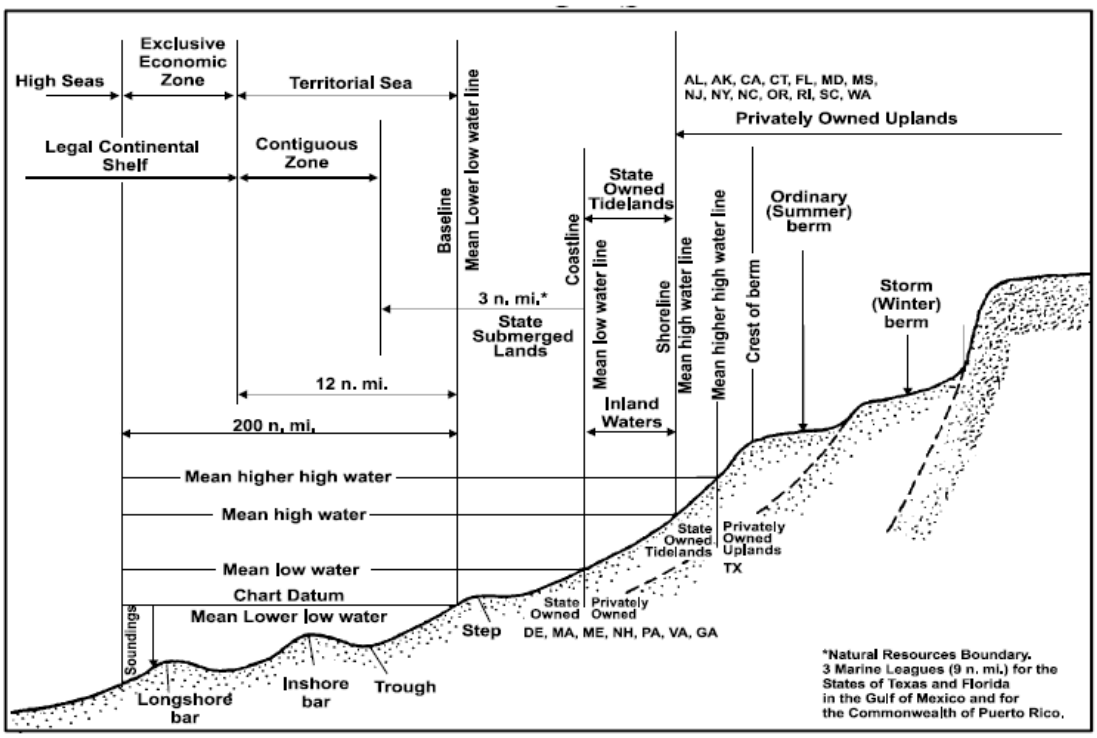

Figure 7-6. The principal tidal datums related to a beach profile. The intersection of the tidal datum with land determines the landward edge of a marine boundary.

b. Marine boundaries. As delineated in Figure 7-6, the marine boundaries of the U.S. are:

(1) Private U.S. property exists in most cases landward of MHW.

(2) State-owned tidelands exist between MHW and MLW in most cases. Refer to Figure 7-6 for individual cases. U.S. Inland Waters are concurrently defined to exist between MHW and MLW for the purpose of marine navigation.

(3) A state's "Submerged Lands Boundary" extends seaward three nautical miles from MLW, except for Texas and the Gulf coast of Florida where it terminates at nine nautical miles. In this band, plus the state-owned tidelands, the states exercise the "Public Trust Doctrine," subject to federal supremacy.

(4) The "Territorial Sea Boundary" extends 12 nautical miles seaward of MLLW. It is also known as the Marginal Sea, Marine Belt, Maritime Belt, 12-Mile Limit, and Adjacent Sea Boundary. Historically, this boundary was three nautical miles; it was changed to its present 12-mile limit in 1988. In the Territorial Sea, the sovereignty of the nation extends to the airspace above, the subsoil, the water, and the resources.

(5) The "Contiguous Zone Boundary" occurs at 12 nautical miles from MLLW. In the U.S., the Territorial Sea and Contiguous Zone are coterminous. In the contiguous zone, the nation may exercise rights to protect its interests, but does not exert sovereign control. The main purpose of the contiguous zone is to exert control over shipping near a nation's coast. Under the United Nations Convention on the Law of the Sea, a coastal nation may declare a Contiguous Zone between 12 and 24 nautical miles.

(6) The 200-mile "Fishery Conservation Zone" extends seaward from MLLW.

(7) The Presidential Proclamation 5030 of March 1983, established the "Exclusive Economic Zone" (EEZ), which claimed rights to living and mineral resources and jurisdiction of approximately 3.9 billion acres. The baseline for demarcation of the EEZ is the MLLW boundary of the Territorial Sea and extends 200 nautical miles. It should be noted that different coastal nations have different definitions of their ordinary low water. These definitions are not usually consistent with NOS definitions.

c. Mean High Water Line. The Mean High Water Line (MHWL) is the coastal boundary between private and state property with the following exceptions:

(1) Maine, New Hampshire, Massachusetts, Pennsylvania, Delaware, Virginia, and Georgia use the Mean Low Water Line (MLWL).

(2) Texas uses the Mean Higher High Water Line (MHHWL) when Spanish or Mexican grants are involved.

(3) Louisiana has adopted the civil law boundary of the line of highest winter tide.

(4) In Hawaii, the upland owner has title to the upper reaches of the wash of the waves.

d. Demarcation of MHWL. In order to map tidal boundaries such as MHWL or MLWL, and determine the latitude and longitude coordinates of their intersection with the coast, the surveyor performs the following basic procedures:

(1) Obtain the published bench mark information at or near the location.

(2) Find the tidal bench marks and run a closed line or loop of differential levels from the bench marks to that part of the shore where the boundary is to be located, run levels along the shoreline, and mark or stake points at intervals along the shore in such a manner that the ground at each point is at the elevation of the tidal datum.

(3) If the boundary is to be mapped, the horizontal distances and directions, or bearings, between each of these points and between those points or features in the area, and between the points and the horizontal control stations are measured so that the boundary may be plotted on a plat or map to the exact scale ratio and in true relation to other boundaries.

7-10. Permit Application Checklist. Table 7-3 outlines some reference datum issues that may warrant review on a permit application.

Table 7-3. Permit Application Checklist for Issues Relating to Geospatial Datums.

Reference Bench Mark for Project Site Surveys
- Datum noted
- Elevation of bench mark noted
- NSRS PID noted, if applicable
- If legacy reference datum (e.g., NGVD29) relationship to NAVD88 identified
- If pool/reservoir/river stage, relationship to NAVD88 identified

Topographic Surveys
- Reference datum identified
- Reference bench mark identified
- Horizontal reference datum identified
- Quantity take off metadata/source noted
- Survey date & source metadata noted

Boundary Survey
- Survey conforms to state minimum technical standards, as applicable

Tidal Datum Transfers
- Primary reference gage identified
- Tidal epoch noted
- Local site gage PBM noted
- Datum transfer to project site meets state minimum technical standards, as applicable
- Datum transfer computation metadata identified

7-11. Example: Sections 10 and 404 Permit Application Involving Tidal Limits. The following example is excerpted from a permit application submitted to the Jacksonville District. The permit involved a bulkhead relocation and fill in Florida tidal waters. This permit is typical of applications for fill in navigable waters or wetlands below the high tide line or MHW line. Some aspects in this example are simulated since this particular permit application did not detail the specific procedures used in transferring tidal datums from an established NOAA NWLON gage.

a. Background. The following general description of the project is excerpted from the permit application and subsequent District technical reviews and findings.

> *"Project Description: The applicant proposes to construct a bulkhead 9 to 27 feet water ward in front of an existing bulkhead and fill approximately 1,660 square feet of waters of the United States with approximately 187.5 cubic yards of fill material to extend the yard.*

Statutory authority: Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act of 1972, as amended.

The existing project area consists of open water and inundated floodplain classified as estuarine, subtidal, unconsolidated bottom. The on-site vegetation consists of water oak (Quercus nigra), arrowhead (Sagittaria lancifolia), wild taro (Colocasia esculenta) and other emergent vegetation. The onsite vegetative communities were classified according to the Florida Department of Transportation's Florida Land Use, Cover and Forms Classification System.

The waters of the United States (wetlands) at the site consist of the tidal floodplain of Doctors Lake, a navigable water of the United States. Doctors Lake is an elongated 3,500 acre embayment situated on the west side of the St. Johns River. It is situated in the tidal, brackish part of the Lower St. Johns River Basin (LSJRB). The lake is about five (5) miles long by one (1) mile wide, connected to the St. Johns River by an approximately 0.25 mile wide opening at its northeast end. Doctors Lake has no freshwater tributaries, making tidal exchange with the St. Johns River the lake's largest source of water ... Tidal currents play an important role in determining estuarine water quality. Tidal currents that flow into Doctors Lake on flood tide and out during ebb tide dilute and transport pollutants over each tidal cycle and thereby flush the system. Tidal circulation provides the dominant flushing mechanism in the lake. The tidal prism or the volume of water exchanged during each half tidal cycle plays an important role on tidal circulation. Reduction of intertidal shoreline can reduce the total prism of water exchanged."

Figure 7-7 depicts the project location relative to the St. Johns River, which flows into the Atlantic Ocean some 30 miles downstream of the permit site. An historic NOAA tide gage station is located directly across the lake from the permit site. Tidal bench marks at this gage site have been connected to the NSRS and have reliable NAVD88 adjusted elevations.

b. Permit site plan details. Figure 7-8 (excerpted from the original permit application) shows the plan layout of the existing bulkhead and proposed extended bulkhead into tidal waters. The "MHW" contour in depicted in plan, along with Section A-A. The section A-A view notes the elevations of MHW and HTL. The source of the elevations was noted as a tidal PBM at NOAA tide gage 872 0406 (DOCTORS LAKE, PEORIA POINT). Elevations were referenced to NGVD29. NAVD88 control is readily available—a previous permit may have been referenced to NGVD29. There was no indication of the source of the HTL elevation (1.71 ft above NGVD29). No metadata was included in the permit detailing the source of the Mean High Water contour depicted in the plan view. It is presumed this underwater contour was derived from a topographic/boundary survey of the site performed prior to the permit application.

Figure 7-7. Permit site and reference NOAA gage locations in tidal inlet.

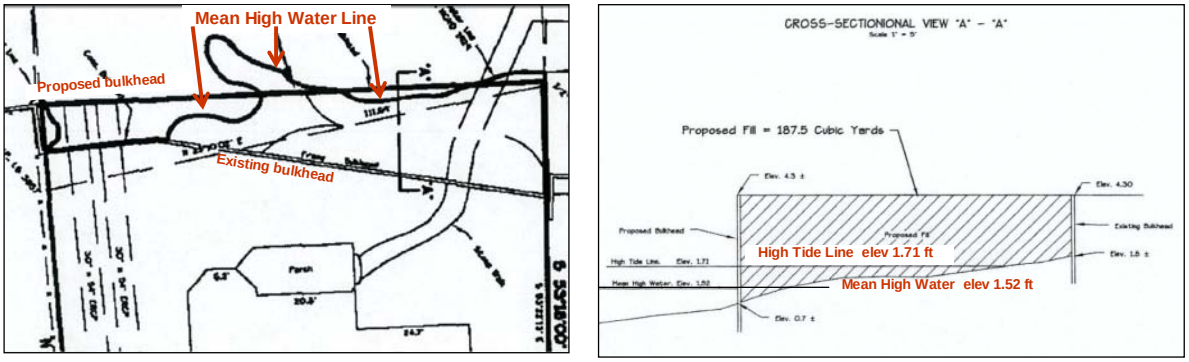

Figure 7-8. Permit site: plan and section views.

Figure 7-9. Apparent surface elevations above surveyed MHW and HTL elevations.

c. NOAA datasheet for gage station 872 0406. The data in Figure 7-10 is taken from the NOAA tide gage directly across the lake from the project site. This data would be used to compare or transfer tidal datums from the gage site to the permit site, as outlined below.

```
 Tidal datums at DOCTORS LAKE, PEORIA POINT based on:

     LENGTH OF SERIES:      5 MONTHS
     TIME PERIOD:           June 1978 - October 1978
     TIDAL EPOCH:           1983-2001
     CONTROL TIDE STATION:  8720496 GREEN COVE SPRINGS, ST. JOHNS R.

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

     MEAN HIGHER HIGH WATER (MHHW)                =  0.278 [0.91 ft]
     MEAN HIGH WATER (MHW)                        =  0.257 [0.84 ft]
     MEAN TIDE LEVEL (MTL)                        =  0.136 [0.45 ft]
     MEAN SEA LEVEL (MSL)                         =  0.130
     NORTH AMERICAN VERTICAL DATUM-1988 (NAVD)    =  0.117 [0.38 ft]
     MEAN LOW WATER (MLW)                         =  0.014
     MEAN LOWER LOW WATER (MLLW)                  =  0.000

National Geodetic Vertical Datum (NGVD 29)
Bench Mark Elevation Information           In METERS above:

     Stamping or Designation               MLLW        MHW

     0406 C 1978                            3.878    3.621
     0406 A 1978                [10.12 ft]  3.084    2.827
     0406 D 1978                            6.638    6.381
```

Figure 7-10. NOAA datasheet for tide gage 872 0496 (Doctors Lake, Peoria Point).

d. NGS datasheet for Tidal Bench Mark 872 0406A. Figure 7-11 is excerpted directly from the NGS datasheet for PBM "872 0406A." This datasheet provides reference NAVD88 relationships at the tide gage from which differential leveling or RTK surveys can be performed. This sheet also provides the relationship between NAVD88 and NGVD29, which can be transferred to the project site.

```
BC1437  TIDAL BM     -  This is a Tidal Bench Mark.
BC1437  DESIGNATION -  872 0406 A
BC1437  PID          -  BC1437
BC1437  STATE/COUNTY-  FL/CLAY
BC1437  USGS QUAD    -  MIDDLEBURG (1993)
BC1437                         *CURRENT SURVEY CONTROL
BC1437  ___________________________________________________________________
BC1437* NAD 83(1986)-  30 07 11.     (N)    081 45 33.     (W)     SCALED
BC1437* NAVD 88      -         2.973  (meters)       9.75   (feet)  ADJUSTED
BC1437  ___________________________________________________________________
BC1437  GEOID HEIGHT-         -28.13  (meters)                      GEOID09
BC1437  DYNAMIC HT   -           2.969 (meters)       9.74  (feet)  COMP
BC1437  MODELED GRAV-     979,343.2   (mgal)                        NAVD 88
BC1437  VERT ORDER   -  FIRST     CLASS II
BC1437                           SUPERSEDED SURVEY CONTROL
BC1437
BC1437  NAVD 88 (06/15/91)    2.964  (m)         9.72   (f) UNKNOWN     1 2
BC1437  NGVD 29 (09/01/92)    3.289  (m)        10.79   (f) ADJUSTED    1 2
BC1437
BC1437.Superseded values are not recommended for survey control.
BC1437.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
BC1437.See file dsdata.txt to determine how the superseded data were derived.
```

Figure 7-11. NGS datasheet for tidal bench mark 872 0406A.

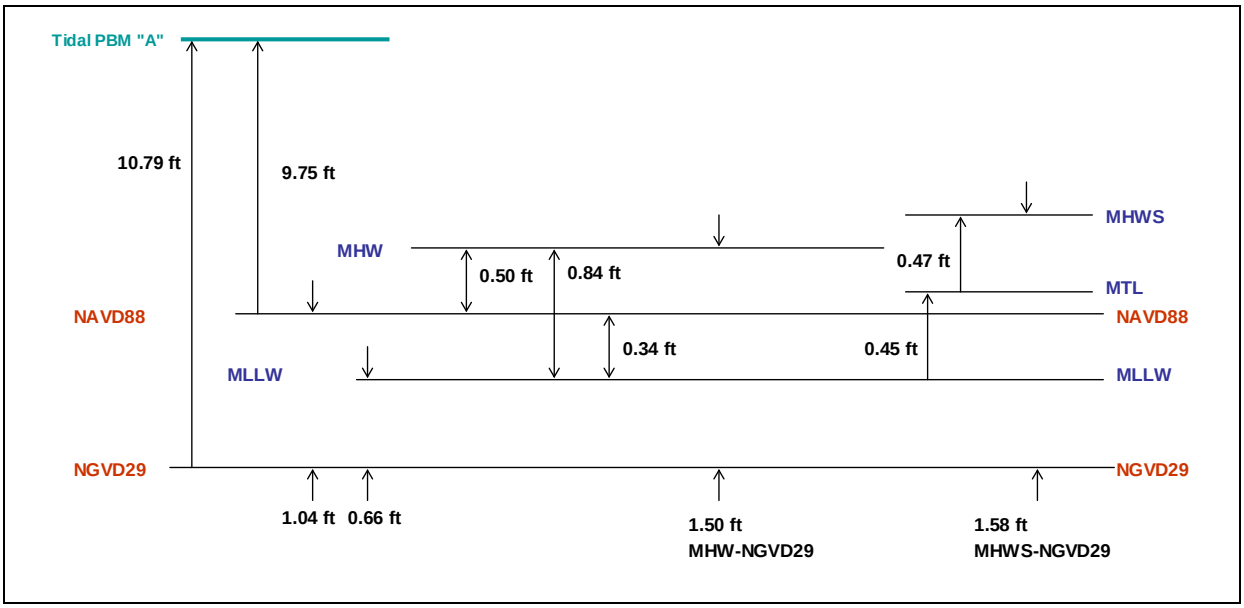

Figure 7-12. Datum relationships at the NOAA DOCTORS LAKE, PEORIA POINT gage.

e. Determining tidal datum relationships to orthometric datums. Using data from the NOAA CO-OPS gage site and the NGS tidal bench mark, the tidal reference datums at the permit site can be referenced to an orthometric datum (NGVD29 or NAVD88) as indicated in Figure 7-12 and the following computations.

(1) MHW elevation relative to NGVD29.

Tidal PBM "A" elevation 10.79 ft above NGVD29 (from NGS Datasheet)
Tidal PBM "A" elevation 9.75 ft above NAVD88 (from NGS Datasheet)

NAVD88 - NGVD29:	(+)	1.04 ft	(concluded from above)
NAVD88 - MLLW:	(-)	0.38 ft	(from CO-OPS Datasheet)
MHW - MLLW:	(+)	0.84 ft	(from CO-OPS Datasheet)
MHW above NGVD29:		1.50 ft	

Similarly, MHW datum can be related to NAVD88:

MHW - MLLW:	(+)	0.84 ft	(from CO-OPS Datasheet)
NAVD88 - MLLW:	(-)	0.38 ft	(from CO-OPS Datasheet)
MHW above NAVD88:		0.46 ft	

(2) High Tide Line (HTL) determination. As stated earlier, the permit application did not indicate the source of the HTL elevation (1.71 ft above NGVD29) shown on the section view. Since the HTL is approximately related to MHWS datum, NOAA station prediction data may be used to estimate the MHWS elevation. The following data in Figure 7-13 is taken from the NOAA tidal predictions for this gage site:

FLORIDA, St. Johns River Predictions Station	Latitude	Longitude	Mean Range (ft)	Spring Range (ft)	Mean Tide Level (ft)
Peoria Point, Doctors Lake	30° 07.2'	81° 45.5'	0.80	0.93	0.45

Figure 7-13. NOAA tidal predictions for Doctors Lake.

(3) Estimated High Tide Line based on NOAA published Spring Tide Range relative to Mean Tide level published on the CO-OPS station Datasheet.

One-half of 0.93 ft Spring Tide Range above Mean Tide Level:	(+)	0.47 ft	(from NOAA Station Predictions)
Mean Tide Level above MLLW:	(+)	0.45 ft	(from CO-OPS Datasheet)
MLLW above NGVD29:	(+)	0.66 ft	
Mean High Water Spring above NGVD29:		1.58 ft	(slightly above 1.57 ft MHHW) (the diurnal range is 0.91 ft)
(or MHWS is 0.58 ft above NAVD88)			

(4) An elevation difference of 0.13 ft exists between the permit HTL (1.71 ft) and the HTL computed from NOAA MHWS estimate (1.58 ft). If this elevation disparity were deemed significant at a project site, then NOAA CO-OPS would need to be contacted to obtain a MHWS computation from the original gage observations—in this case, from the 1978 series.

f. Transferring tidal datum elevations to a permit site. Three options would exist to transfer tidal datums from a remote gage to the project site—the permit site in this example.

(1) Perform simultaneous tide gage comparisons between NOAA gage and a temporary gage at the permit site. Given the relatively short distance (1 mile) between the gage site and the permit site, an accurate "water level transfer" of datums between the sites could be easily accomplished. In this jurisdiction, State of Florida approval for a gaging transfer would be required. Three-day staff readings would likely suffice for the datum transfer, given the short distance. For more remote project sites that are distant from the reference gage, longer comparison tide readings may be required.

(2) Run differential levels from the NOAA gage site to the permit site. In this example, a six to seven mile level line would be required around the lake to connect the sites—a 12 to 14 mile level line loop. Maintaining 0.1 ft loop closures over this distance would be problematic; thus, differential leveling over this distance may not be as effective as water transfer or GPS methods.

(3) Perform differential GPS surveys to transfer elevations from the tidal PBMs to the permit site. A static GPS baseline would effectively and accurately transfer tidal datums over this short 1-mile distance. Given the short distance, rapid/fast-static methods would also suffice. Longer baseline lengths would require full static GPS baseline observations.

On this particular site, option (3) above would likely represent the most cost-effective method for transferring tidal datums to the permit site. This transfer could be performed in less than 4 hours time. Leveling would take at minimum 2 days and water level transfer 3 days. For more distant project sites from the reference gage, option (1) would represent the preferred choice, given use of hydraulic comparisons as opposed to geodetic comparisons. Option (2) is only effective over short distances.

7-12. References.

33 U.S.C. 403
Rivers and Harbors Act of 1899 (Section 10)

33 U.S.C. 1344
Clean Water Act of 1972, as amended, (Section 404)

33 U.S.C. 1413
Marine Protection, Research, and Sanctuaries Act of 1972 (Section 103)

33 CFR 328
Navigation and Navigable Waters, Definition of Waters in the United States