DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

November 7, 2014

Planning and Environmental Branch

Mr. Tom McGill
Chief, Ocean, Wetlands and Stream Protection Branch
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street, SW
Atlanta, Georgia 30303-8960

Dear Mr. McGill:

Enclosed is a Section 103, Tier I Evaluation prepared on behalf of the Military Ocean Terminal, Sunny Point (MOTSU), Southport, North Carolina. This Evaluation addresses the suitability for ocean disposal of dredged material from regular maintenance of the facility. On behalf of MOTSU, we request your concurrence that the proposed ocean disposal of dredged material complies with the Ocean Dumping Regulations and Criteria.

This Criteria Compliance Evaluation evaluates existing information for the proposed dredging project including previously collected physical, chemical, and biological data. Furthermore, the present Evaluation updates previous determinations that sediments dredged from MOTSU are acceptable for transportation for ocean dumping under Section 103 of the Marine Protection Research and Sanctuaries Act of 1972, as amended.

If you have any questions, please contact Mr. Justin Bashaw, Environmental Resources Section, at Justin.P.Bashaw@usace.army.mil, or you may call him at (910) 251-4581.

Sincerely,

Elden J. Gatwood

Elden J. Gatwood
Chief, Planning and Environmental Branch

Enclosure

WILMINGTON DISTRICT
SOUTH ATLANTIC DIVISION

US Army Corps of Engineers ®

SECTION 103 TIER 1 EVALUATION OF DREDGED MATERIAL PROPOSED FOR OCEAN DISPOSAL

MILITARY OCEAN TERMINAL, SUNNY POINT
SOUTHPORT, NORTH CAROLINA

NOVEMBER 2014

Table of Contents

1.0 Purpose 1
2.0 Project Description 1
2.1 Description of Project Site 1
2.2 Description of New Wilmington ODMDS 2
2.3 Environmental Documents Addressing MOTSU and Wilmington Harbor Federal Navigation Project Dredging Programs 2
2.3.1 Disposal 7
2.3.2 Dredging Methods 7
2.4 Beneficial Uses of Dredged Material 7
2.5 Maintenance Dredging 7
2.6 Historical Testing 8
3.0 Need for Sediment Evaluation 10
3.1 Exclusionary Criteria 10
3.2 Upland Sources of Pollutants 10
3.3 Need for Ocean Dumping 11
4.0 Section 103 Disposal Criteria Compliance Evaluation – Tier I 11
4.1 Evaluation of Existing Information: 12
4.1.1 Review of Sediment Chemical Analyses 20
4.1.2 Review of Water Column Determinations 31
4.1.3 Review of Liquid – Suspended Particulate Phase Bioassays 31
4.1.4 Review of Benthic Determinations (Whole Sediment Bioassay) 36
4.1.5 Review of Benthic Bioavailability (Bioaccumulation) Evaluation 38
4.2 Recent Spills, Releases, and Discharges in MOTSU Vicinity 47
4.3 MPRSA Section 103 Ocean Disposal Criteria Compliance Evaluation 53
4.3.1 Subpart A – General 53
4.3.2 Subpart B – Environmental Impact 53
4.3.3 Subpart C – Need for Ocean Dumping 55
4.3.4 Subpart D – Impacts of the Proposed Dumping on Aesthetic, Recreational, and Economic Values 56
4.3.5 Subpart E – Impact of Proposed Dumping on Other Uses of the Ocean 57
5.0 Conclusions 57
6.0 References 58

1.0 Purpose

The U.S. Environmental Protection Agency's (USEPA) Ocean Dumping Regulations and Criteria (40 CFR 220-228) require in Part 225 that applications and authorizations for Dredged Material Permits under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), as amended, for transportation of dredged material for the purpose of dumping it in ocean waters will be evaluated by the U.S. Army Corps of Engineers (USACE) in accordance with criteria set forth in Part 227. Additionally, a Memorandum of Understanding between the USACE and USEPA on Ocean Dredged Material Disposal requires that re-evaluation of routine maintenance dredged sediments occur on a periodic basis in order to document the continued suitability of dredged material for ocean disposal. In accordance with these criteria, the following is an assessment of transportation of dredged material from Military Ocean Terminal, Sunny Point (MOTSU) to the New Wilmington Offshore Dredged Material Disposal Site (ODMDS) for the purpose of ocean disposal.

2.0 Project Description

2.1 Description of Project Site

MOTSU is located in Southport, Brunswick County, North Carolina, on the west bank of the Cape Fear River, approximately 10 miles upstream from the river's mouth (Figures 1, 2). Port facilities include three wharves approximately 2,500 feet long and three interconnected basins 800 feet in width and varying from 2,800 feet to 4,100 feet in length. The entrance channels have bottom widths of 300 feet. Project depth is 38 feet mean lower low water (mllw) plus 2 feet of overdepth for all navigation facilities except the north basin which is dredged to 34 feet mllw plus 2 feet of overdepth. The two maintained entrance channels (the south and center entrance channel) connect the MOTSU facilities to the Wilmington Harbor Federal navigation channel. The Wilmington Harbor Federal navigation channel is a 30.8-mile-long channel 500 feet wide through the Cape Fear River ocean bar, then up the river 400 feet wide to Wilmington, North Carolina. The Wilmington Harbor Federal navigation channel depth is currently 44 feet mllw at the ocean bar and 42 feet upstream to Wilmington. Table 1 shows the authorized maintenance depths, overdepth, and basin/channel widths for the MOTSU and Wilmington Harbor Federal Navigation Project channels discussed in this evaluation.

Table 1. Authorized Maintenance Depths.

MOTSU Basin and Channel Dredging Depths			
Reach	**Nominal Depth (ft)**	**Allowable Overdepth (ft)**	**Nominal Basin/Channel Width (ft)**
Basin - S	38	2	800
Basin - C	38	2	800
Basin - N	34	2	800
Entrance Channel 1	38	2	300
Entrance Channel 2	38	2	300
Entrance Channel 3	38	2	300
Connecting Channel	38	2	300
Adjacent Wilmington Harbor Federal Navigation Channel Dredging Depths			
Reach	**Nominal Depth (ft)**	**Allowable Overdepth (ft)**	**Nominal Channel Width (ft)**
Fourth East Jetty	42	2	500
Upper Brunswick Chanel	42	2	400
Lower Brunswick Channel	42	2	400
Upper Big Island Channel	42	2	510 - 700
Lower Big Island Channel	42	2	400
Keg Island Channel	42	2	400
Upper Lilliput Channel	42	2	400
Lower Lilliput Channel	42	2	600
Upper Midnight Channel	42	2	600
Lower Midnight Channel	42	2	600

2.2 Description of New Wilmington ODMDS

The New Wilmington ODMDS (Figure 3) was designated by USEPA pursuant to Section 102 of the MPRSA as suitable for ocean disposal of dredged material. The Final Rule was promulgated by USEPA on 05 July 2002 (FR. Vol. 67 No. 129), effective 05 August 2002. The New Wilmington ODMDS, Site Management and Monitoring Plan (SMMP) was most recently updated in December 2012. Location is approximately 5 miles offshore of Bald Head Island, NC and area is 9.4 square nautical miles. Bottom elevations range from -52 to -35 feet MLLW.

The capacity of the New Wilmington ODMDS is approximately 166 million cubic yards based on a fill to -30 feet MLLW. A specific disposal zone within the New Wilmington ODMDS is planned for MOTSU material use.

2.3 Environmental Documents Addressing MOTSU and Wilmington Harbor Federal Navigation Project Dredging Programs

The following environmental documents address aspects of the MOTSU and Wilmington Harbor Federal Navigation Project dredging programs, respectfully.

MOTSU:

U.S. Army Corps of Engineers, Wilmington District. 1972. Final Environmental Statement, Military Ocean Terminal, Sunny Point, North Carolina. Prepared by Coastal Zone Resources Corporation, Wilmington, North Carolina. May 1972.

U.S. Army Corps of Engineers, Wilmington District. 1980a. Environmental Assessment, Use of Disposal Area 4 Military Ocean Terminal, Sunny Point, Brunswick County, North Carolina. April 1980.

U.S. Army Corps of Engineers, Wilmington District. 1980b. Environmental Assessment, Ocean Dumping, Military Ocean Terminal, Sunny Point, Brunswick County, North Carolina. July 1980.

U.S. Army Corps of Engineers, Wilmington District. 1984. Environmental Assessment, Clamshell Dredging, Military Ocean Terminal, Sunny Point, North Carolina. September 1984.

U.S. Army Corps of Engineers, Wilmington District. 1994. Final Environmental Impact Statement, Harbor Improvements, Military Ocean Terminal, Sunny Point, North Carolina. November 1994.

Wilmington Harbor Federal Navigation Project:

U.S. Army Corps of Engineers, Wilmington District. 1989. Final Environmental Impact Statement, Long-Term Maintenance of Wilmington Harbor, New Hanover and Brunswick Counties, North Carolina. October 1989.

U.S. Army Corps of Engineers, Wilmington District. 1996. Final Supplement I To The Final Environmental Impact Statement For Wilmington Harbor Channel Widening, New Hanover and Brunswick Counties, North Carolina. June 1996.

U.S. Army Corps of Engineers, Wilmington District. 2000a. Environmental Assessment, Preconstruction Modifications of Authorized Improvements, Wilmington Harbor, North Carolina. February 2000.

U.S. Army Corps of Engineers, Wilmington District. 2000b. Finding of No Significant Impact, Preconstruction Modifications of Authorized Improvements, Wilmington Harbor, North Carolina, August 2000.

U.S. Army Corps of Engineers, Wilmington District. 2007. Dredged Material Management Plan, Alternative Formulation Briefing, Preconference Materials, Port of Wilmington, Cape Fear River, NC. October 2007.

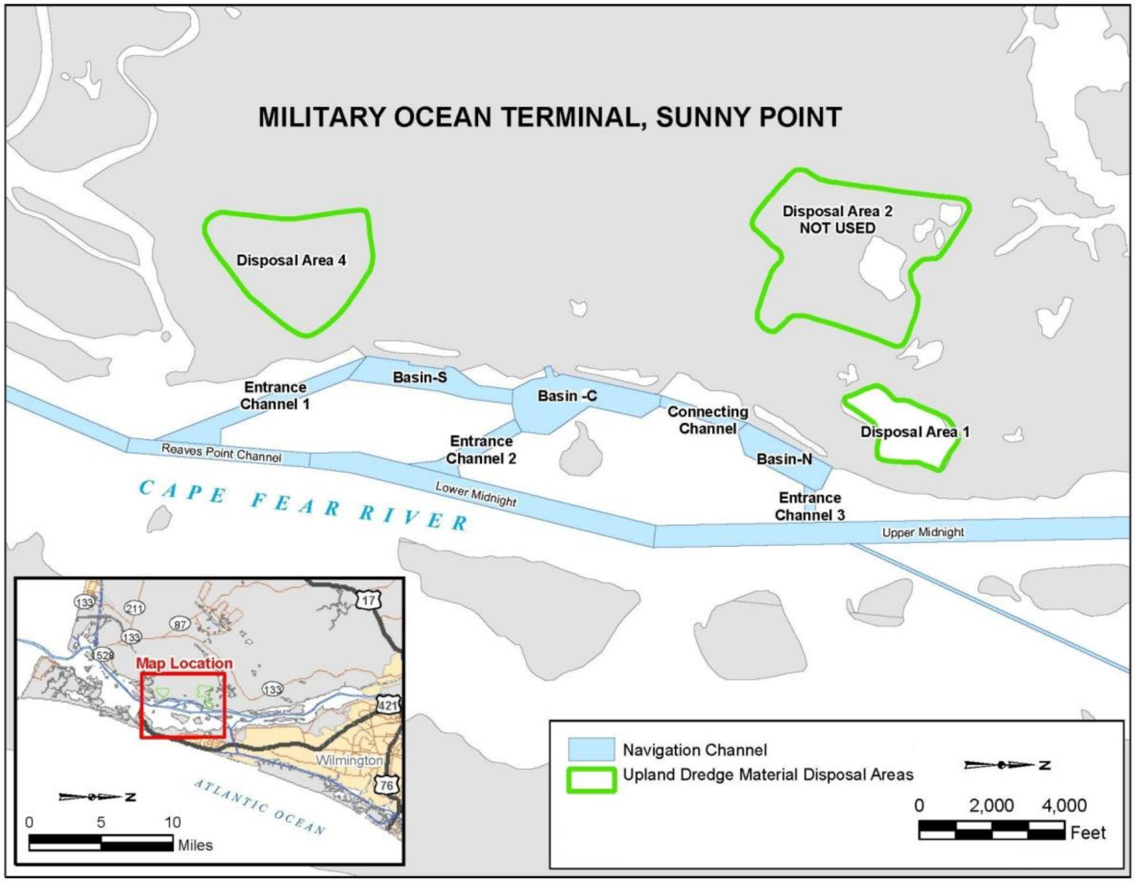

Figure 1. MOTSU Basins, Channels, and Wilmington Harbor Federal Navigation Project Channels.

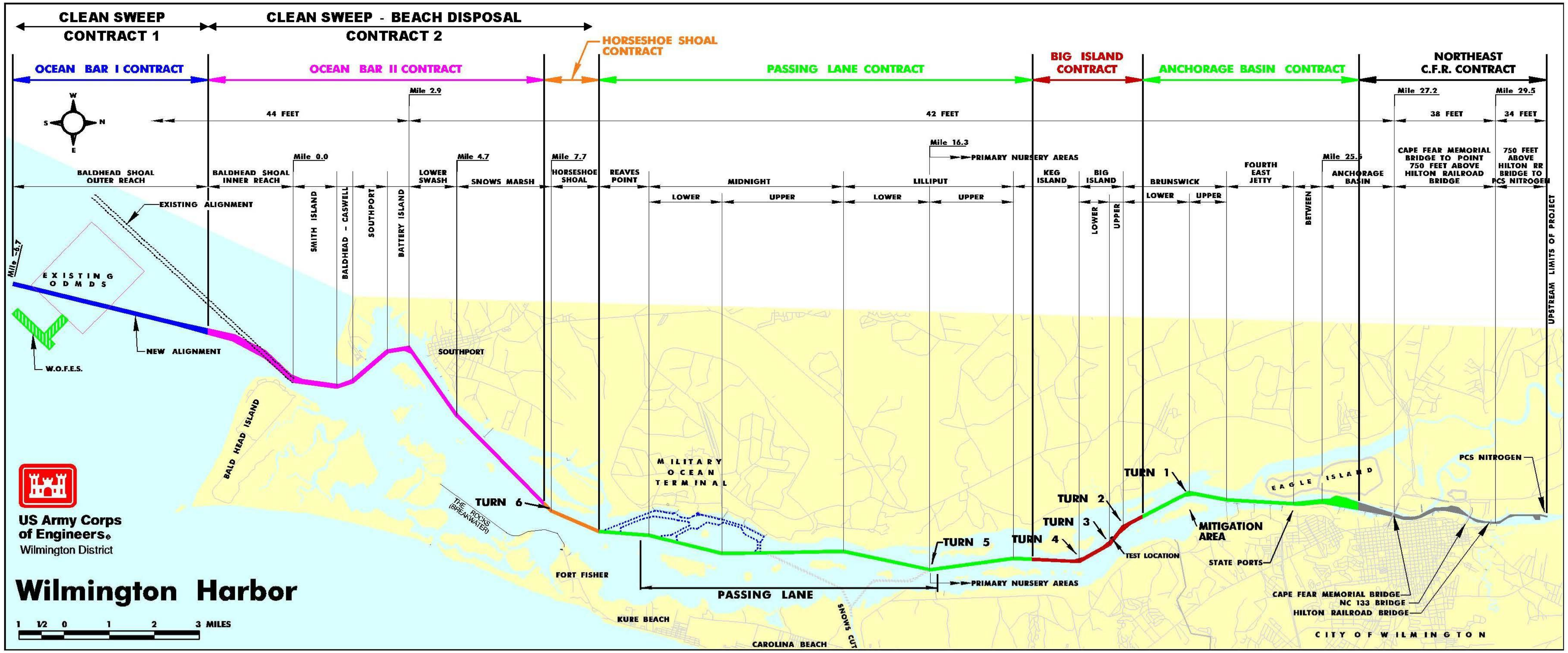

Figure 2. Wilmington Harbor Federal Navigation project reaches.

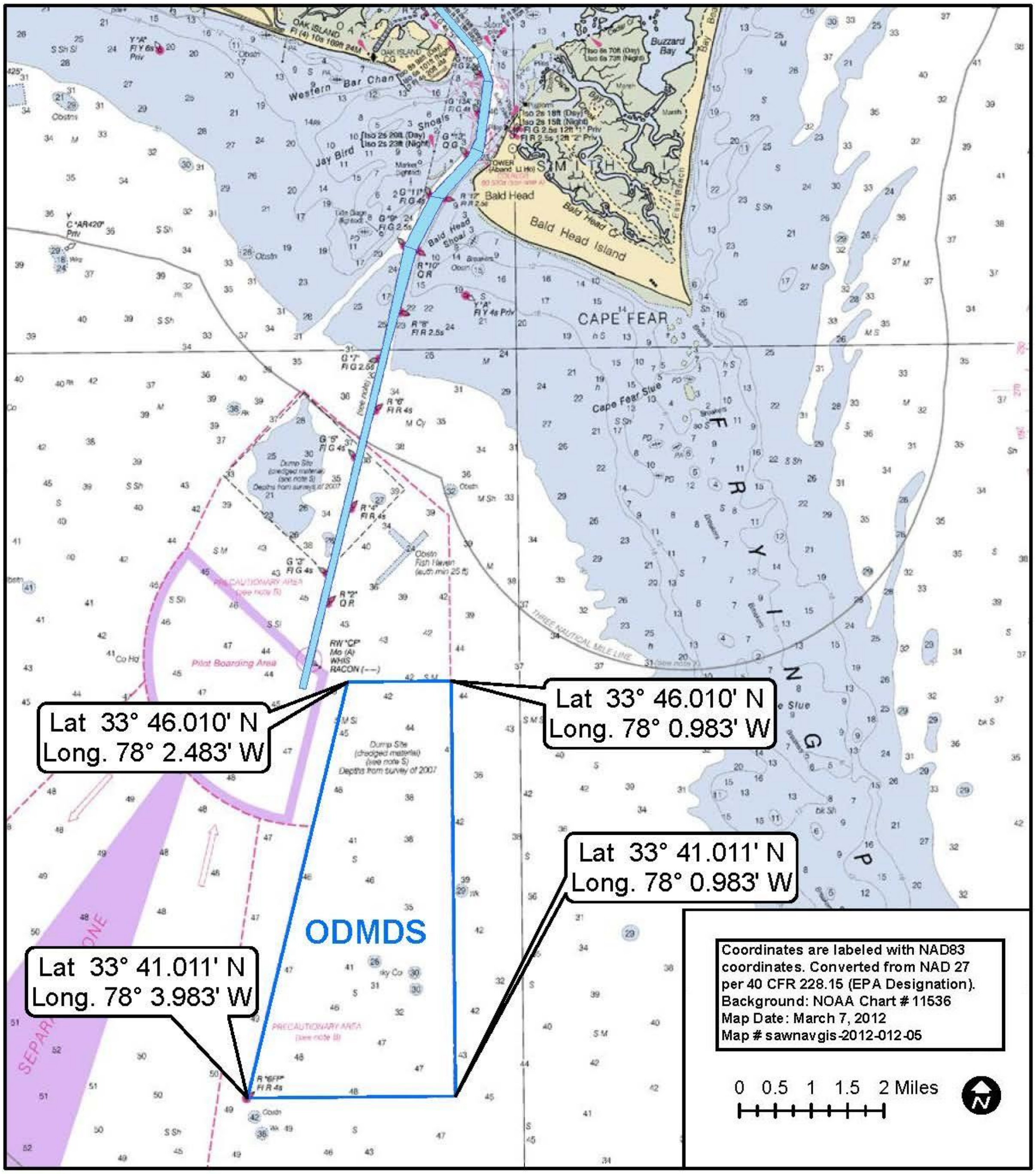

Figure 3. Location of New Wilmington ODMDS.

2.3.1 Disposal

The only, currently available, long-term dredged material disposal alternative for routine MOTSU maintenance is ocean disposal.

For MOTSU dredged material, available diked (confined) disposal capacity is extremely limited. Concerns for ground water contamination with chlorides limit the availability of new diked upland disposal facilities. Diked upland disposal area 4 (DA 4) has limited remaining capacity (1.4 million yd^3) and this disposal area has been held in strategic reserve for several years. DA 1 is full. DA 2 has not been used since 1975 because of chloride contamination to ground waters beneath and adjacent to that disposal area. There is no DA 3. Open-water disposal in the estuary (in the Cape Fear River) has not been used since approximately 1970. Open-water, estuarine dredged material disposal is not consistent with the approved North Carolina Coastal Management Program and is strongly opposed by State and Federal environmental resource agencies.

2.3.2 Dredging Methods

Since 1987, at MOTSU, dredging has been performed with a clamshell dredge, hopper dredge, or combination thereof, with ocean disposal occurring at the Wilmington ODMDS. Prior to 1987, all dredging was performed with a hydraulic pipeline dredge, with disposal either in diked upland dredged material disposal areas located on the MOTSU facility or unconfined in the Cape Fear River (USACE 2012).

2.4 Beneficial Uses of Dredged Material

Beneficial uses of the fine-grained dredged material are greatly exceeded by the quantities of material produced by MOTSU maintenance dredging requirements. The high water content, fine-grained nature of MOTSU dredged material makes beneficial uses difficult. Fine-grained dredged material previously placed within the upland diked disposal areas and dewatered has been used for construction of earthen berms at MOTSU. This dredged material has potential use as a raw material for manufactured soil or soil blocks after de-watering. The costs of these alternatives are not known but the process is likely not viable because it would require initial placement and storage in diked retaining areas, which are limited.

2.5 Maintenance Dredging

About 1 million cubic yards of silt and clay must be removed from MOTSU, principally on an annual basis, to maintain navigable conditions there. Excavation is accomplished by clamshell, hydraulic pipeline, or hopper dredge, or a combination thereof.

Likewise, the Wilmington Harbor Federal Navigation Project, known officially as the Wilmington Harbor 96 Act following the signing of the Energy and Water Appropriations Bill on October 13, 1998, and associated facilities including the North Carolina State Ports Authority (NCSPA) require annual maintenance dredging to ensure navigability and continued international commerce.

Since August 2002, which was the date of site designation, dredged materials from both Wilmington Harbor Federal Navigation Project channels and MOTSU have been placed within the New Wilmington ODMDS (Table 2).

Table 2. Dredged Material Quantity by Year

Year	Wilmington Harbor Federal Navigation Project (yd^3)	MOTSU (yd^3)	Total Material (yd^3)
2002	1,259,000	233,000	1,492,000
2003	3,165,000	0*	3,165,000
2004	95,000	0	95,000
2005	2,384,000	1,503,000	3,887,000
2006	1,680,000	0	1,680,000
2007	1,114,000	1,198,000	2,312,000
2008	138,000	934,000	1,072,000
2009	0	0*	0
2010	470,000	723,000	1,193,000
2011	360,000	429,000	789,000
2012	1,678,000	1,239,000	2,917,000
2013	0*	855,000	855,000
2014	1,067,000	0	1,067,000

* Ocean disposal crossed the calendar year. Total material reported is for year majority of work was performed.

2.6 Historical Testing

Chemical and biological analyses of MOTSU and Wilmington Federal Navigation Project sediment has been performed several times in the past. These data are presented in the following reports:

MOTSU:

Jones, Edmunds, and Associates, Inc. 1979. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment, Access Channels and Anchorage Basins, Military Ocean Terminal, Sunny Point, N. C. Prepared under Contract to the U.S. Army Corps of Engineers, Wilmington District.

Biological and Chemical Assessment of Sediments from Proposed Dredge Sites in Military Ocean Terminal Sunny Point, North Carolina, February 1989. Prepared for U.S. Army Corps of Engineers, Wilmington District by EPA, Environmental Research Laboratory, Gulf Breeze Florida.

Ecological Evaluation of Proposed Dredged Material From Wilmington Harbor and Military Ocean Terminal Sunny Point, North Carolina, July 1993. Prepared for U.S. Army Corps of Engineers, Wilmington District by Battelle, Marine Science Laboratory, Sequim, Washington.

Results of Chemical Analyses of Sediment Samples From Wilmington Harbor, North Carolina, October 1996. Prepared for U.S. Army Corps of Engineers, Wilmington District by EA Engineering, Science and Technology, Inc., Sparks, Maryland.

Analytical Characterization Report of Proposed Excavated Material at the Military Ocean Terminal Sunny Point, October 2003. Prepared for U.S. Army Corps of Engineers, Wilmington District by Normandeau Associates, Inc. Spring City, Pennsylvania.

Evaluation of Dredged Material Proposed for Ocean Disposal, Military Ocean Terminal, Sunny Point, North Carolina, October 2007. Prepared for U.S. Army Corps of Engineers, Wilmington District by ANAMAR Environmental Consulting, Inc. Gainesville, Florida.

Evaluation of Dredged Material Proposed for Ocean Disposal, Military Ocean Terminal, Sunny Point, NC, September 2011. Prepared for U.S. Army Corps of Engineers, Wilmington District by ANAMAR Environmental Consulting, Inc. Gainesville, Florida.

Wilmington Harbor Federal Navigation Project:

EG and G, Bionomics. 1978. Laboratory Evaluation of the Toxicity of Material to be Dredged from the Outer Ocean Bar of the Cape Fear River, N.C. Prepared Under Contract to the U.S. Army Corps of Engineers, Wilmington District.

Jones, Edmunds, and Associates, Inc. 1979. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment, Access Channels and Anchorage Basins, Military Ocean Terminal, Sunny Point, N.C. Prepared Under Contract to the U.S. Army Corps of Engineers, Wilmington District.

Jones, Edmunds, and Associates, Inc. 1980. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment, Smith Island and Baldhead Shoal Channels, Wilmington Harbor, N.C. Prepared by Under Contract to the U.S. Army Corps of Engineers, Wilmington District.

U.S. Army Corps of Engineers, Wilmington District. 1986. Channels, Wilmington Harbor, N.C., Appendices A and B Summarizes Chemical and Biological Analyses of Keg Island Channel Sediments. Unpublished data provided by New York Testing Laboratories, Inc. Under Contract to Wilmington District.

U.S. Environmental Protection Agency. 1989. Biological and Chemical Assessment of Sediments From Proposed Dredge Sites in Military Ocean Terminal Sunny Point, North Carolina, Prepared by Environmental Research Laboratory, Gulf Breeze, FL. Under Contract to the U.S. Army Corps of Engineers, Wilmington District. Contract to the U.S. Army Corps of Engineers, Wilmington District.

U.S. Environmental Protection Agency. 1989. Studies With Sediment From the Proposed Wilmington Harbor Passing Lane, North Carolina, and Representative Marine Organisms, Prepared by Environmental Research Laboratory, Gulf Breeze, FL. Under

U.S. Army Corps of Engineers, Wilmington District. 1993. Ecological Evaluation of Proposed Dredged Material from Wilmington Harbor and Military Ocean Terminal Sunny Point, North Carolina, July 1993. Prepared by J.A. Ward, M.E. Barrows, M.R. Pinza, and J.Q. Word, Battelle/Marine Science Laboratory, Sequim, Washington. Pacific Northwest Laboratory (PNL-8766). Under Contract to Wilmington District.

U.S. Army Corps of Engineers, Wilmington District. 1996. Results of Chemical Analyses of Sediment Samples from Wilmington Harbor, North Carolina, October 1996. Prepared by EA Engineering, Science and Technology, Inc. Under Contract to Wilmington District.

U.S. Army Corps of Engineers 2005. Maintenance and Authorized Improvements, Wilmington Harbor, North Carolina, Evaluation Pursuant to Section 103. Prepared by ANAMAR Environmental Consultants, Under Contract to the U.S. Army Corps of Engineers, Wilmington District.

Northeast Cape Fear River Turning Basin and North Carolina State Port Authority Maintenance Dredging, Wilmington Harbor, North Carolina, Evaluations Pursuant to Section 103, September 2010. Prepared by ANAMAR Environmental Consultants, Under Contract to the U.S. Army Corps of Engineers, Wilmington District.

Evaluation of Dredged Material Proposed for Ocean Disposal Maintenance of Wilmington Harbor, Wilmington, North Carolina, September 2013. Prepared by ANAMAR Environmental Consultants, Under Contract to the U.S. Army Corps of Engineers, Wilmington District.

3.0 Need for Sediment Evaluation

3.1 Exclusionary Criteria

Material dredged from MOTSU basins and navigation channels include ocean source (sandy, littoral material), river source (fine grained sands, silts, and clays derived from easily eroded soils from the upper Cape Fear River basin), and mixtures of both.

Based on the physical characteristics of MOTSU dredged materials sampled in 2007, sediment does not meet the exclusion criteria of part 227.13(b) and must, therefore, be tested in accordance with part 227.13(c) (Table 4a).

3.2 Upland Sources of Pollutants

New Hanover County and (eastern) Brunswick County drain to the Cape Fear River basin, are highly developed, and are continually growing in population. Spanning 2010-2013, the populations of New Hanover and Brunswick Counties have grown by 5.2% and 7.3%, respectively, both exceeding the average North Carolina population growth rate of 3.3% over the same period (www.census.gov). As a result, runoff from urban areas and construction areas can be expected to increase. Urban runoff contaminants may include automobile-related contaminants, household wastes, lawn-care contaminants, and human and animal wastes (failing septic systems).

Industrial facilities including NSPCA terminals, which handle containerized, roll on/roll off and breakbulk cargo, multiple waste water treatment plants, a power generation plant, a paper mill, and multiple textile and chemical manufacturing facilities may contribute to discharges and runoff to the Cape Fear River.

With respect to agriculture, large hog production facilities in Sampson and Duplin counties to the north and upstream of MOTSU and the Wilmington Harbor Federal Navigation Project may contribute to pollution as well. Best management practices for these facilities have improved n recent years.

3.3 Need for Ocean Dumping

Constructed in 1951 and opened in 1955, MOTSU is the largest military terminal in the world and is primarily responsible for the import/export of weapons, ammunition, explosives, and military equipment in support of U.S. Armed Forces overseas. A principle factor in the ability of MOTSU to accomplish its mission is the maintenance condition of the terminal's navigation basins, access channels, and berthing areas. When the MOTSU berths, basins, and channels become shoaled, the immediate capacity of the terminal to transport military materials is reduced and/or delays are incurred until full project capabilities are restored through maintenance dredging.

Upland disposal is not available or adequate for dredged materials resulting from required maintenance of MOTSU basins and navigation channels. Currently, DA 4 at MOTSU has only 1.4million yd^3 of remaining capacity. River (in water) disposal is not feasible as it is strongly opposed by State and Federal environmental resource agencies. Accordingly, continued maintenance of MOTSU basins and navigation channels depend on appropriate Ocean Disposal of dredged material.

4.0 Section 103 Disposal Criteria Compliance Evaluation – Tier I

The purpose of Tier I is to determine whether a decision on compliance within the limiting permissible concentration (LPC) can be made on the basis of existing information (USEPA and USACE 1991). Tier I is a comprehensive analysis of all existing and readily available, assembled, and interpreted information on the proposed dredging project, including all previously collected physical, chemical, and biological data. If the information set compiled in Tier I is complete and comparable to that which would appropriately satisfy Tier II, III, or IV, a decision on LPC compliance can be completed without proceeding into the higher tiers.

For an LPC evaluation to be completed within Tier I, the weight of evidence of the collected information must convincingly show that the dredged material disposal will or will not meet the LPC. If no exclusionary criteria can be met, the LPC is evaluated based on the collected information. This information must include data analysis of the toxicity and bioaccumulation potential of the dredged material and of the reference sediments. The information must also be sufficient to determine if the WQC or 1% of the LC_{50} will be exceeded in the water column following the initial mixing period.

This Section 103 Tier I Evaluation deals specifically with maintenance of MOTSU basins and navigation channels. Data pertaining to adjacent Wilmington Harbor Federal Navigation Project navigation channel reaches have been included due to their proximity and similarities in sediment character (Figure 2). Sediment physical characteristics are similar at MOTSU, referencing 2007 and 2011 sampling events (Table 4a). Additionally, MOTSU sediment toxicity has either remained relatively constant, or shown improvement between 2007 and 2011 sampling events (Tables 5a, 5d). Furthermore, 2007 MOTSU liquid-suspended particulate phase bioassays, whole sediment bioassays, and bioaccumulation analyses, and analogous analyses for adjacent 2004 and 2013 Wilmington Harbor Federal Navigation Project sample locations, all passed toxicity criteria (Tables 6, 7a, 7b, 8, 9a, 9b, 10a, 10b, 11a, and 11b).

4.1 Evaluation of Existing Information:

Chemical and biological analyses of MOTSU and Wilmington Harbor Federal Navigation Project sediments have been previously performed. These data are presented in the following reports:

MOTSU:

- Evaluation of Dredged Material Proposed for Ocean Disposal, Military Ocean Terminal, Sunny Point, North Carolina, October 2007. Prepared for U.S. Army Corps of Engineers, Wilmington District by ANAMAR Environmental Consulting, Inc. Gainesville, Florida.
- Analytical Characterization Report of Proposed Excavated Material at the Military Ocean Terminal Sunny Point, October 2003. Prepared for U.S. Army Corps of Engineers, Wilmington District by Normandeau Associates, Inc. Spring City, Pennsylvania.
- Before 2003, MOTSU sediments were sampled in 1979, 1989, 1993, and 1996.

Wilmington Harbor Federal Navigation Project:

- Evaluation of Dredged Material Proposed for Ocean Disposal Maintenance of Wilmington Harbor, Wilmington, North Carolina, September 2013. Prepared by ANAMAR Environmental Consultants, Under Contract to the U.S. Army Corps of Engineers, Wilmington District.
- Northeast Cape Fear River Turning Basin and North Carolina State Port Authority Maintenance Dredging, Wilmington Harbor, North Carolina, Evaluations Pursuant to Section 103, September 2010. Prepared by ANAMAR Environmental Consultants, Under Contract to the U.S. Army Corps of Engineers, Wilmington District.
- Evaluation of Dredged Material Proposed For Ocean Disposal, Wilmington Harbor, North Carolina, April 2005. Prepared by ANAMAR Environmental Consultants, Under Contract to the U.S. Army Corps of Engineers, Wilmington District. (Sediment samples for this evaluation were collected in July 2004)
- Before 2005, Wilmington Harbor Federal Navigation Project sediments were sampled in 1978, 1979, 1980, 1986, 1989, 1993, and 1996.

The results of 2011 and 2007, and 2013 and 2004 sampling events, for MOTSU and the Wilmington Harbor Federal Navigation Project, respectively, were reviewed and the sediment chemistry results were compared to recent results from ongoing maintenance at MOTSU and Wilmington Harbor (Table 3). The results of the sediment chemistry comparison and a summary of most recent water column, bioassay, and bioaccumulation testing for MOTSU and nearby Wilmington Harbor Federal navigation channels are provided below. USEPA has previously concurred that dredged material from MOTSU and the Wilmington Harbor Federal Navigation Project was acceptable for ocean disposal. Pre-2004 sampling data from both MOTSU and Wilmington Harbor Federal Navigation Project indicated acceptability of dredged material for ocean disposal, but was not included simply because of its age.

2011 MOTSU sampling locations are shown on Figure 4. A figure indicating 2007 MOTSU sampling locations is included as Figure 5. With the exceptions of sample MOTMA-07-N in 2007, which was a composite of 2 subsamples, and sample MOTMA-07-REF, which consisted of a single grab sample, each 2011 and 2007 MOTSU sample station represented a composite of 5 subsamples.

Sampling locations for Wilmington Harbor Federal Navigation Project are shown on Figures 6 and 7, corresponding to 2013 and 2004 sampling events, respectively. For 2013, five sample stations were established: 3 in the Upper Harbor (each represented by a composite of 5 subsamples), 2 stations in the Mid-Harbor, (each represented by a composite of 5 subsamples), and 1station in the Outer Harbor & Entrance Channel (consisting of 2 composite subsamples due to preliminary grain size analysis). For 2004, six sample stations were established: each represented by a composite of 5 core samples except for samples NECFU04 and WHREF04 (which consisted of a single sample each), and sample NECFD04 (which consisted of 2 subsamples). For the purposes of this evaluation, only Wilmington Harbor Federal Navigation Project sample locations within approximately 10 miles of MOTSU were included.

All sampling locations were established by USACE Wilmington District as representative of maintenance dredged material from each project.

Table 3. MOTSU and adjacent Wilmington Harbor Federal Navigation Project Sediment Samples; Representative Locations and Analyses Performed

Project	Sediment Collection Year	Composite Sample	Representive Location (Figures 1,2,8)*	Analyses Performed				
				Sediment Chemistry	Water Column Determinations	Liquid-Suspended Particulate Phase Bioassays	Benthic Determinations (Whole Sediment Bioassays)	Bioaccumulaton
MOTSU	2011	MOTMA11-N	MOTSU North Basin	Yes	No	No	No	No
		MOTMA11-C	MOTSU Center Basin	Yes	No	No	No	No
		MOTMA11-S	MOTSU South Basin	Yes	No	No	No	No
	2007	MOTMA-07-N	MOTSU North Basin	Yes	Yes	Yes	Yes	Yes
		MOTMA-07-C	MOTSU Center Basin	Yes	Yes	Yes	Yes	Yes
		MOTMA-07-S	MOTSU South Basin	Yes	Yes	Yes	Yes	Yes
		MOTMA-REF	Atlantic Ocean Reference	Yes	Yes	Yes	Yes	Yes
Wilmington Harbor Federal Navigation Project	2013	URCMA13	Fourth East Jetty, Upper Brunswick	Yes	Yes	Yes	Yes	Yes
		UMRMA13	Lower Brunswick, Keg Island, Upper and Lower Big Island, Upper Lilliput	Yes	Yes	Yes	Yes	Yes
		LMRMA13	Lower Lilliput, Upper Midnight, Lower Midnight	Yes	Yes	Yes	Yes	Yes
		WH-REF13	Atlantic Ocean Reference	Yes	Yes	Yes	Yes	Yes
	2004	KIBIMA04	Lower Big Island, Keg Island	Yes	Yes	Yes	Yes	Yes
		UMMA04	Upper Midnight	Yes	Yes	Yes	Yes	Yes
		WHREF04	Atlantic Ocean Reference	Yes	Yes	Yes	Yes	Yes

* See Figures 4, 5, 6, 7 for detailed sample locations.

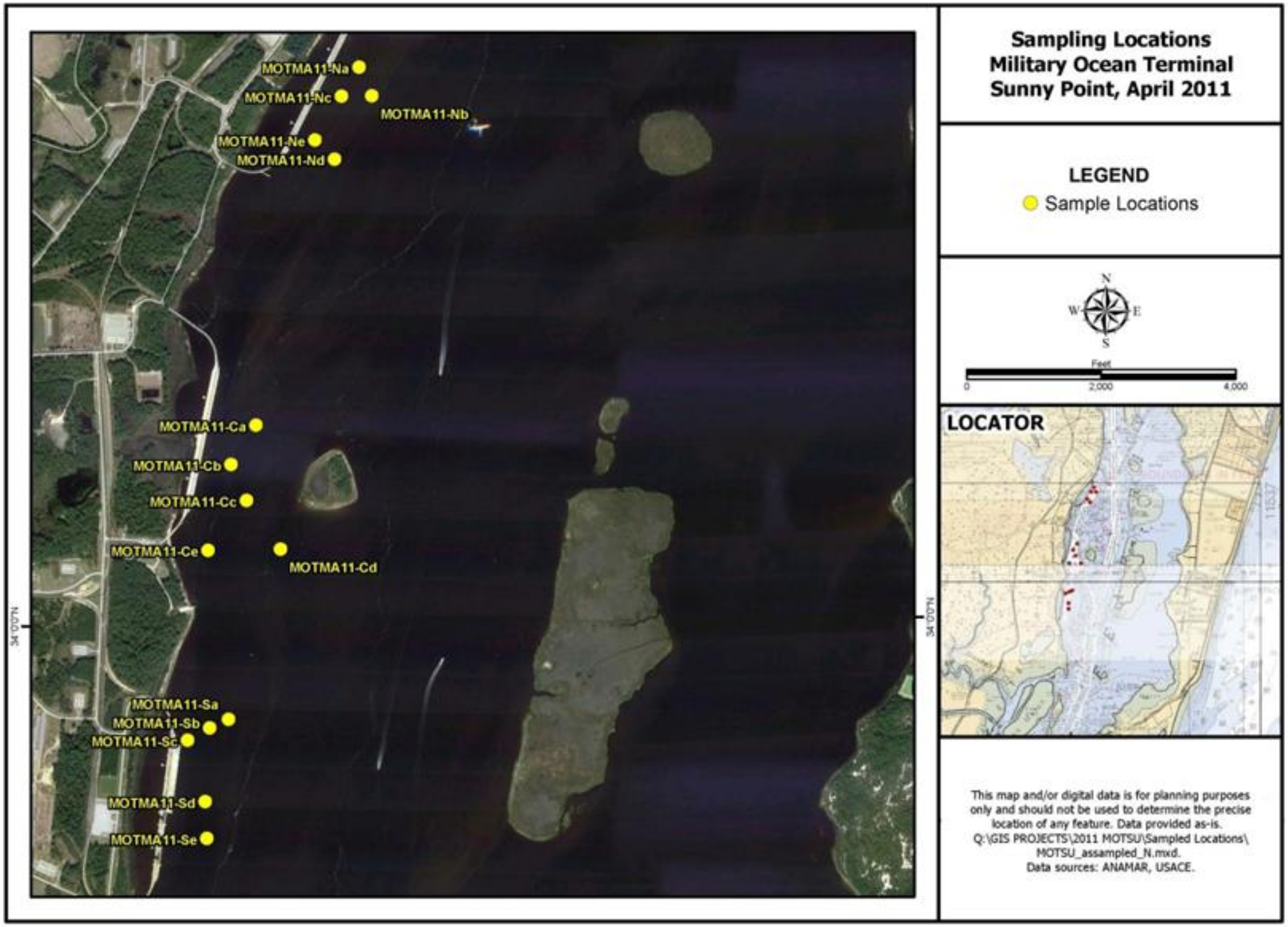

Figure 4. 2011 MOTSU Sampling Locations.

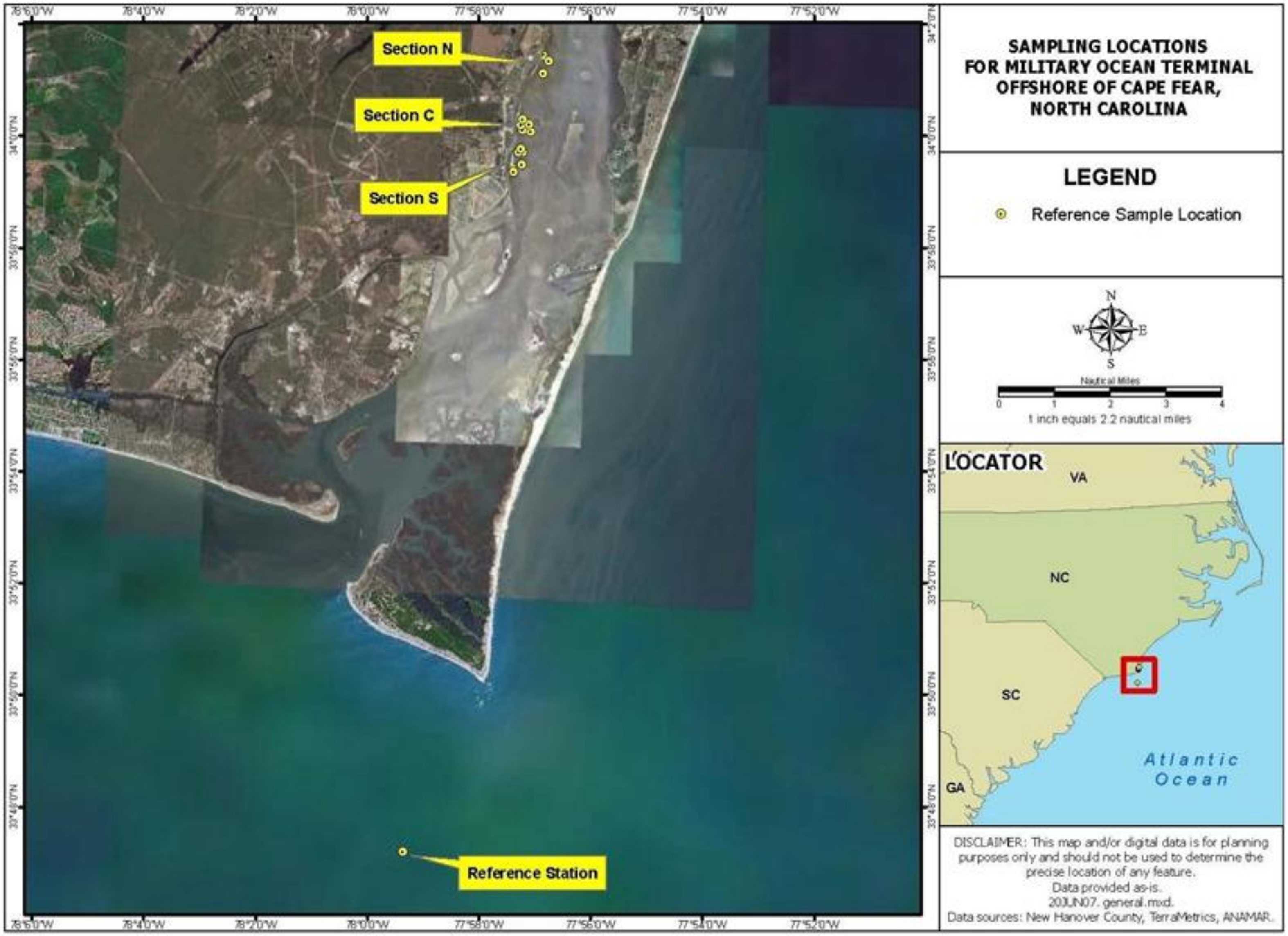

Figure 5. 2007 MOTSU Sampling Locations.

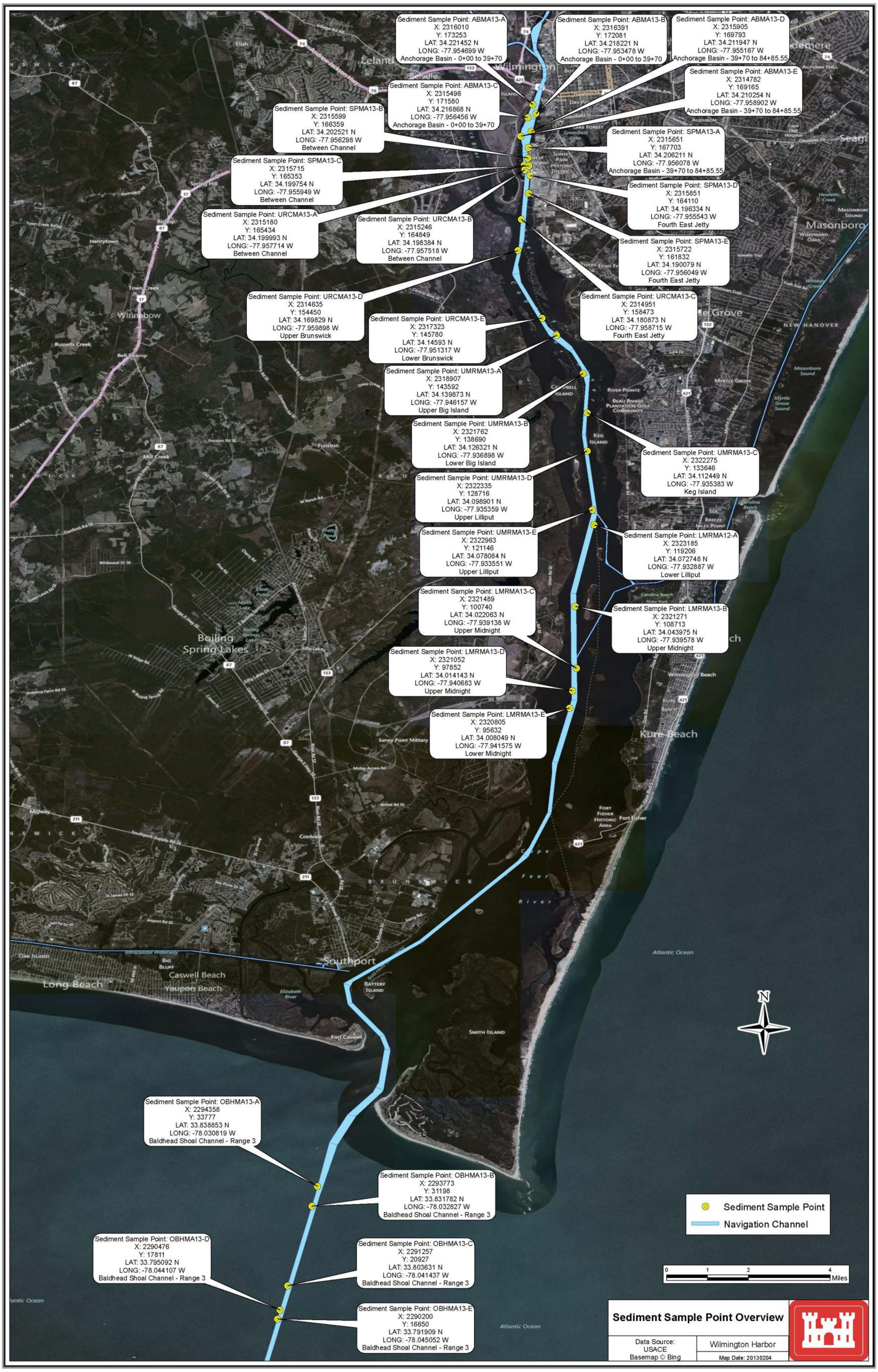

Figure 6. 2013 Wilmington Harbor Federal Navigation Project Sampling Locations (Samples named ABMA13, SPMA13, and OBHMA13 were not assessed for this present evaluation).

Figure 7. 2004 Wilmington Harbor Federal Navigation Project Sampling Locations (Samples named NECFU04, NECFD04, and ANBMA04 were not assessed for this present evaluation).

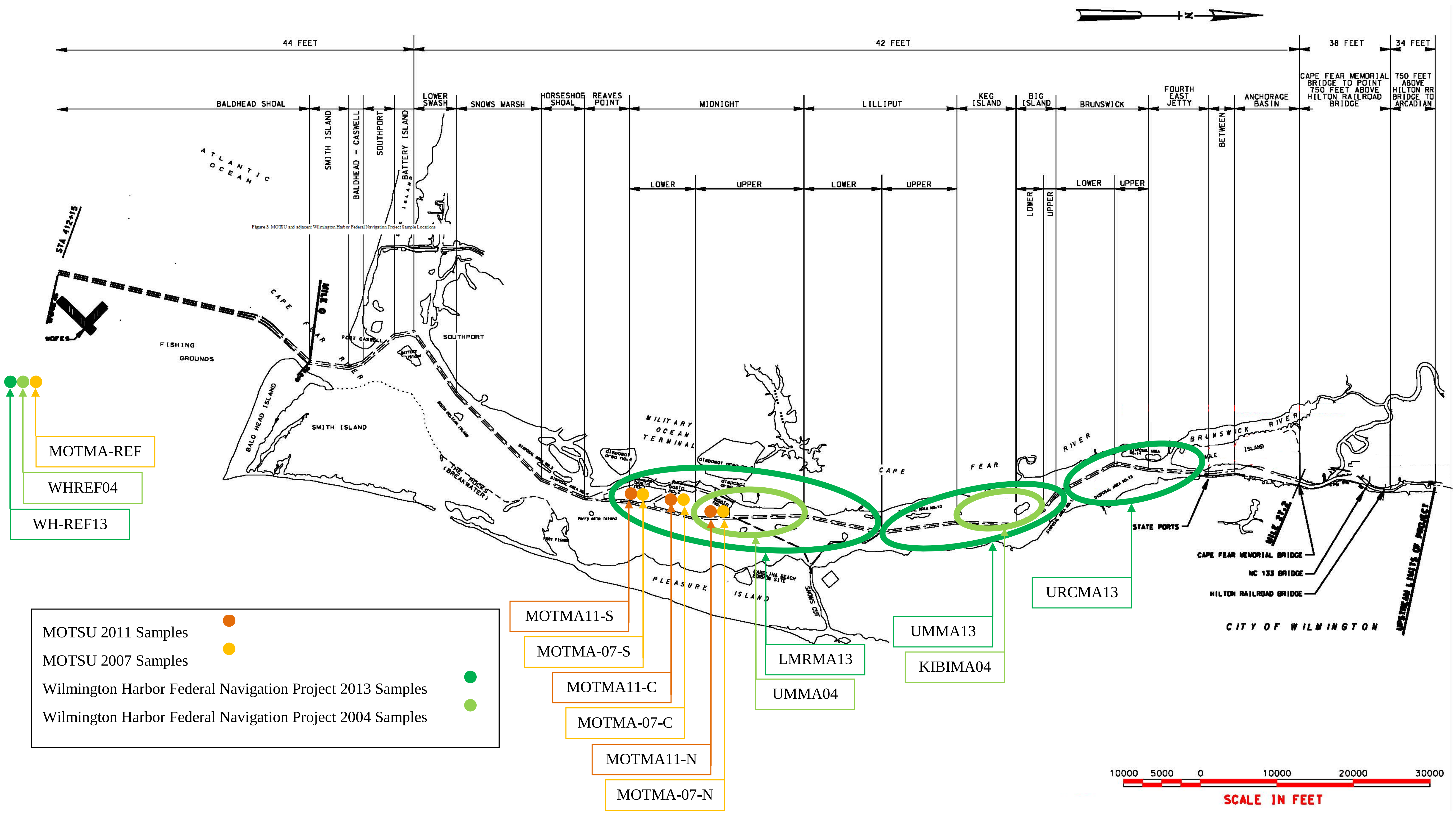

Figure 8. Approximate Sample Locations for all MOTSU and Nearby Wilmington Harbor Federal Navigation Project Referenced in This Present Evaluation

4.1.1 Review of Sediment Chemical Analyses

Sediment analyses were performed in accordance with and using published procedures. Physical characteristics of 2011 and 2007 MOTSU sediments, and adjacent 2013 and 2004 Wilmington Harbor Federal Navigation Project sediments, are shown in Tables 4a and 4b and summarized below. A comparison of 2011 MOTSU (MOTMA11-C) and 2013 Wilmington Harbor Federal Navigation Project (LMRMA13) sediment physical characteristics is shown in Table 4c.

Chemical analysis results for 2011 and 2007 MOTSU sampling events, and 2013 and 2004 Wilmington Harbor Federal Navigation Project sampling events are shown in Tables 5a and 5b, and are summarized below. A comparison of 2011 MOTSU and 2013 Wilmington Harbor Federal Navigation Project sediment chemical analysis is shown in Table 5c. A comparison of only chemical analytes which exceeded the Threshold Effects Level (TEL) for 2011 and 2007 MOTSU sediments is included as Table 5d. Sediments were analyzed for the following analytes:

Metals	Organotins
Total Organic Carbon (TOC)	Organochlorine Pesticides
Dioxins/Furans	Polychlorinated Biphenyls (PCBs) congeners
Polychlorinated Biphenyls (PCBs) aroclors	Polynuclear Aromatic Hydrocarbons (PAHs)
Total Petroleum Hydrocarbons (Oil and Grease)	

MOTSU:

Physical Characteristics: The results from the 2011 and 2007 sediment samples are consistent. Physical analysis indicated dredged materials were comprised predominately of silts.

Metals. The results from the 2011 and 2007 sediment samples are consistent. Antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, thallium, and zinc were found in each 2007 test station sample at levels higher than at the reference station. Arsenic was found at levels above the sediment screening guidelines Threshold Effects Level (TEL) and Effects Range Low (ER-L) in 2007 samples MOTMA-07-N, MOTMA-07-C, and MOTMA-07-S, and in 2011 samples MOTMA11-N, MOTMA11-C, and MOTMA11-S. Nickel was found above the TEL is 2007 sample MOTMA-07-S. For 2011 and 2007 samples, sediment from MOTSU's northern most basin contained the highest levels of most metals. With the exception of selenium, which was not detected at or above the Method Detection Limit in 2007, all metals analyzed for in 2011 samples were of a lower maximum detected concentration than in 2007.

Total Organic Carbon (TOC). The results for 2011 and 2007 sediment samples are consistent. For 2011 samples, TOC ranged from 3.32% dry (MOTMA11-N) to 2.71% dry (MOTMA11-S). In 2007, TOC ranged from 3.55% (MOTMA-07-S) to 3.94% (MOTMA-07-N).

Oil and Grease. The results for 2011 and 2007 sediment samples differ. For 2011 samples, oil and grease ranged from 900 mg/kg (MOTMA11-S) to 1100 mg/kg (MOTMA11-N). In 2007, oil and grease ranged from 210 mg/kg (MOTMA11-S) to 380 mg/kg (MOTMA11-N). Total oil and grease, at comparable sample locations, was approximately 3-fold greater in 2011 as compared to 2007.

Organochloride Pesticides. No sample contained pesticide concentrations that exceeded the TEL or ERL for 2007 or 2011 samples.

Polynuclear Aromatic Hydrocarbons (PAHs). The results from the 2011 and 2007 sediment samples are consistent. Polynuclear aromatic hydrocarbons (PAHs) were found in all 2011 and 2007 sediment samples. In general, for 2011 and 2007 samples, sediment from MOTSU's northern most basin contained the highest levels of most PAH analytes. Although acenaphthene was not detected in any sample, each of the other 16 PAHs analyzed for in 2011 were found in at least trace amounts in sample MOTMA11-N and at least 13 PAHs analyzed for were found in all other samples; however, no sample exceeded the TEL or the ERL for any PAH analyte for either 2011 or 2007 samples.

Polychlorinated Biphenyls (PCB Congeners) and PCB Aroclors. No PCB congener or PCB aroclor was detected above the MDL for any 2011 or 2007 sample.

Dioxins and Furans. 2011 sample MOTMA11-C had the highest TEQ at 0.722 ng/Kg. This TEQ value is significantly less than the highest measured value from any 2007 sample (2.5859 ng/Kg; sample MOTMA-07-C).

Organotins. For 2011 and 2007 samples, the highest organotin value was recorded for the 2007 sample MOTMA-07-C (4.2 µg/kg of tri-n-butyltin). For all 2011 samples, organotins were not detected at or above the method detection limit.

Wilmington Harbor Federal Navigation Project (using lower Cape Fear River sample locations):

Physical Characteristics: The results from the 2013 and 2004 sediment samples are consistent. Physical analysis indicated dredged materials were comprised predominately of sands; although sample KIBIMA04 was primarily silt/clay.

Metals. The results from 2013 and 2004 sediment sampling events are consistent. Most metals were detected in concentrations greater than the method reporting limit (MRL), but below the threshold effects level (TEL). Only arsenic was found at levels exceeding the TEL in 2004 sample KIBIMA04. Arsenic levels did not exceed the TEL at comparable 2013 sample stations.

Total Organic Carbon (TOC). The results from 2013 and 2004 sediment sampling events are consistent. For 2013 samples included in this Tier I evaluation, TOC ranged from 0.531% (LMRMA13) to 3.15% dry (URCMA13). For 2004 samples included in this Tier I evaluation, TOC ranged from 1.25% (UMMA04) to 2.27% dry (KIBIMA04).

Oil and Grease. The results from 2013 and 2004 sediment sampling events are consistent. For 2013 samples, oil and grease were values ranged from 160 mg/Kg (LMRMA13) to 740mg/Kg (URCMA13). For 2004 samples, oil and grease were values ranged from 170 mg/Kg (UMMA04) to 180mg/Kg (KIBIMA04). Comparing 2013 and 2004 sample data, oil and grease values at comparable sampling locations were consistent with the exception of station URCMA13, which is the northern-most location included in this present evaluation.

Organochloride Pesticides. No sample contained pesticide concentrations that exceeded the TEL or ERL for 2013 or 2004 samples.

Polynuclear Aromatic Hydrocarbons (PAHs). The results from 2013 and 2004 sediment sampling events are consistent. Sample URCMA13 had the highest levels of every PAH analyte; although, no sample exceeded the TEL for any PAH analyte.

Polychlorinated Biphenyls (PCB Congeners) and PCB Aroclors. For 2013 and 2004 sampling stations referenced in this report, most PCBs were not detected above the MDL and none were detected above the MRL except for PCB Congener 206, which was detected above the MRL in 2013 sample URCMA13, and IUPAC 206, which was detected above the MRL in 2004 sample KIBIMA04. No Aroclors were detected in any sample. No samples exceeded the TEL or ERL for total PCBs.

Dioxins and Furans. For 2013 sampling stations referenced in this report, 4 of the 17 dioxin and furan congeners tested were detected in concentrations above the MRL and had total TEQ concentrations exceeding the TEL or AET (with the exception of WH-REF13). For 2013 samples, TEQ values ranged from 1.96 ng/kg (UMRMA13) to 2.94 ng/kg (URCMA13). For 2004 samples, TEQ values ranged from 1.23 ng/kg (UMMA04) to 2.78 ng/kg (KIBIMA04). All TEQ values for comparable 2013 and 2004 samples were lesser for 2013 samples.

Organotins. The results from 2013 and 2004 sediment sampling events are consistent for sample locations used in this report, with no organotin cation detected in an amount greater than the MRL.

Table 4a. 2011 and 2007 MOTSU Sediment Physical Analyses.

Analyte	Sample:	2011 MOTSU Sediment		
		MOTMA11-N	**MOTMA11-S**	**MOTMA11-C**
Description		Gray Slightly Sandy SILT	Gray Sandy SILT	Gray Sandy SILT
Gravel[1]	**%**	0.1	0.0	0.0
Sand[2]	**%**	7.0	28.1	40.7
Silt[3]	**%**	40.5	35.5	29.8
Clay[3]	**%**	52.4	36.4	29.5
Solids	**%**	29.8	34.8	29.5
Moisture (wet)	**%**	71.1	65.2	70.5
Specific Gravity	**--**	2.527	2.508	2.484
Classification	**USCS**	MH	MH	MH

Analyte	Sample:	2007 MOTSU Sediment			
		MOTMA-07-N	**MOTMA-07-S**	**MOTMA-07-C**	**MOTMA-REF**
Description		Silt, some clay, few sand, dark gray	Silt, some clay, little sand, dark gray	Silt, some clay, few sand, dark gray	Sand, fine quartz, few silt, few clay, dark gray
Gravel[1]	**%**	0.0	0.0	0.0	0.0
Sand[2]	**%**	9.5	14.6	9.3	81.5
Silt[3]	**%**	57.9	47.8	52.5	7.7
Clay[3]	**%**	32.6	37.6	38.2	10.8
Solids	**%**	30.7	25.8	23.8	76.4
Moisture (wet)	**%**	69.3	74.2	76.2	23.6
Specific Gravity	**--**	2.583	2.600	2.600	2.675
Classification	**USCS**	ML	ML	ML	SM

[1] Gravel = Particles ≥4.750mm

[2] Sand = Particles ≥0.075mm but <4.750mm

[3] Silt/Clay = Particles <0.075mm

U = The compound was analyzed for but not detected at or above the Method Detection Limit.

^ = Moisture Content (weight of wet sediment - weight of oven dried sediment)/(weight of oven dried sediment)

Table 4b. 2013 and 2004 Wilmington Harbor Federal Navigation Project Sediment Physical Analyses.

		2013 Wilmington Harbor Federal Navigation Project Sediment (for sample stations adjacent to MOTSU)			
Analyte	**Sample:**	**URCMA13**	**UMRMA13**	**LMRMA13**	**WH-REF13**
Description		SAND, clayey, few medium to mostly fine grained sand-sized quartz, little clay, little silt, dark gray	SAND, clayey, few medium to mostly fine grained sand-sized quartz, little clay, little silt, dark gray	SAND, poorly graded with silt, little medium to mostly fine grained sand-sized quartz, few silt, few clay, dark gray	SAND, silty, mostly fine grained sand-sized quartz, few silt, trace clay, dark grayish brown
Gravel[1]	**%**	0.0	0.0	0.0	0.0
Sand[2]	**%**	53.8	58.3	86.7	86.5
Silt[3]	**%**	22.6	20.0	5.2	9.3
Clay[3]	**%**	23.6	21.7	8.1	4.2
Solids	**%**	43.8	46.7	67.9	73.9
Moisture (wet)	**%**	56.2	53.3	32.1	26.1
Specific Gravity	**--**	2.583	2.597	2.666	2.694
Classification	**USCS**	SC	SC	SM	SM

		2004 Wilmington Harbor Federal Navigation Project Sediment (for sample stations adjacent to MOTSU)		
Analyte	**Sample:**	**KIBIMA04**	**UMMA04**	**WHREF04**
Description		Predominately Silt/Clay	Predominately Sand	Predominately Sand
Gravel[1]	**%**	0.0	0.0	0.0
Sand[2]	**%**	42.1	81.1	81.1
Silt/Clay[3]	**%**	57.9	18.9	18.9
Solids	**%**	46.1	63.8	70.8
Moisture (wet)	**%**	116.8 ^	56.8	41.2
Specific Gravity	**--**	2.576	2.596	2.633
Classification	**USCS**	CH	SC	SM

[1] Gravel = Particles ≥4.750mm

[2] Sand = Particles ≥0.075mm but <4.750mm

[3] Silt/Clay = Particles <0.075mm

U = The compound was analyzed for but not detected at or above the Method Detection Limit.

^ = Moisture Content (weight of wet sediment - weight of oven dried sediment)/(weight of oven dried sediment)

Table 4c. 2011 MOTSU and 2013 Wilmington Harbor Federal Navigation Project Sediment Physical Analyses Comparison.

		2011 MOTSU Sediment	2013 Wilmington Harbor Federal Navigation Project Sediment
Analyte	**Sample:**	**MOTMA11-C**	**LMRMA13**
Description		Gray Sandy SILT	SAND, poorly graded with silt, little medium to mostly fine grained sand-sized quartz, few silt, few clay, dark gray
Gravel[1]	**%**	0	0
Sand[2]	**%**	40.7	86.7
Silt[3]	**%**	29.8	5.2
Clay[3]	**%**	29.5	8.1
Solids	**%**	29.5	67.9
Moisture (wet)	**%**	70.5	32.1
Specific Gravity	**--**	2.484	2.666
Classification	**USCS**	MH	SM

[1] Gravel = Particles ≥4.750mm

[2] Sand = Particles ≥0.075mm but <4.750mm

[3] Silt/Clay = Particles <0.075mm

U = The compound was analyzed for but not detected at or above the Method Detection Limit.

^ = Moisture Content (weight of wet sediment - weight of oven dried sediment)/(weight of oven dried sediment)

Table 5a. Comparison of 2011 and 2007 MOTSU Sediment Chemistry Testing Results.

Parameter	TEF	MOTMA11-N	MOTMA-07-N	MOTMA11-S	MOTMA-07-S	MOTMA11-C	MOTMA-07-C	MOTMA-07-REF[3]	TEL[2]	ERL[2]	AET[2]
Dioxins	**ng/kg**										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	ND	ND	ND	ND	0.136	ND	ND	x	x	x
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	ND	ND	ND	0.389	0.107	2.087	1.755	x	x	x
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	ND	0.7	ND	0.247	0.163	ND	ND	x	x	x
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.3	1.1	0.3	0.579	0.54	ND	ND	x	x	x
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.5	2	0.9	0.845	0.735	ND	ND	x	x	x
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	9.3	30	14	11.745	15	7.016	0.373	x	x	x
Octachlorodibenzo-p-dioxin (OCDD)	0.0001	170	586	209	183.21	244	112.265	2.211	x	x	x
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	0.2	ND	0.1	ND	0.215	ND	ND	x	x	x
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.05	ND	ND	ND	ND	ND	ND	ND	x	x	x
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.5	ND	ND	ND	ND	ND	ND	ND	x	x	x
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	ND	ND	ND	ND	ND	ND	ND	x	x	x
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	ND	ND	ND	ND	ND	ND	ND	x	x	x
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	ND	ND	ND	ND	ND	ND	ND	x	x	x
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	ND	ND	ND	ND	ND	ND	ND	x	x	x
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	1.4	3.7	1.1	2.338	1.61	1.24	ND	x	x	x
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	ND	ND	ND	ND	ND	ND	ND	x	x	x
Octachlorodibenzofuran (OCDF)	0.0001	2.4	5.8	2.2	2.809	2.68	1.324	ND	x	x	x
TEQ[1]		0.6	0.8	0.6	0.7155	0.722	**2.1809**	**1.759**	0.85	x	3.6
Metals	**mg/kg**										
Antimony		0	0.2	0	0.13	0.031	0.13	0.04	x	x	9.3
Arsenic		**13**	**14**	**13**	**16.3**	**13.3**	**14.7**	4.19	7.24	8.2	35
Beryllium		0.7	1	0.7	0.924	0.689	0.941	0.227	x	x	x
Cadmium		0.1	0.2	0.1	0.118	0.095	0.142	0.06	0.68	1.2	3
Chromium		29	41	28	42.4	27.6	36.4	12	52.3	81	62
Copper		12	14	7.7	9.9	8.3	10.2	1.5	18.7	34	390
Lead		14	25	12	19	12.7	18.6	3.53	30.24	46.7	400
Mercury		0.1	0.1	0	0.046	0.045	0.056	0.009	0.13	0.15	0.4
Nickel		9	14	8.5	**16.9**	8.38	14.7	6.65	15.9	20.9	110
Selenium		1	ND	1	ND	0.9	ND	ND	x	x	1
Silver		0.1	0.1	0	0.054	0.051	0.066	0.012	0.73	1	3.1
Thallium		0.1	0.2	0.1	0.172	0.107	0.148	0.08	x	x	x
Zinc		53	71	44	53.9	46	56.3	11.7	124	150	410
PAHs	**µg/kg**										
2-Methylnaphthalene		1.1	2.1	0.8	ND	0.76	ND	0.62	20.2	70	64
Acenaphthene		ND	1.4	ND	ND	ND	ND	ND	6.71	16	130
Acenaphthylene		1.1	1.7	ND	ND	ND	1.1	ND	5.87	44	71
Anthracene		2.6	3.4	2	2	2.1	3.3	ND	46.9	85.3	280
Benz(a)anthracene		9.8	15	9.6	5.7	5.7	9.5	0.93	74.8	261	960

Parameter	TEF	MOTMA11-N	MOTMA-07-N	MOTMA11-S	MOTMA-07-S	MOTMA11-C	MOTMA-07-C	MOTMA-07-REF[3]	TEL[2]	ERL[2]	AET[2]
Benzo(a)pyrene		9.5	18	6.8	7.3	5.8	11	0.71	88.8	430	##
Benzo(b)fluoranthene		19	28	12	12	11	16	0.99	x	x	x
Benzo(g,h,i)perylene		9.1	19	5.3	7.4	5	11	1.1	x	x	x
Benzo(k)fluoranthene		6.8	10	4.4	3.7	4	5.2	0.39	x	x	x
Chrysene		10	19	6.7	8.9	5.4	12	0.63	108	384	950
Dibenz(a,h)anthracene		1.9	3.8	ND	1.4	ND	2	0.47	6.22	63.4	230
Fluoranthene		22	51	12	20	11	23	1.5	113	600	##
Fluorene		1.7	2.8	ND	ND	ND	ND	ND	21.2	19	120
Indeno(1,2,3-cd)pyrene		8.2	20	4.6	7.5	4.8	11	1.3	x	x	600
Naphthalene		3.4	5	2.5	4.9	2.3	5.5	2.4	34.6	160	230
Phenanthrene		8.6	9.8	3.2	6.1	3.4	6.5	ND	86.7	240	660
Pyrene		24	44	12	16	13	19	0.95	153	665	##
Oil & Grease	**mg/kg**										
Total Petroleum Hydrocarbons		1110	380	900	210	960	260	70 U	x	x	x
Total Organic Carbon	**Dry Weight %**										
Total Organic Carbon		3.32	3.94	2.71	3.55	3.14	3.81	0.42	x	x	x
Pesticides	**µg/kg**										
Total Pesticides		ND	0	ND	0.0209	ND	0.01833	0.005	x	x	x
PCB Aroclors	**µg/kg**										
Total PCB Aroclors		ND	ND	ND	ND	ND	ND	ND	x	x	x
PCB Congeners	**µg/kg**										
Total PCB Congeners		3.0*	0.9	2.4*	ND	3.1*	ND	ND	x	x	x
Organotins	**µg/kg**										
n-Butyltin		ND	ND	ND	0.82	ND	1.3	ND	x	x	x
Di-n-butyltin		ND	ND	ND	1.2	ND	1.7	ND	x	x	x
Tri-n-butyltin		ND	1.9	ND	0.84	ND	4.2	ND	x	x	x

[1] = TEQ calculated as $\{\sum[C_{PCDDi} \text{ x } TEF_i] + \sum[C_{PCDFi} \text{ x } TEF_i]\}$ using the 2005 WHO TEF values. When a concentration of a particular dioxin or furan compound was ND, the detection limit was used in the formula for calculating the TEQ.

[2] = For Threshold Effects Limit (TEL), Probable Effects Level (PEL), Effects Range Low (ERL), Effects Range Median (ERM), and Apparent Effects Threshold (AET), values from NOAA Quick Reference Tables (Buchman 2008)

[3] = Same location as Wilmington Reference Station

TEQ = Toxic Equivalency Quotient, TEQ = TEF x Result [U Qualified data calculated as 0]

Bolded values are greater than the TEL, ERL, and/or AET.

x = No TEL, PEL, ERL, ERM, and/or AET published for parameter.

ND = Parameter was not detected at or above the method detection limit.

U = The compound was analyzed for but not detected at or above the Method Detection Limit.

* = Total EPA Region 4 PCBs

Table 5b. Comparison of 2013 and 2004 Wilmington Harbor Federal Navigation Project Sediment Chemistry Testing Results.

Parameter	TEF	URCMA13	UMRMA13	KIBIMA04	LMRMA13	UMMA04	WH-REF13	WHREF04	TEL[2]	ERL[2]	AET[2]
Dioxins	**ng/kg**										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	ND	ND	0.374U	ND	0.224 U	ND	0.034 U	x	x	x
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	0.58	0.433	0.663 U	0.367	0.236 U	0.148	0.068 U	x	x	x
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.994	0.782	0.858 U	0.534	0.350 J	0.346	0.206 J	x	x	x
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	2.19	1.66	0.759 U	0.964	0.937 J	0.54	0.328 JK	x	x	x
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	3.92	2.92	4.136	2.2	1.363 J	0.966	0.888 J	x	x	x
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	67.5	41	66.88	30.6	27.322	11	8.643	x	x	x
Octachlorodibenzo-p-dioxin (OCDD)	0.0001	1500	864	1299.87 E	2090	658.623	118	96.064	x	x	x
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	0.447	ND	0.394 U	ND	0.238 U	ND	0.030 U	x	x	x
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.05	ND	ND	0.588 U	ND	0.240 U	ND	0.047 U	x	x	x
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.5	ND	ND	0.593 U	ND	0.241 U	ND	0.044 U	x	x	x
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	0.401	ND	0.540 U	0.136	3.335 U	ND	0.054 U	x	x	x
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	0.323	0.229	0.540 U	0.192	0.191 U	ND	0.052 U	x	x	x
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	ND	ND	1.515 U	ND	0.245 U	ND	0.062 U	x	x	x
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	0.416	0.283	0.603 U	0.213	0.214 U	ND	0.054 U	x	x	x
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	9.47	5.69	8.843	2.42	3.474	0.631	0.484 J	x	x	x
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	ND	ND	0.923 U	ND	0.359 U	ND	0.144 U	x	x	x
Octachlorodibenzofuran (OCDF)	0.0001	11.1	7.16	11.751	5.13	5.938	0.784	0.567 J	x	x	x
TEQ[1]		**2.94**	**1.96**	**2.78**	**2**	**1.23**	0.762	**0.36**	0.85	x	3.6
Metals	**mg/kg**										
Antimony		0.052	0.022	0.1	0.011	0.05	0.027	0.06	x	x	9.3
Arsenic		7.05	3.42	**7.9**	1.86	3.4	3.9	5	7.24	8.2	35
Beryllium		0.554	0.259	0.685	0.155	0.331	0.187	0.287	x	x	x
Cadmium		0.099	0.036	0.392	0.0165	0.086	0.053	0.058	0.68	1.2	3
Chromium		19.7	9.08	28.2	5.64	10.9	9.76	14.6	52.3	81	62
Copper		6.95	2.51	7.31	1.16	3.57	0.92	2.07	18.7	34	390
Lead		9.95	4.14	10.7	2.39	5.77	2.92	4.61	30.24	46.7	400
Mercury		0.033	0.013	0.04	0.005	0.02	0.004	0.01	0.13	0.15	0.41
Nickel		6.03	2.68	11.7	1.43	3.57	1.91	4.93	15.9	20.9	110
Selenium		0.36	0.15	1.1	0.059	0.7	0.08	0.8	x	x	1
Silver		0.041	0.015	0.062	0.006	0.03	0.006	0.02	0.73	1	3.1
Thallium		0.067	0.03	0.164	0.0186	0.091	0.058	0.089	x	x	x
Zinc		40.5	16.5	45.6	9.94	22.9	10.8	14.8	124	150	410
PAHs	**µg/kg**										
2-Methylnaphthalene		0.94	ND	1.4 J	ND	0.70 J	ND	1.0 J	20.2	70	64
Acenaphthene		1.7	ND	0.85 J	ND	0.31 J	ND	0.24 U	6.71	16	130

Parameter	TEF	URCMA13	UMRMA13	KIBIMA04	LMRMA13	UMMA04	WH-REF13	WHREF04	TEL[2]	ERL[2]	AET[2]
Acenaphthylene		1.1	ND	3.8 J	ND	1.0 J	ND	0.33 U	5.87	44	71
Anthracene		3.1	0.81	7.8	ND	1.7 J	ND	0.33 U	46.9	85.3	280
Benz(a)anthracene		12	3.3	14	1.5	3.4 J	ND	0.66 J	74.8	261	960
Benzo(a)pyrene		15	3.4	14	1.3	3.5 J	ND	0.66 J	88.8	430	1100
Benzo(b)fluoranthene		20	4.6	15	1.7	4.6 J	ND	1.2 J	x	x	x
Benzo(g,h,i)perylene		9.8	2.6	10	0.95	3.0 J	ND	0.61 J	x	x	x
Benzo(k)fluoranthene		7.2	2.2	14	ND	4.2 J	ND	0.63 J	x	x	x
Chrysene		12	3.2	21	ND	4.5 J	ND	0.81 J	108	384	950
Dibenz(a,h)anthracene		2.2	ND	1.9 J	ND	0.48 U	ND	0.39 U	6.22	63.4	230
Fluoranthene		29	6.5	28	1.8	7.9	ND	1.4 J	113	600	1300
Fluorene		1.7	ND	1.7 J	ND	0.56 J	ND	0.29 U	21.2	19	120
Indeno(1,2,3-cd)pyrene		12	3	11	1.1	2.9 J	ND	0.64 J	x	x	600
Naphthalene		1.7	0.72	2.9 J	ND	1.6 J	ND	1.9 J	34.6	160	230
Phenanthrene		6.9	2	6.2	ND	2.3 J	ND	0.71 J	86.7	240	660
Pyrene		26	6.5	39	1.6	9.9	ND	1.5 J	153	665	2400
Oil & Grease	**mg/kg**										
Total Petroleum Hydrocarbons		740	190	180	160	170	ND	110	x	x	x
Total Organic Carbon	**Dry Weight %**										
Total Organic Carbon		3.15	0.963	2.27	0.531	1.25	0.331	0.6	x	x	x
Pesticides	**µg/kg**										
Total Pesticides		22	10	57.46	9.7	39.599	9.7	20.061	x	x	x
PCB Aroclors	**µg/kg**										
Total PCB Aroclors		10.5	ND	1.21	ND	0.67	ND	0	x	x	x
PCB Congeners	**µg/kg**										
Total PCB Congeners		6.1*	1.8*	4.757	1.5*	3.358	1.4*	2.47	x	x	x
Organotins	**µg/kg**										
n-Butyltin		ND	ND	0.20 J	ND	0.17 J	ND	0.11 J	x	x	x
Di-n-butyltin		ND	ND	0.28 J	0.73	0.19 J	ND	0.062 J	x	x	x
Tri-n-butyltin		ND	ND	1.0 J	3.6	0.44 J	ND	0.24 J	x	x	x

[1] = TEQ calculated as $\{\sum[C_{PCDDi} \times TEF_i] + \sum[C_{PCDFi} \times TEF_i]\}$ using the 2005 WHO TEF values. When a concentration of a particular dioxin or furan compound was ND, the detection limit was used in the formula for calculating the TEQ.

[2] = For Threshold Effects Limit (TEL), Probable Effects Level (PEL), Effects Range Low (ERL), Effects Range Median (ERM), and Apparent Effects Threshold (AET), values from NOAA Quick Reference Tables (Buchman 2008)

TEQ = Toxic Equivalency Quotient, TEQ = TEF x Result [U Qualified data calculated as 0]

Bolded values are greater than the TEL, ERL, and/or AET.

x = No TEL, PEL, ERL, ERM, and/or AET published for parameter.

E = The result is an estimated concentration that is less than the Method Reporting Limit but greater than the Method Detection Limit.

J = The result is an estimate amount because the value exceeded the instrument calibration range.

K = The result is an estimated maximum concentration.

ND = Parameter was not detected at or above the method detection limit.

U = The compound was analyzed for but not detected at or above the Method Detection Limit.

* = Total EPA Region 4 PCBs

Table 5c. 2011 MOTSU and 2013 Wilmington Harbor Federal Navigation Project Sediment Chemical Analyses Comparison.

Parameter	TEF	MOTMA11-N	MOTMA11-S	MOTMA11-C	URCMA13	UMRMA13	LMRMA13	WH-REF13 (reference)	TEL[2]	ERL[2]	AET[2]
Dioxins	**ng/kg**										
2,3,7,8-TCDD	1	ND	ND	0.136	ND	ND	ND	ND	x	x	x
2,3,7,8-TCDF	0.1	0.2	0.1	0.215	0.447	ND	ND	ND	x	x	x
TEQ[1]		0.6	0.6	0.722	**2.94**	**1.96**	**2**	0.762	0.85	x	3.6
Metals	**mg/kg**										
Antimony		0	0	0.031	0.052	0.022	0.011	0.027	x	x	9.3
Arsenic		**13**	**13**	**13.3**	7.05	3.42	1.86	3.9	7.24	8.2	35
Beryllium		0.7	0.7	0.689	0.554	0.259	0.155	0.187	x	x	x
Cadmium		0.1	0.1	0.095	0.099	0.036	0.0165	0.053	0.68	1.2	3
Chromium		29	28	27.6	19.7	9.08	5.64	9.76	52.3	81	62
Copper		12	7.7	8.3	6.95	2.51	1.16	0.92	18.7	34	390
Lead		14	12	12.7	9.95	4.14	2.39	2.92	30.24	46.7	400
Mercury		0.1	0	0.045	0.033	0.013	0.005	0.004	0.13	0.15	0.41
Nickel		9	8.5	8.38	6.03	2.68	1.43	1.91	15.9	20.9	110
Selenium		1	1	0.9	0.36	0.15	0.059	0.08	x	x	1
Silver		0.1	0	0.051	0.041	0.015	0.006	0.006	0.73	1	3.1
Thallium		0.1	0.1	0.107	0.067	0.03	0.0186	0.058	x	x	x
Zinc		53	44	46	40.5	16.5	9.94	10.8	124	150	410
PAHs	**µg/kg**										
2-Methylnaphthalene		1.1	0.8	0.76	0.94	ND	ND	ND	20.2	70	64
Acenaphthene		ND	ND	ND	1.7	ND	ND	ND	6.71	16	130
Acenaphthylene		1.1	ND	ND	1.1	ND	ND	ND	5.87	44	71
Anthracene		2.6	2	2.1	3.1	0.81	ND	ND	46.9	85.3	280
Benz(a)anthracene		9.8	9.6	5.7	12	3.3	1.5	ND	74.8	261	960
Benzo(a)pyrene		9.5	6.8	5.8	15	3.4	1.3	ND	88.8	430	1100
Benzo(b)fluoranthene		19	12	11	20	4.6	1.7	ND	x	x	x
Benzo(g,h,i)perylene		9.1	5.3	5	9.8	2.6	0.95	ND	x	x	x
Benzo(k)fluoranthene		6.8	4.4	4	7.2	2.2	ND	ND	x	x	x
Chrysene		10	6.7	5.4	12	3.2	ND	ND	108	384	950
Dibenz(a,h)anthracene		1.9	ND	ND	2.2	ND	ND	ND	6.22	63.4	230
Fluoranthene		22	12	11	29	6.5	1.8	ND	113	600	1300
Fluorene		1.7	ND	ND	1.7	ND	ND	ND	21.2	19	120
Indeno(1,2,3-cd)pyrene		8.2	4.6	4.8	12	3	1.1	ND	x	x	600
Naphthalene		3.4	2.5	2.3	1.7	0.72	ND	ND	34.6	160	230
Phenanthrene		8.6	3.2	3.4	6.9	2	ND	ND	86.7	240	660
Pyrene		24	12	13	26	6.5	1.6	ND	153	665	2400
Total Petroleum Hydrocarbons	**mg/Kg**										
TPH		1110	900	960	740	190	160	ND	x	x	x
TOC	**(% dry wt)**										
Total Organic Carbon		3.32	2.71	3.14	3.15	0.963	0.531	0.331	x	x	x
Pesticides	**µg/kg**										
Total Pesticides		ND	ND	ND	22	10	9.7	9.7	x	x	x
PCB Aroclors	**µg/kg**										
Total PCB Aroclors		ND	ND	ND	10.5	ND	ND	ND	x	x	x
PCB Congeners	**µg/kg**										
Total Region 4 PCBs		3	2.4	3.1	6.1	1.8	1.5	1.4	21.6	22.7	x
Organotins	**µg/kg**										
n-Butyltin		ND	ND	ND	ND	ND	ND	ND	x	x	x
Di-n-butyltin		ND	ND	ND	ND	ND	0.73	ND	x	x	x
Tri-n-butyltin		ND	ND	ND	ND	ND	3.6	ND	x	x	x

[1] = TEQ calculated as $\{\sum[C_{PCDDi} \times TEF_i] + \sum[C_{PCDFi} \times TEF_i]\}$ using the 2005 WHO TEF values. When a concentration of a particular dioxin or furan compound was ND, the detection limit was used in the formula for calculating the TEQ.
[2] = For Threshold Effects Limit (TEL), Probable Effects Level (PEL), Effects Range Low (ERL), Effects Range Median (ERM), and Apparent Effects Threshold (AET), values from NOAA Quick Reference Tables (Buchman 2008)
[3] = Same location as Wilmington Reference Station
TEQ = Toxic Equivalency Quotient, TEQ = TEF x Result [U Qualified data calculated as 0]
Bolded values are greater than the TEL, ERL, and/or AET.
x = No TEL, PEL, ERL, ERM, and/or AET published for parameter.
ND = Parameter was not detected at or above the method detection limit.
U = The compound was analyzed for but not detected at or above the Method Detection Limit.

Table 5d. Comparison of 2011 and 2007 MOTSU Chemical Analytes Exceeding TEL.

Parameter	TEF	MOTMA11-N	MOTMA-07-N	MOTMA11-S	MOTMA-07-S	MOTMA11-C	MOTMA-07-C	MOTMA-07-REF[3]	TEL[2]	ERL[2]	AET[2]
Dioxins	**ng/kg**										
TEQ[1]		0.6	0.8	0.6	0.7155	0.722	**2.1809**	**1.759**	0.85	x	3.6
Metals	**mg/kg**										
Arsenic		**13**	**14**	**13**	**16.3**	**13.3**	**14.7**	4.19	7.24	8.2	35
Nickel		9	14	8.5	**16.9**	8.38	14.7	6.65	15.9	20.9	110

[1] = TEQ calculated as $\{\sum[C_{PCDDi} \times TEF_i] + \sum[C_{PCDFi} \times TEF_i]\}$ using the 2005 WHO TEF values. When a concentration of a particular dioxin or furan compound was ND, the detection limit was used in the formula for calculating the TEQ.
[2] = For Threshold Effects Limit (TEL), Probable Effects Level (PEL), Effects Range Low (ERL), Effects Range Median (ERM), and Apparent Effects Threshold (AET), values from NOAA Quick Reference Tables (Buchman 2008)

[3] = Same location as Wilmington Reference Station

TEQ = Toxic Equivalency Quotient, TEQ = TEF x Result [U Qualified data calculated as 0]

Bolded values are greater than the TEL, ERL, and/or AET.

x = No TEL, PEL, ERL, ERM, and/or AET published for parameter.

4.1.2 Review of Water Column Determinations

Site water and elutriate analyses were performed in accordance with published procedures. The site waters and elutriates were analyzed for the following analytes: Metals, Organochloride Pesticides, Polynuclear Aromatic Hydrocarbons (PAHs), and Ammonia. Elutriate results were compared to the USEPA's Water Quality Criteria for contaminants of concern in marine waters. Both the Criteria Continuous Concentration (CCC) and the Criterion Maximum Concentration (CMC) (acute concentrations) were used. The CMC is an estimate of the highest concentration of a pollutant in saltwater to which an aquatic community can be exposed briefly without resulting in an unacceptable effect (Buchman 2008). The results from 2007 site water and elutriate analyses for MOTSU, and 2013 and 2004 Wilmington Harbor Federal Navigation Project, respectively, are provided below. 2011 MOTSU site water and elutriate analyses were not performed.

Metals. No detections were greater than either the CCC or CMC.

Pesticides. No detections were greater than either the CCC or CMC.

PAHs. No detections were greater than either the CCC or CMC.

Water Column Determinations Summary. Since all site water and elutriate results were below the CMC found in the National Recommended Water Quality Criteria (USEPA 2002), running the Water Quality Criteria Mixing Model (STFATE) was not necessary (USEPA and USACE 2008).

4.1.3 Review of Liquid – Suspended Particulate Phase Bioassays

Liquid phase (elutriate) bioassays were performed to determine the potential impact on test organisms of dissolved and suspended contaminants in sediments collected. For 2007 MOTSU, and 2013 and 2004 Wilmington Harbor Federal Navigation Project sampling events, organisms for analysis included the inland silverside *Menidia beryllina*, the mysid shrimp *Americamysis bahia*, and the larvae of two mussel species (*Mytilus galloprovincialis* for 2007 MOTSU and 2013 Wilmington Harbor Federal Navigation Project analysis, and *Mytilus californicus* for 2004 Wilmington Harbor Federal Navigation Project analysis). 2011 MOTSU suspended particulate phase bioassays were not performed.

Table 6. Summary of Water-Column (Suspended Particulate Phase) Test Results.

2007 MOTSU			
Sample	***Menidia beryllina*** **LC_{50} (%)**	***Americamysis bahia*** **LC_{50} (%)**	***Mytilus galloprovincialis*** **EC_{50} (%)**
MOTMA-07-N	33.4	63.6	21.4
MOTMA-07-C	>100	>100	78.5
MOTMA-07-S	>100	>100	74.7
2013 Wilmington Harbor Federal Navigation Project (for sample locations near MOTSU)			
Sample	***Menidia beryllina*** **LC_{50} (%)**	***Americamysis bahia*** **LC_{50} (%)**	***Mytilus galloprovincialis*** **EC_{50} (%)**
URCMA13	>100	>100	55.7
URCMA13 (ammonia reduced)	n/a	n/a	>100
UMRMA13	>100	>100	77.2
LMRMA13	>100	>100	>100
2004 Wilmington Harbor Federal Navigation Project (for sample locations near MOTSU)			
Sample	***Menidia beryllina*** **LC_{50} (%)**	***Americamysis bahia*** **LC_{50} (%)**	***Mytilus californicus*** **EC_{50} (%)**
KIBIMA04	>100	>100	92
UMMA04	>100	>100	87
Control 072804	>100	>100	96

***Menidia beryllina*. MOTSU Test Result.**
The LC_{50} value of *M. beryllina* in the elutriate treatments from samples MOTMA-07-C and MOTMA-07-S exceeded 100%. The LC_{50} was 33.4% from MOTMA-07-N. The mean survivorship in the control was 96.0%.

Ammonia is a potential cause of survival and development effects observed in the SPP tests of MOTSU dredged material elutriates. For the bioassay with a 50% dilution of elutriate prepared from MOTMA-07-N, ammonia ranged from 14.5 mg/L to 22.3 mg/L at the initiation of the test. The 100% elutriate MOTMA-07-N ammonia ranged from 30.5 mg/L to 45.5 mg/L initially. The Elutriates prepared from MOTMA-07-S and MOTMA-07-C sediments did not have ammonia concentrations exceeding 5.39 mg/L and LC_{50}s for those were >100% and the EC_{50}s were 74.7% or greater. A possible reason for the difference between MOTMA-07-N and the MOTMA-07-C and MOTMA-07-S samples is that the MOTMA-07-N samples were collected by vibracore as compared to grab sample methods for the -C and -S samples.

***Americamysis bahia*. MOTSU Test Result.**
LC_{50} in all of the elutriate treatments was greater than 100% for samples MOTMA-07-C and MOTMA-07-S. The LC_{50} value for survival was 63.6% from MOTMA-07-N. The mean control survival was 96.0%.

***Mytilus galloprovincialis*. MOTSU Test Result.**
The EC_{50} value was 21.4%, 78.5%, and 74.7% of the sediment elutriates from samples MOTMA-07-N, MOTMA-07-C, and MOTMA-07-S, respectively. The mean percent survival and mean percent normal larvae development in the control met acceptable range of greater than or equal to 70% survival and greater than or equal to 90% normal development.

***Menidia beryllina*. Wilmington Harbor Wilmington Harbor Navigation Project Test Result.**
Tests were conducted under a 25 ppt salinity regime. Samples included in this report were not significantly different than the control and associated site water samples. The estimated LC_{50} values were >100% for all treatments.

***Americamysis bahia*. Wilmington Harbor Wilmington Harbor Navigation Project Test Result.**
Tests were conducted under a 25 ppt salinity regime. Mean percent survival in the 100% elutriate treatments were not significantly different than the respective controls and site water treatments for any of the samples. The estimated LC_{50} values were >100% for all treatments.

***Mytilus galloprovincialis/Mytilus californicus*. Wilmington Harbor Wilmington Harbor Navigation Project Test Result.**
The 100% elutriate treatments of samples URCMA13 and UMRMA13 were statistically different than the control and the respective site water samples. The 100% elutriate treatments of sample LMRMA13 was not statistically different than the control or respective site water samples. The estimated EC_{50} values for the standard treatments, for samples included in this report, ranged from 55.7% to >100%. Ammonia concentrations in the bulk sediment were sufficiently elevated to predict ammonia-related impacts in the elutriate tests using the larval mussels. Based on the ammonia observations, an elutriate was prepared with ammonia-reduced sediment for sample URCMA13 and was tested concurrently with the standard elutriate preparations. Normal development and survivorship greatly increased in this ammonia-reduced treatment. Mean survivorship in the ammonia-reduced 100% elutriate treatment was not significantly different than that of the control or site water samples. The estimated EC_{50} value was greater than 100% following ammonia reduction and observed toxicity was ameliorated by the ammonia-reduction procedure.

For samples KIBIMA04 and UMMA04, statistical analysis revealed that there was no significant difference between the normal development rate in the control seawater treatment and normal development rate in all of the elutriate treatments ($p > 0.05$). EC_{50} values was greater than 100% for all treatments.

Limiting Permissible Concentration (LPC Compliance). Simulations of the STFATE module of the

ADDAMS model were run to establish the compliance of the water column toxicity for MOTSU sediment samples. Based on analytical results, no samples were selected for modeling Tier II – Water Quality Criteria as all results were below the CMC (National Recommended Water Quality Criteria: 2006, Criteria Maximum Concentration).

Based on the water column (elutriate) bioassay results (LC_{50} / EC_{50}) results, four applications (runs) of the model were performed for all 2007 MOTSU samples and one application (run) was run for 2013 Wilmington Harbor Navigation Project samples URCMA13 and UMRMA13. Sample MOTMA-07-N initially violated toxicity criteria after the 4-hour mixing period. As a result, the model was re-run for MOTMA-07-N using alternative operational constraints to accommodate the necessary dilution. The initial mixing computation results for the southeast and northwest boundaries of the proposed disposal area are presented in Table 7a. With the proposed operational constraint, the MOTMA-07-N dredging unit did not violate toxicity criteria after 4 hours of mixing. The model was not run for 2011 MOTSU sediments, or 2004 Wilmington Harbor Federal Navigation Project sediments. This model simulates disposal from a split hull barge or hopper. No significant difference in results were observed between sample LMRMA13 and that of the control, and in accordance with Section 3.3.1 of the SERIM, sample LMRMA13 did require modeling to meet disposal criteria.

Sediment characteristics were used to calculate the volumetric fractions. Data inputs for the ADDAMS model were taken from Appendix G of the SERIM (USEPA and USACE 2008) and the Wilmington Harbor SMMP (USACE and USACE 2012). These data are presented in 2007 and 2011 Section 103 Evaluations for MOTSU and Wilmington Harbor Federal Navigation project, respectively.

The lowest LC_{50} or EC_{50} for MOTSU or adjacent Wilmington Harbor Federal Navigation Project samples was 21.4% for *Mytilus galloprovincialis* (Table 6). By definition, compliance with the LPC for this area is achieved if the dilution of the dredged material is less than 0.01 x 21.4% (i.e., 0.214%) at all times outside the disposal site and after four hours inside the disposal site.

All models were run at a disposal location of 15,750 x 15,750 feet (Figure 9). Total grid dimensions are 30,800 x 30,800 feet. Dredging Units were tested at 9,000 cubic yards based on capacity of a Great Lakes Dredge & Dock Co. vessel.

LPC Compliance Results. All MOTSU and Wilmington Harbor Navigation Project samples were analyzed with established input parameters and all representative samples passed the toxicity criteria. Results of the initial mixing simulations after 4 hours of mixing (specified for water column evaluation) and the maximum concentration found outside the disposal area are provided in Tables 7a and 7b. New Wilmington ODMDS LPC’s were not violated during the Tier III toxicity simulations.

Table 7a. STFATE Summary Results @ 9,000 cy - 2007 MOTSU Sediment

	Limiting Permissible Concentration and Required Dilution		STFATE Summary Results - Four Hour Criteria after Initial Mixing		
	Lowest LC_{50} / EC_{50} (See Table 6 - *M. galloprovincialis)*	Concentration Required to Meet Criteria	Depth (feet)	Maximum Contaminant Concentration (Cmax) above Background on Entire Grid (%)	Maximum Contaminant Concentration (Cmax) above Outside Disposal Site (%)
MOTMA-07-N, Southeast Edge	21.4%	0.214%	25	0.0145	0.0145
			35.7	0.2060	0.2060
			44	0.0419	0.0419
MOTMA-07-N, Northwest Edge	21.4%	0.214%	25	0.0152	0.000755
			35.7	0.2130	0.0106
			44	0.0433	0.00215
MOTMA-07-C	78.5%	0.785%	25	0.0158	0.0158
			35.7	0.2310	0.2310
			44	0.0470	0.0470
MOTMA-07-S	74.4%	0.744%	25	0.1550	0.1550
			35.7	0.2240	0.2240
			44	0.0457	0.0457

Table 7b. STFATE Summary Results @ 9,000 cy - 2013 Wilmington Habor Federal Navigation Project Sediment (for adjacent samples)

	Limiting Permissible Concentration and Required Dilution		STFATE Summary Results - Four Hour Criteria after Initial Mixing		
	Lowest LC_{50} / EC_{50} (See Table 6 - *M. galloprovincialis)*	Concentration Required to Meet Criteria	Depth (feet)	Maximum Contaminant Concentration (Cmax) above Background on Entire Grid (%)	Maximum Contaminant Concentration (Cmax) above Outside Disposal Site (%)
URCMA13	55.7%	0.557%	10	0.00000000959	0.00000000959
			25	0.0150	0.0150
			35.5	0.1730	0.8590
			45	0.0234	0.1160
UMRMA13	77.2%	0.772%	10	0.00000000105	0.00000000105
			25	0.0131	0.0131
			35.5	0.1410	0.6910
			45	0.0190	0.0939

Liquid – Suspended Particulate Phase Bioassays Summary. Based on these STFATE model results and liquid (suspended phase) bioassay results, ocean disposal of the tested sediments will not exceed the limiting permissible concentration (LPC) and complies with Part 227.6(c)(2) and 227.27(b) using the methods simulated in the model runs.

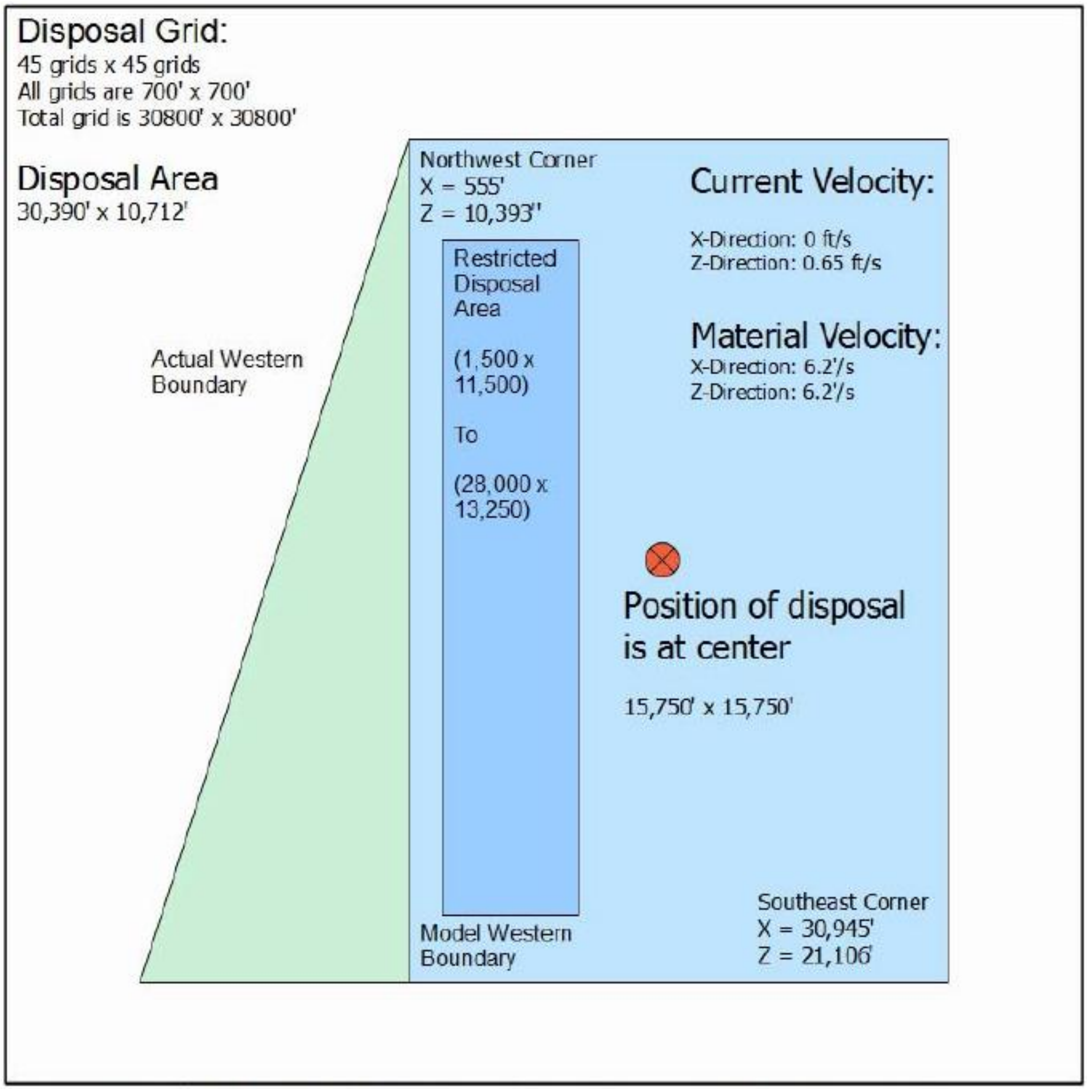

Figure 9. New Wilmington ODMDS Map.

4.1.4 Review of Benthic Determinations (Whole Sediment Bioassay)

Whole sediment (solid phase) bioassays and benthic bioavailability evaluations were performed to determine compliance with parts 227.6(c)(3) and 227.27(b). The benthic determinations were performed using appropriate sensitive marine organisms according to procedures approved by USEPA and USACE. Sediment was tested in 10-day tests using two species: The infaunal amphipod, *Leptocheirus plumulosus*, and the polychaete, *Nereis arenaceodentata* were used in 2007 MOTSU analyses. The amphipod, *Ampelisca abdita*, and the polychaete, *Neanthes arenaceodentata*, were used in 2013 Wilmington Harbor Federal Navigation Project analyses. The amphipod, *leptocheirus plumulosus* and the polychaete, *Nereis* *arenaceodentata* were used in 2004 Wilmington Harbor Federal Navigation Project analyses. Survival tests were conducted under the guidance of the SERIM (USEPA and USACE 2008) and ITM (USEPA and USACE 1998). 2011 MOTSU whole sediment bioassays were not performed.

Modifications were conducted with tests to account for various factors that became apparent during the course of the whole sediment bioassay evaluations. These modifications included performing tests for particular composite samples as static renewals due to elevated ammonia concentrations in test samples. All test modificaitions were coordinated with USEPA region 4 prior to their use. Test modifications are further discussed in the following sections where they are applicable.

MOTSU (2007):

***Neanthes arenceodentata* Test Results (Table 8).** Because of elevated ammonia concentrations in test samples, tests were performed as static renewals in accordance with SERIM and Inland Testing Maunal (ITM) procedures. Each treatment was performed with five replicates containing 10 organisms per test chamber. *N. arenceodentata* exhibited survivorship of 92-100% for all MOTSU sediments and statistical analysis was not necessary.

***Leptocheirus plumulosus* Test Results (Table 8).** Because of elevated ammonia concentrations in test samples, tests were performed as static renewals in accordance with SERIM and Inland Testing Maunal (ITM) procedures. Each treatment was performed with five replicates containing 20 organisms per test chamber. *L. plumulosus* exhibited survivorship of 81-93% for all MOTSU sediments and statistical analysis was not necessary.

Wilmington Harbor Federal Navigation Project (2013):

***Neanthes arenceodentata* Test Results (Table 8).** Mean survival within the *N. arenaceodentata* solid phase test ranged from 94% to 100%. With the exception of sample LMRMA13, survival within all samples was not found to be statistically different that of the reference. Mean percent survival in all treatments was within 10% of the reference (100%).

***Ampelisca abdita* Test Results (Table 8).** Mean survival within the *A. abdita* solid phase test ranged from 86% to 96%. With the exception of sample UMRMA13, survival within all samples was not found to be statistically different than that of the reference. Mean percent survival in all treatments was within 20% of that of the reference, indicating that the test treatments met the LPC for benthic toxicity.

Wilmington Harbor Federal Navigation Project (2004):

***Nereis arenceodentata* Test Results (Table 8).** Mean survival within the *N. arenaceodentata* solid phase test was 100% for sample stations in the MOTSU vicinity. Survival within all samples was not found to be statistically different that of the reference.

***Leptocheirus plumulosus* Test Results (Table 8).** Mean survival within the *L. plumulosus* solid phase test ranged from 97% to 100%. Survival within all samples was not found to be statistically different than that of the reference. Survival within all samples was not found to be statistically different that of the reference.

Table 8. Summary of Whole Sediment (Solid-Phase) Test Results.

Test organism	Mean Survival (%) at Sample Station				
	MOTMA-07-N	MOTMA-07-C	MOTMA-07-S	MOTMA-07-REF	Control
Neanthes arenaceodentata	92	98	98	100	98
Leptocheirus plumulosus	81	84	93	92	91
	URCMA13	UMRMA13	LMRMA13	WHREF13	Control
Neanthes arenaceodentata	98	98	94	100	100
Ampelisca abdita	96	86	92	97	98
	KIBIMA04	UMMA04	WHREF04	Control	
Nereis arenaceodentata	100	97	100	100	
Leptocheirus plumulosus	100	100	100	100	

Benthic Determinations (Whole Sediment Bioassay) Summary. The whole sediment bioassays show that the tested sediments did not cause significant acute toxicity and meet the solid phase toxicity criteria of Part 227.6(c)(3).

4.1.5 Review of Benthic Bioavailability (Bioaccumulation) Evaluation

Assessment of bioaccumulation potential was determined by 28-day exposure to treatment samples. Bioaccumulation tests were conducted using the bi-valve mollusk *Macoma nasuta* and the polychaete *Nereis virens*. Tissue analytes included: metals PAHs for 2007 MOTSU sediments; metals, organotins, and PAHs for 2013 Wilmington Harbor Federal Navigation Project sediments in the MOTSU vicinity; and metals for 2004 Wilmington Harbor Federal Navigation Project sediments in the MOTSU vicinity. All project samples had 5 replicates. Statistical tests included using ANOVA and Dunnett's multiple comparisons procedure. The mean % survival during the 28-day bioaccumulation tests was greater than 90% (acceptable criteria is >90%) for both *Macoma nasuta* and *Nereis virens*, for MOTSU and Wilmington Harbor Federal Navigation Project samples in the MOTSU vicinity. A bioaccumulation evaluation was not performed for MOTSU's 2011 sampling event.

The evaluation of Dredge Material Proposed for Ocean Disposal Testing Manual (USEPA and USACE 1991) and the SERIM (USEPA and USACE 2008) describe processes for evaluating bioaccumulation potential using comparative analysis of test sediment bioaccumulation to Food and Drug Administration (FDA) Action Limits, reference sediment bioaccumulation, and general risk based evaluations. Guidance from the SERIM indicates that the wet weight values should be used for statistical comparisons to thresholds. If the evaluation shows that the project sediment does not exceed a) the FDA Action Limit or b) the reference test results for a particular compound, then this indicates that the disposal of the material would not result in adverse effects due to that chemical, and there is no need to further evaluate that individual chemical in the third step (i.e., general risk based evaluations).

MOTSU (2007):

Bioaccumulation Results for *Macoma nasuta* Tissues. Summary results for all parameters can be found in Evaluation of Dredged Material Proposed for Ocean Disposal, Military Ocean Terminal, Sunny Point, North Carolina, October 2007 (See section 2.7 Historical Testing). Samples statistically greater than the reference sample are shown in Table 9a.

Table 9a. Summary of Bioaccumulation Analyses for *Macoma nasuta*, 2007 Sediments.

Chemical Results for 2007 MOTSU Tissues Statistically Greater than the Reference Tissues							
		MOTMA07-N	MOTMA07-C	MOTMA07-S	MOTMA07-REF	Pre-Test
Metals (mg/kg)	Beryllium	--	--	0.0040	0.0020	0.0020*
	Lead	--	--	0.1694	0.1270	0.0836
	Nickel	--	--	0.485	0.444	0.397
	Thallium	--	--	0.0013	0.0010	0.0009
PAHs (µg/kg)	Anthracene	--	0.472 J	--	0.32 U	0.472 J
	Benz(a)anthracene	0.72 J	--	--	0.326 U	.72 J
	Benzo(a)pyrene	0.63 J	--	--	0.406 U	.63 J
	Benzo(b)fluoranthene	0.79 J	0.53 J	0.51 J	0.346 U	0.79 J
	Benzo(k)fluoranthene	0.71 J	0.44 J	0.38 J	0.28 U	0.71 J
	Chrysene	1.20 J	0.85 J	0.76 J	0.376 U	1.20 J
	Fluoranthene	3.78 J	--	--	1.27 J	3.78 J
	Pyrene	3.42 J	1.94 J	1.92 J	0.66 J^	3.42 J

-- Mean not signifiacantly different than reference station (MOTMA07-REF)

Pre-Test is concentration in test organisms before exposures to test and reference sediments, (Pre-Test is a mean of 3 replicates)

* Value is MDL as all replicates were Non-Detects

J - All 5 test results were estimated concentrations, that is less than the MRL but greater than or equal to the MDL

J^ - The 5 test results include estimated concentrations and one or non-detect result

U - The compound was analyzed for but not detected at or above the MDL

Metals. The magnitude by which metal concentrations in clams exposed to MOTSU sediments exceeded those exposed to reference sediments were small. Only beryllium was elevated to levels approaching two times the MOTMA07-REF (reference). The *M. nasuta* clams tested normally regulate metals within an enhancement factor of 2.2 (Word, personal communication 1992). The bioaccumulation seen may be a result of the biology of the species rather than bioaccumulation of contaminants. No metal concentration in tissues of bivalves exposed to test sediments exceeded FDA Action Limits. Two metal constituents, lead and copper, from the MOTSU test treatment <u>and the reference</u> exceeded the Ecological Non-Specific Effects Threshold (Appendix H, SERIM; USEPA and USACE 2008). No bivalves exceeded the South Atlantic Bight Background Concentrations.

PAHs. The concentrations of PAHs in tissues exposed to the MOTMA07-REF (reference) were low, generally less than 1.5µg/Kg for each PAH analyte. No tissue PAHs exceeded the USEPA Region 4 background tissue concentrations (<20µg/Kg). There are few available Ecological Non-Specific Effects Thresholds for PAHs. The tissue concentrations of acenaphthene and flouranthene in *M. nasuta* did not exceed the Ecological Non-Specific Effects Threshold for bivalves.

Organotins. 2007 MOTSU tissues were not analyzed for organotins.

Pesticides. 2007 MOTSU tissues were not analyzed for pesticides.

Dioxins. 2007 MOTSU tissues were not analyzed for pesticides.

Bioaccumulation Results for *Nereis virens* Tissues. Summary results for all parameters can be found in Evaluation of Dredged Material Proposed for Ocean Disposal, Military Ocean Terminal, Sunny Point, North Carolina, October 2007 (See section 2.7 Historical Testing). Samples statistically greater than the reference sample are shown in Table 9b.

Table 9b. Summary of Bioaccumulation Analyses for *Nereis virens*, 2007 MOTSU Sediments.

Chemical Results for 2007 MOTSU Tissues Statistically Greater than the Reference Tissues						
		MOTMA07-N	MOTMA07-C	MOTMA07-S	MOTMA07-REF	Pre-Test
Metals (mg/kg)	Beryllium	0.00076	--	--	0.00040	0.0006
	Silver	0.0094	--	--	0.0052	0.0176

Metals. The magnitude by which metal concentrations in clams exposed to MOTSU sediments exceeded those exposed to reference sediments were small. Beryllium and silver were elevated to levels approaching two times the MOTMA07-REF (reference). No metal concentration in tissues of polychaetes exposed to test sediments exceeded FDA Action Limits. Two metal constituents, lead and copper, from the MOTSU test treatment <u>and the reference</u> exceeded the Ecological Non-Specific Effects Threshold. Zinc and copper in the for all sample treatments <u>and reference</u> treatments exceeded South Atlantic Bight Background Concentrations.

PAHs. There was no significant accumulation of PAHs in *N. virens* tissues.

Pesticides. 2007 MOTSU tissues were not analyzed for pesticides.

Dioxins. 2007 MOTSU tissues were not analyzed for pesticides.

Wilmington Harbor Federal Navigation Project (2013):

Bioaccumulation Results for *Macoma nasuta* Tissues. Summary results for all parameters can be found in Evaluation of Dredged Material Proposed for Ocean Disposal Maintenance of Wilmington Harbor, Wilmington, North Carolina, September 2013 (See section 2.7 Historical Testing). Samples in the MOTSU vicinity with results statistically greater than the reference sample are shown in Table 10a.

Table 10a. Summary of Bioaccumulation Analyses for *Macoma nasuta*, 2013 Wilmington Harbor Federal Navigation Project Sediments.

<table>
<tr><th colspan="7">Chemical Results for adjacent 2013 Wilmington Harbor Federal Navigation Project Tissues Statistically Greater than the Reference Tissues</th></tr>
<tr><td colspan="2"></td><td>URCMA13</td><td>UMRMA13</td><td>LMRA13</td><td>WHREF13</td><td>Pre-Test</td></tr>
<tr><td colspan="2">All Metals</td><td>--</td><td>--</td><td>--</td><td>n/a</td><td>n/a</td></tr>
<tr><td>Organotins (µg/kg)</td><td>tri-butyltin</td><td>--</td><td>--</td><td>--</td><td>0.11</td><td>0.1100</td></tr>
<tr><td rowspan="2">PAHs(µg/kg)</td><td>Fluoranthene</td><td>9.3</td><td>--</td><td>--</td><td>1.9</td><td>3.8</td></tr>
<tr><td>Pyrene</td><td>7.4</td><td>--</td><td>--</td><td>1.2</td><td>2.1</td></tr>
</table>

-- no significant exceedance

n/a - not applicable

Metals. No metals were elevated to levels approaching the WHREF13 (reference). No metal concentration in tissues of bivalves exposed to test sediments exceeded FDA Action Limits. No bivalves exceeded the South Atlantic Bight Background Concentrations.

PAHs. No tissue PAHs exceeded the USEPA Region 4 background tissue concentrations (<20µg/Kg) for Wilmington Harbor Federal Navigation Project sediments in the MOTSU vicinity; however, Fluoranthene and Pyrene levels in sample URCMA13 significantly exceeded and were statistically greater than the reference. There are few available Ecological Non-Specific Effects Thresholds for PAHs. The tissue concentrations of acenaphthene and flouranthene in *M. nasuta* did not exceed the Ecological Non-Specific Effects Threshold for bivalves.

Organotins. For samples in the MOTSU vicinity, no 2013 Wilmington Harbor Federal Navigation Project tissues significantly exceeded reference organotin levels.

Pesticides. For samples in the MOTSU vicinity, 2013 Wilmington Harbor Federal Navigation Project tissues were not analyzed for pesticides.

Dioxins. For samples in the MOTSU vicinity, 2013 Wilmington Harbor Federal Navigation Project tissues were not analyzed for pesticides.

Bioaccumulation Results for *Nereis virens* Tissues. Summary results for all parameters can be found in Evaluation of Dredged Material Proposed for Ocean Disposal Maintenance of Wilmington Harbor, Wilmington, North Carolina, September 2013 (See section 2.7 Historical Testing). Samples in the MOTSU vicinity with results statistically greater than the reference sample are shown in Table 10b.

Table 10b. Summary of Bioaccumulation Analyses for N*ireis virens*, 2013 Wilmington Harbor Federal Navigation Project Sediments.

Chemical Results for 2013 Wilmington Harbor Federal Navigation Project Tissues Statistically Greater than the Reference Tissues						
		URCMA13	UMRMA13	LMRA13	WHREF13	Pre-Test
Metals (mg/kg)	Chromium	0.209	--	--	0.092	0.261
	Nickel	0.205	--	--	0.127	0.328

-- no significant exceedence

Lipids and Total Solids. For samples in the MOTSU vicinity, 2013 Wilmington Harbor Federal Navigation Project tissues not analyzed for lipids and total solids.

Metals. Chromium and Nickel were elevated to levels statistically greater than those of WHREF13 (reference). No metal concentration in tissues of polychaetes exposed to test sediments exceeded FDA Action Limits. No polychaetes exceeded the South Atlantic Bight Background Concentrations.

PAHs. There was no significant accumulation of PAHs in *N. virens* tissues for Wilmington Harbor Federal Navigation Project samples in the MOTSU vicinity.

Organotins. For samples in the MOTSU vicinity, no 2013 adjacent Wilmington Harbor Federal Navigation Project tissues significantly exceeded reference organotin levels.

Pesticides. For samples in the MOTSU vicinity, 2013 Wilmington Harbor Federal Navigation Project tissues were not analyzed for pesticides.

Dioxins. For samples in the MOTSU vicinity, 2013 Wilmington Harbor Federal Navigation Project tissues were not analyzed for pesticides.

Wilmington Harbor Federal Navigation Project (2004):

Bioaccumulation Results for *Macoma nasuta* Tissues. Summary results for all parameters can be found in Evaluation of Dredged Material Proposed for Ocean Disposal Maintenance of Wilmington Harbor, Wilmington, North Carolina, April 2005 (See section 2.7 Historical Testing). Samples in the MOTSU vicinity with results statistically greater than the reference sample are shown in Table 11a.

Table 11a. Summary of Bioaccumulation Analyses for *Macoma nasuta*,
2004 Wilmington Harbor Federal Navigation Project Sediments.

Chemical Results for adjacent 2004 Wilmington Harbor Federal Navigation Project Tissues Statistically Greater than the Reference Tissues				
		KIBIMA04	UMMA04	WHREF04
Metals (mg/kg)	Selenium	0.29	--	--
	Nickel	1.46	--	--

-- no significant exceedance
n/a - not applicable

Lipids and Total Solids. No 2004 Wilmington Harbor Federal Navigation Project tissues were analyzed for lipids and total solids.

Metals. Selenium and Nickel were statistically greater than the WHREF04 (reference) for samples in the MOTSU vicinity. No metal concentration in tissues of bivalves exposed to test sediments exceeded FDA Action Limits. No bivalves exceeded the South Atlantic Bight Background Concentrations.

PAHs. For samples in the MOTSU vicinity, 2004 Wilmington Harbor Federal Navigation Project tissues were not analyzed for PAHs.

Organotins. No 2004 Wilmington Harbor Federal Navigation Project tissues were analyzed for organotins.

Pesticides. No 2004 Wilmington Harbor Federal Navigation Project tissues were analyzed for pesticides.

Dioxins. For samples in the MOTSU vicinity, 2004 Wilmington Harbor Federal Navigation Project tissues were not analyzed for pesticides.

Bioaccumulation Results for *Nereis virens* Tissues. Summary results for all parameters can be found in Evaluation of Dredged Material Proposed for Ocean Disposal Maintenance of Wilmington Harbor, Wilmington, North Carolina, April 2005 (See section 2.7 Historical Testing). Samples in the MOTSU vicinity with results statistically greater than the reference sample are shown in Table 11b.

Table 11b. Summary of Bioaccumulation Analyses for *Nireis virens*,
2004 Wilmington Harbor Federal Navigation Project Sediments.

Chemical Results for adjacent 2004 Wilmington Harbor Federal Navigation Project Tissues Statistically Greater than the Reference Tissues				
		KIBIMA04	UMMA04	WHREF04
Metals (mg/kg)	Cadmium	0.0454	--	--
	Copper	0.908	--	--

-- no significant exceedance
n/a - not applicable

Lipids and Total Solids. No 2004 Wilmington Harbor Federal Navigation Project tissues were analyzed for lipids and total solids.

Metals. Cadmium and Copper were statistically greater than the WHREF04 (reference) for samples in the MOTSU vicinity. No metal concentration in tissues of bivalves exposed to test sediments exceeded FDA Action Limits. No bivalves exceeded the South Atlantic Bight Background Concentrations.

PAHs. For samples in the MOTSU vicinity, 2004 Wilmington Harbor Federal Navigation Project tissues were not analyzed for PAHs.

Organotins. No 2004 Wilmington Harbor Federal Navigation Project tissues were analyzed for organotins.

Pesticides. No 2004 Wilmington Harbor Federal Navigation Project tissues were analyzed for pesticides.

Dioxins. For samples in the MOTSU vicinity, 2004 Wilmington Harbor Federal Navigation Project tissues were not analyzed for pesticides.

Bioaccumulation Evaluation

Comparison with FDA Action Levels for Poisonous or Deleterious Substances in Fish and Shellfish for Human Food. MOTSU and Wilmington Harbor Federal Navigation Project samples in the MOTSU vicinity did not have values greater than any of the published FDA Action Limits in tissues of organisms exposed to the sediments.

Comparisons to Reference Sediment Bioaccumulation. Concentrations of contaminants in tissues of organisms exposed for 28 days to 2007 MOTSU and 2013 Wilmington Harbor Federal Navigation Project sediments were compared to concentrations in tissues of organisms exposed for 28 days to reference sediment. These analyses took place for 2004 Wilmington Harbor Federal Navigation Project sediments as well, although *M. nasuta* underwent 24-day exposure and *N. virens* underwent 25-day exposure. Tables 9a, 9b, 10a, 10b, 11a, and 11b above display where sample contaminants were found to be statistically greater than the reference sediment. For both species, none of these contaminants were higher than any published FDA Action Limit.

General Risk-based Evaluations. When the bioaccumulation of contaminants in project sediments exceeds that in the reference, general risk-based evaluations must be considered. To comply with Part 227.13(c)(3), eight factors are used to make this determination.

1. The number of species in which bioaccumulation from the dredged material is statistically greater than bioaccumulation from the reference material.

There were two species tested in this evaluation, *Macoma nasuta* (a bivalve) and *Nereis virens* (a polychaete). Both species exhibited significantly greater bioaccumulation of certain contaminants when compared to the reference sediment.

2. The number of contaminants for which bioaccumulation from the dredged material is statistically greater than bioaccumulation from the reference.

   The tables above (Tables 9a, 9b, 10a, 10b, 11a, and 11b) for both species indicate the number of contaminants for which bioaccumulation in the dredged material from the entrance channel exceeded the bioaccumulation in the reference sediment.

3. Magnitude by which the bioaccumulation from the dredged material exceeds bioaccumulation from the reference material.

   The magnitude by which 2007 MOTSU contaminants exceeded reference levels ranged from 1.09 (Nickel in sample MOTMA07-S) to 5.18 (Pyrene in sample MOTMA07-N).

   The magnitude by which 2013 Wilmington Harbor Federal Navigation Project contaminants in the MOTSU vicinity exceeded reference levels ranged from 1.61 (Nickel in sample URCMA13) to 4.89 (Fluoranthene in sample URCMA13).

   The magnitude by which 2004 Wilmington Harbor Federal Navigation Project contaminants in the MOTSU vicinity exceeded reference levels ranged from 0.0454 (Cadmium in sample KIBIMA04) to 1.46 (Nickel in sample KIBIMA04).

4. Toxicological importance of the contaminants whose bioaccumulation from the dredged material statistically exceeds bioaccumulation from the reference.

   Beryllium: Bioconcentration of berylliumn is low because of low uptake from water, and biomagnifications of beryllium in aquatic food chains does not occur (Fishbein 1981 in EPA 1999).

   Cadmium: Cadmium is considered highly toxic to wildlife, even at low concentrations (Eisler 1985a in USEPA 2014), and bioaccumulates at all trophic levels (Sindayigaya, et al. 1994 and Sadiq 1992 in USEPA 2014); although cadmium sensitivity is less severe in fish and mollusks than in crustaceans (Sadiq 1992 in USEPA 2014).

   Chromium: Chromium has a low potential for trophic transfer and therefore is unlikely to biomagnify (USEPA 2014).

   Lead: While lead can bioaccumulate in algae, macrophytes, and benthic organisms, it is not known to biomagnify within the food chain (USEPA 2014). Results were below the published FDA Action Limits for bivalves. Additionally, results were within the range for the South Atlantic Bight Background concentrations within bivalves (0.05-0.77 mg/kg), including reference sediments.

Nickel: Nickel has a low potential for trophic transfer and therefore is unlikely to biomagnify (USACE 1995); however, mollusks and crustaceans are more sensitive than other organisms (USEPA 2014).

Silver: Silver may biomagnify in some aquatic invertebrates (USEPA 2014); however, silver did not exceed the published FDA Action Limit.

Thallium: Thallium has low rates of bioconcentration in aquatic systems and may be as toxic as copper on a weight basis (USEPA 2014).

PAHs: PAHs are semi-volatile compounds that have a high affinity for fine grained sediments. PAHs can be bioconcentrated to high concentrations by some aquatic organisms; however, many have the ability to metabolize PAHs. The main exposure route for upper level predators is ingestion, and since wildlife can readily metabolize PAHs, biomagnifications within the food chain is predicted to be minimal (USEPA 1999). There are no published FDA Action Limits for any of the PAHs in the above tables. Additionally, none of the values for either *M. nasuta* or *N. virens* were greater than the South Atlantic Bight Background concentrations.

5. Phylogenetic diversity of the species in which bioaccumulation for the dredged material statistically exceeds bioaccumulation from the reference material.

   The species tested were *Macoma nasuta* and *Nereis virens*. These species were recommended in the original 1991 "Green Book". The basic recommendations include requirements that a burrowing polychaete and a deposit feeding bivalve mollusk be tested. The test organisms are important in the region ecologically, represent species that provide adequate biomass for analysis, and are detritus feeders, which ingest sediments.

6. Propensity for the contaminants with statistically significant bioaccumulation to biomagnify within the aquatic food webs.

   None of the contaminants with statistically significant bioaccumulation have been shown to significantly biomagnify in the food chain.

7. Magnitude of toxicity and the number and phylogenetic diversity of species exhibiting greater mortality in the dredged material than in the reference material.

   Phylogenetic diversity is discussed in the response to factor 5 above. All species selected for testing were selected based in part on their phylogenetic diversity and also due to guidance in the 1991 "Green Book" and 2008 SERIM. The whole sediment bioassays show that the tested sediment does not cause significant acute toxicity (mortality) and meets the solid phase toxicity criteria of Part 227.6(c)(3).

8. Magnitude by which contaminants whose bioaccumulation from the dredged material exceeds that from the reference material also exceed the concentrations found in comparable species living in the vicinity of the proposed site.

   None of the contaminants whose bioaccumulation from the dredged material exceeded that of the reference material had bioaccumulation values greater than the South Atlantic Bight Background concentrations.

Benthic Bioavailability (Bioaccumulation) Evaluation Summary. Due to the evaluation of these eight factors and comparisons to FDA Action Limits, it is determined that there is no potential for undesirable effects due to bioaccumulation as a result of the presence of individual chemicals or of the solid phase of the dredge material as a whole. Accordingly, it is concluded that the solid phase of the material proposed for disposal meets the ocean disposal criteria at 40 CFR Parts 227.6(c)(3) and 227.27(b).

4.2 Recent Spills, Releases, and Discharges in MOTSU Vicinity

A USCG National Response Center query (http://www.nrc.uscg.mil) for releases in the MOTSU vicinity (including the municipalities of Bald Head Island, Carolina Beach, Leland, Southport, Wilmington, and Winnabow), was conducted and revealed 65 release reports into the Cape Fear River and nearby waters since sampling last took place in April 2011. These reports cover the entirety of MOTSU wharf facilities and associated basins and navigation channels, in addition to nearby Cape Fear River and marine waters. These reports indicate that the primary contaminants are paints, fuels, or oils, but that none of the reports were for major spills.

The 1972 National Pollutant Discharge Elimination System (NPDES) program was established under authority of the Clean Water Act and is focused on reducing pollutant sources (point source discharges) associated with facility operations. There are 11 major NPDES facilities in the MOTSU vicinity (http://portal.ncdenr.org/web/wq/npdes-major-facility-map), meaning these facilities disturbed 5 or more acres in a municipality of 100,000 or more and having a separate storm sewer system (MS4) (Figure 10).

The Inactive Hazardous Sites Branch (IHSB) of the North Carolina Division of Waste Management (DWM) is responsible for oversight and approval of the assessment and remediation of historical and accidental releases of hazardous substances and pollutants. DWM's IHSB viewer (http://portal.ncdenr.org/web/wm/gis/maps/ihs) was queried revealing over 50 past or accidental spills within an approximately 15-mile radius of MOTSU (Figure 11).

USEPA's National Priorities List (NPL), which contains national priorities among known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories, is used to determine sites warranting investigation (http://www.epa.gov/superfund/sites/query/queryhtm/nplmapsg.htm). The NPL was queried revealing 3 final and 1 deleted sites in the MOTSU vicinity (Figure 12).

USEPA's EnviroMapper for Envirofacts (http://www.epa.gov/emefdata/em4ef.home) was also queried, revealing 45 facilities or facility clusters (manufacturing/transporting primarily oil, concrete, and other industrial products) reporting toxic releases, transfers, and waste management to USEPA within an approximately 15-mile radius of MOTSU (Figure 13).

Recent Spills, Releases, and Discharges Summary. Based on the above information, no significant spill, release, or discharge events have recently occurred in the MOTSU vicinity. Any spills, releases, or discharges may be expected to have had negligible effect on the proposed dredged materials assessed in this evaluation.

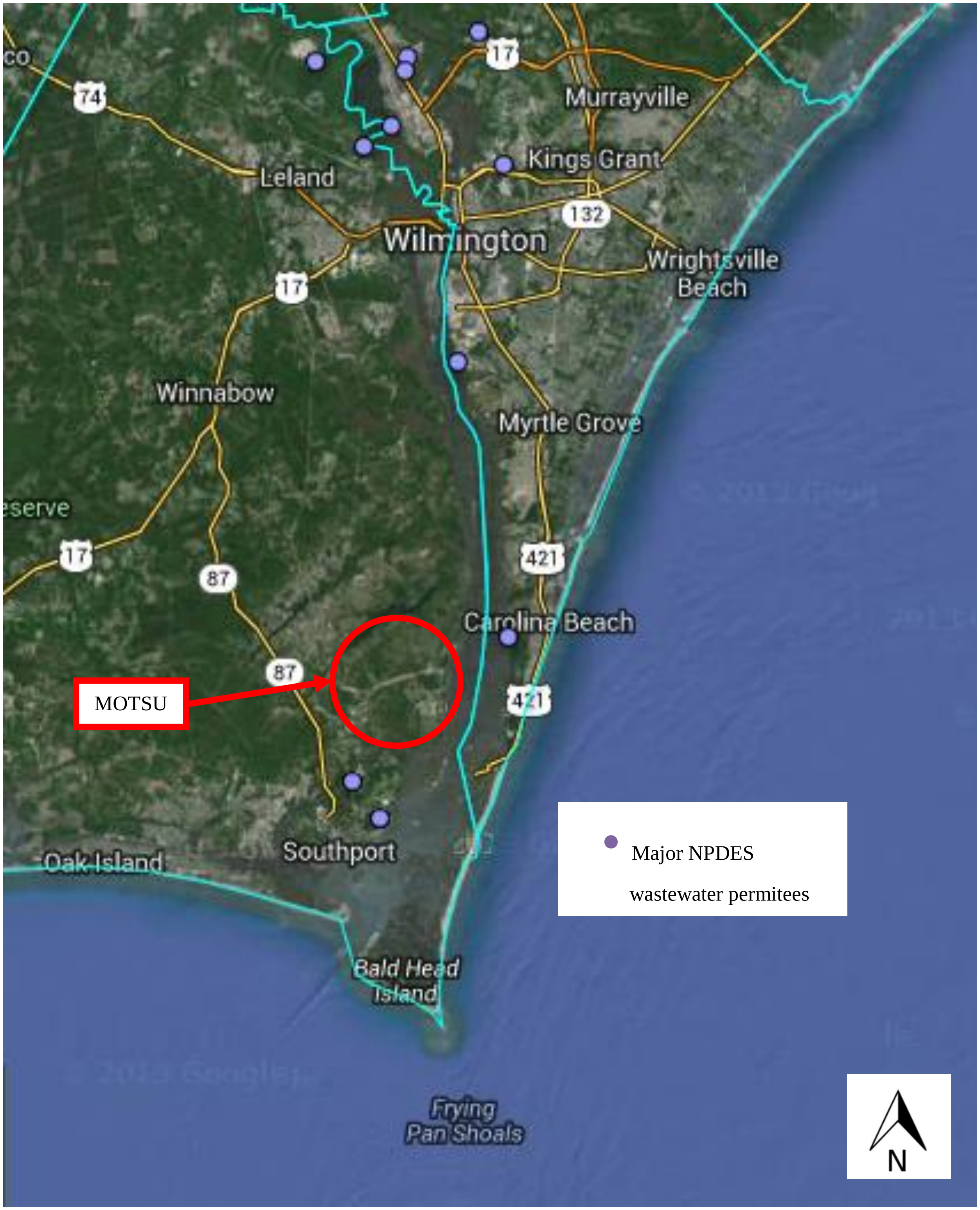

Figure 10. Major NPDES wastewater permitees in MOTSU vicinity.

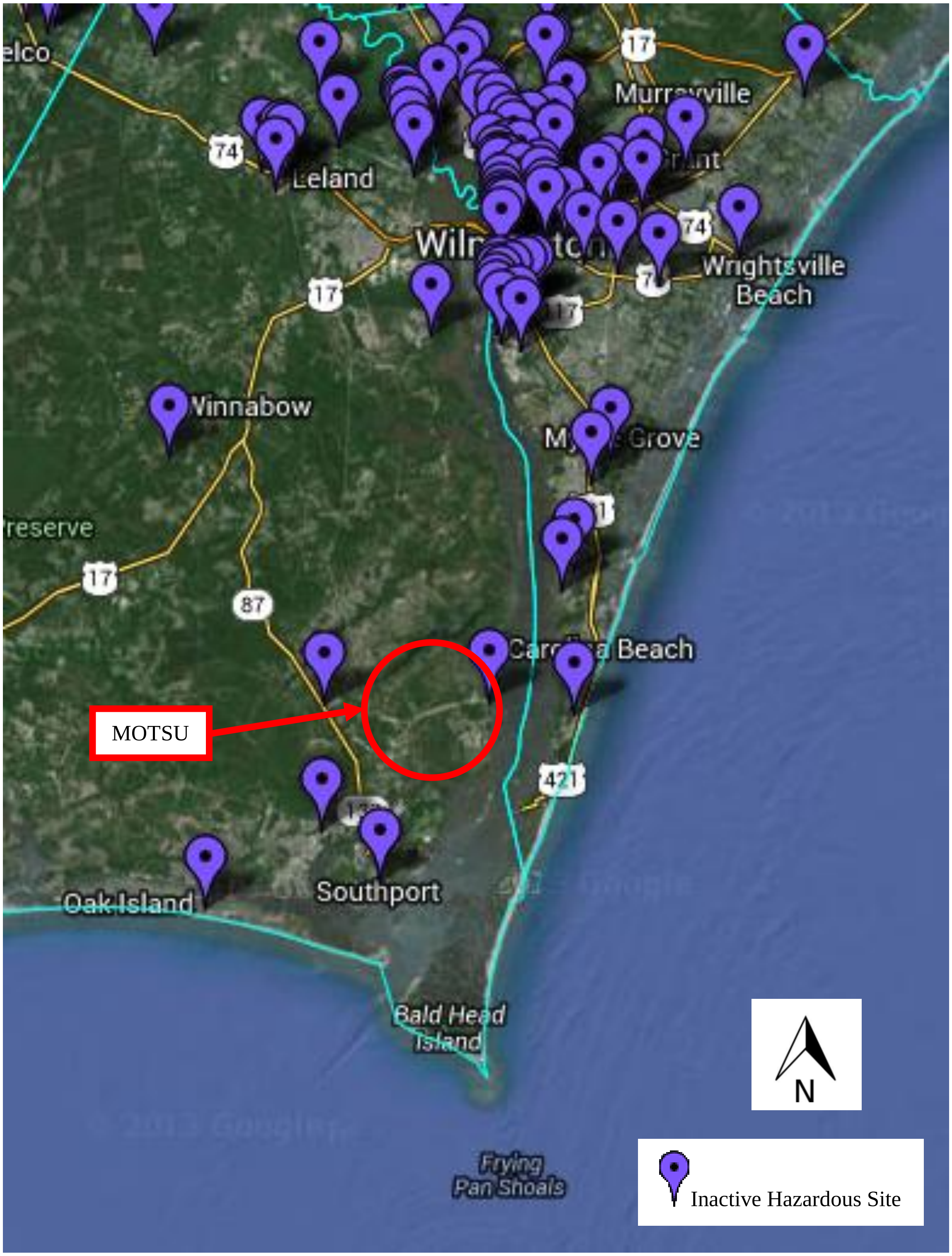

Figure 11. Inactive Hazardous Sites in MOTSU vicinity.

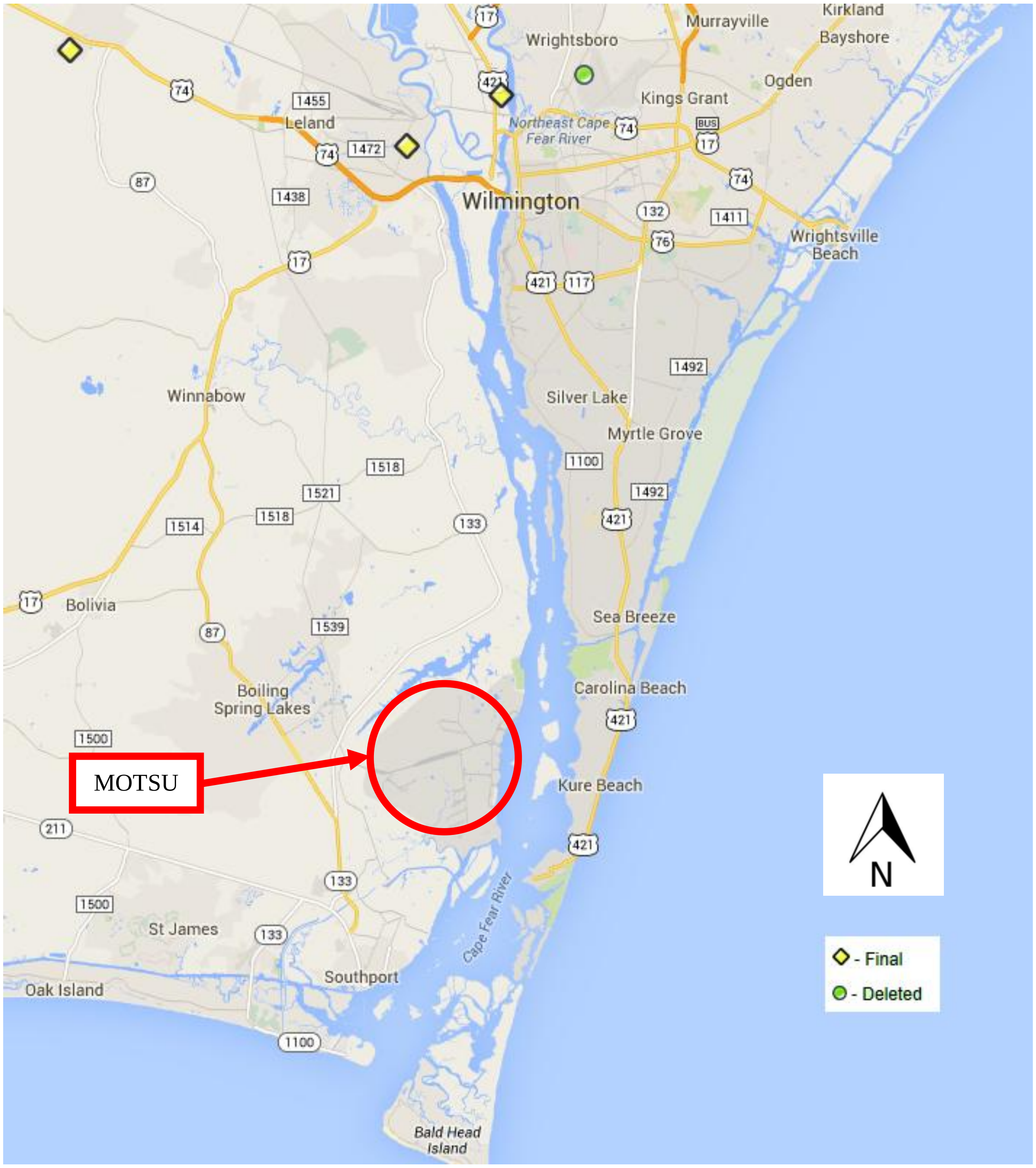

Figure 12. National Priorities List (NPL) Sites in MOTSU vicinity.

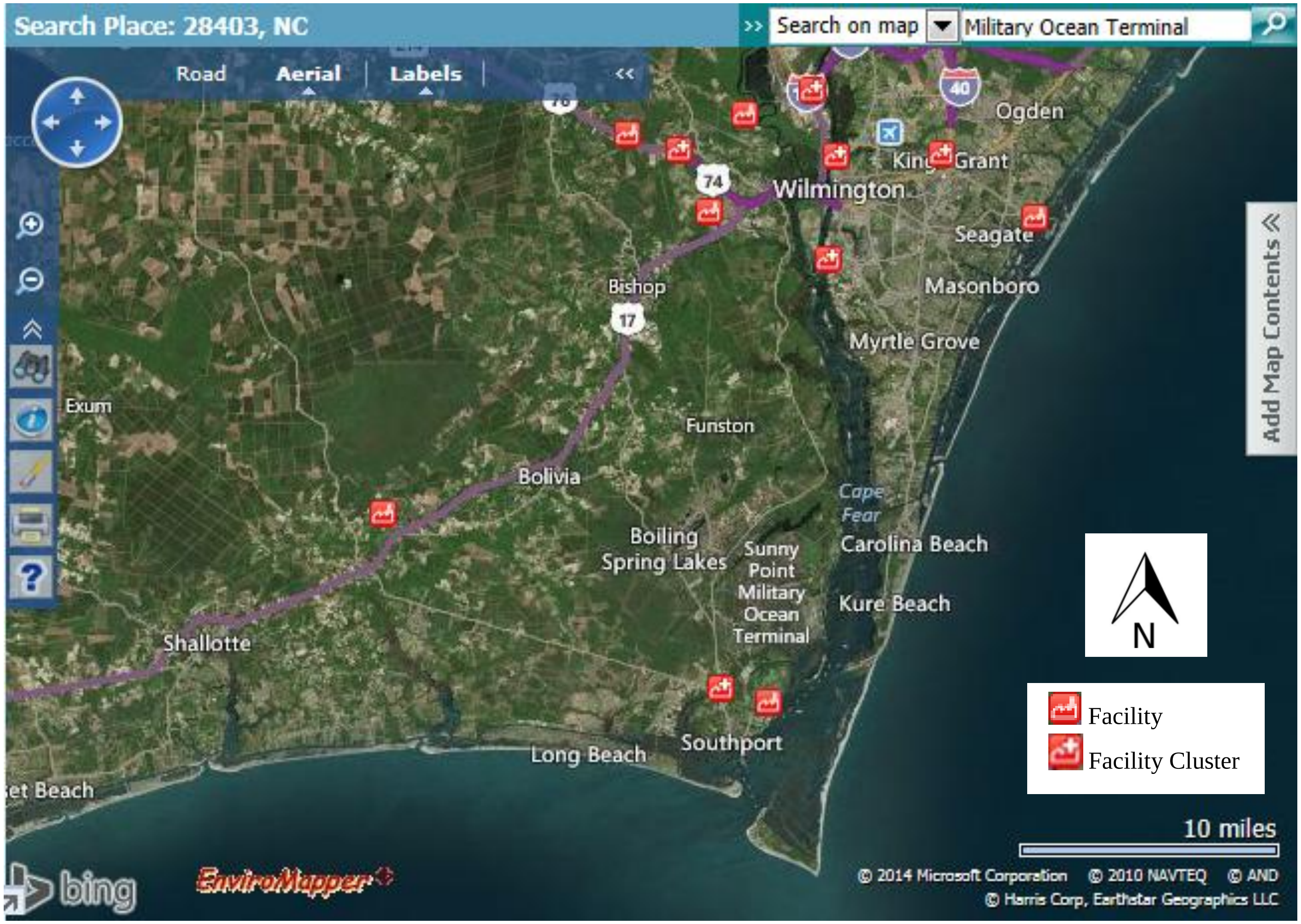

Figure 13. Toxic releases reported to USEPA in MOTSU vicinity.

4.3 MPRSA Section 103 Ocean Disposal Criteria Compliance Evaluation

4.3.1 Subpart A – General

Part 227.1 Applicability

The proposed transportation of this dredged material for disposal in ocean waters was evaluated to ensure that the proposal would not unreasonably degrade or endanger human health, welfare, or amenities or the marine environment, ecological systems, or economic potentialities. In making this determination, the criteria established by the Administrator, USEPA, pursuant to Section 102(a) of the MPRSA of 1972, as amended, where applied. In addition, navigation, economic, and industrial development, and foreign and domestic commerce of the United States, and the availability of other alternatives were considered in determining the need to dispose of the dredged material in ocean waters.

Part 227.2 Materials Which Satisfy the Environmental Impact Criteria of Subpart B

The material proposed for ocean dumping satisfies the environmental impact criteria set forth in Subpart B. The information to follow supports that determination. In addition, the information presented in the introductory paragraphs and to follow indicates that there is a need for ocean dumping in accordance with Subpart C; there are no unacceptable adverse effects on aesthetic, recreational, or economic values in accordance with the criteria set forth in Subpart D; and, there are no unacceptable adverse effects on other uses of the ocean as determined in accordance with criteria established in Subpart E.

Part 227.3 Materials Which Do Not Satisfy the Environmental Impact Criteria of Subpart B

Not applicable.

4.3.2 Subpart B – Environmental Impact

Part 227.4 Criteria for Evaluating Environmental Impact

The proposed transportation of this dredged material for disposal in ocean waters was evaluated to determine that the proposal would not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. In making this determination, the criteria established by the Administrator, USEPA, pursuant to Section 102(a) of the MPRSA of 1972, as amended, were applied.

Part 227.5 Prohibited Materials

The dredged material proposed for ocean dumping is not known to include prohibited materials as defined in this section.

Part 227.6 Constituents Prohibited as Other Than Trace Metals

MOTSU sediments proposed for ocean disposal as described previously, have been tested to determine acceptability for ocean disposal in accordance with EPA's Ocean Dumping Regulations and Criteria (part 227.13(c)) using methods described in *Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual* (USEPA and USACE 1991) and the *Southeastern Regional Implementation Manual Requirements and Procedures for Evaluation of the Ocean Disposal of Dredged Material in Southeastern Atlantic and Gulf Coastal Waters* (USEPA and USACE 2008). The evaluation included **Water Column** (Part 227.6(c)(1) and 227.27(a)), **Suspended Particulate Phase** (Part 227.6(c)(2) and 227.27(b)), and **Benthic** (Part 227.6(c)(2) and 227.27(b)) determinations.

Part 227.7 Limits Established for Specific Wastes of Waste Constituents
The dredged material to be disposed of in the New Wilmington ODMDS does not exceed the limits set forth for the designated specific wastes or waste constituents listed in this section, such as: 1) liquid waste constituents immiscible with or slightly soluble in seawater, 2) radioactive materials, 3) wastes containing living organisms that may endanger human health or wildlife, and 4) wastes that are highly acidic or alkaline.

Part 227.8 Limitations on the Disposal Rates of Toxic Wastes
No toxic wastes will be dumped exceeding the limiting permissible concentration as defined in 40 CFR Part 227.27.

Part 227.9 Limitations on Quantities of Waste Materials
The quantities of dredged material to be dumped will not cause long-term damage to the marine environment or to amenities. All dumping activities meet the requirements of the USEPA approved New Wilmington ODMDS SMMP (2012).

Part 227.10 Hazards to Fishing, Navigation, Shorelines, or Beaches
Use of the New Wilmington ODMDS will be managed to address mounding. The dredged material will be distributed over sufficient area to prevent mounding from being a hazard to navigation. The site provides ample capacity for dredged material disposal. The disposal area appears on NOAA NOS navigation charts. The proposed ocean disposal will not cause unacceptable interference with fishing or produce unacceptable conditions on shorelines or beaches. The material proposed for ocean disposal is fine-grained material and, as such, is not suitable for direct placement on shorelines as beachfill material.

Part 227.11 Containerized Wastes
No containerized wastes are to be dumped.

Part 227.12 Insoluble Wastes
The dredged material proposed for ocean dumping consists of naturally occurring sediment materials. These materials are compatible with the ocean environment of the New Wilmington ODMDS. The majority of materials to be disposed of are fine-grained material. Sediment chemistry testing, bioassays, bioaccumulation testing, and ADDAMS modeling indicates that these materials would be rapidly dispersed or deposited without damage to marine life (e.g., benthic, demersal, or pelagic).

Part 227.13 Dredged Materials
Dredged materials from MOTSU basins and navigation channels have been evaluated in accordance with EPA's Ocean Dumping Regulations and Criteria (40 CFR 220-229) using techniques described in Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual (Green Book; USEPA and USACE 1991) and the Southeast Regional Implementation Manual Requirements and Procedures for Evaluation of the Ocean Disposal of Dredged Material in Southeastern Atlantic and Gulf Coast Waters (SERIM; USEPA and USACE 2008). The sampling design was closely coordinated with USEPA, Region 4 and included bulk sediment evaluations, bioassays, and bioaccumulation evaluations. The results of these analyses are presented in Section 103 Evaluation or Dredged Material Proposed for Ocean Disposal,

Military Ocean Terminal Sunny Point, North Carolina (USACE 2012). The rest results indicate that the sediments are acceptable for ocean disposal under Section 103 of the MPRSA of 1972, as amended.

4.3.3 Subpart C – Need for Ocean Dumping

Part 227.14 Criteria for Evaluating the Need for Ocean Dumping and Alternatives for Ocean Dumping

A determination of the need for the proposed ocean dumping was made based on the guidelines specified in 40 CFR Part 227 Subpart C. There is a need for ocean dumping for materials associated with the MOTSU dredging program as upland disposal is not a long-term, viable alternative. Ocean disposal is the most cost-effective, and the only long-term disposal solution for MOTSU dredged materials.

Part 227.15 Factors Considered in Determination of Need for Ocean Dumping

a. **Degree of treatment useful and feasible for the waste to be ocean dumped –** No treatment for the dredged material to be ocean dumped is needed, nor is it feasible. The dredged material is naturally occurring material deposited from riverine sedimentation.
b. **Raw Materials and manufacturing or other processes resulting in waste –** Not applicable.
c. **Other materials –**
    a. **Landfill (diked upland disposal) –** Although confined disposal does occur at MOTSU's diked upland disposal area 4 (DA 4), it has limited remaining capacity (1.4 million yd^3) and has been held in strategic reserve for several years. No other long-term dredged material disposal option is available.
    b. **Beachfill –** MOTSU dredged materials are fine-grained sediments, and are unacceptable for use as beachfill.
    c. **Well Injection –** Not applicable.
    d. **Incineration –** Not applicable.
    e. **Spread material over the open ground –** Not applicable.
    f. **Recycling of material for reuse –** The large volumes of fine-grained materials produced each year and the high water content make significant reuse expensive and unlikely.
    g. **Additional biological, chemical, or physical treatment of intermediate or final waste –** Not applicable.
    h. **Storage –** The temporary storage of dredged materials for later beneficial use is not feasible due to the large annual volumes. No economic or environmental advantages are obtained with storage.
d. **Irreversible or irretrievable consequences of the use of alternatives to ocean dumping –** No environmentally acceptable or economically feasible alternatives to ocean dumping are available. Existing confined upland disposal is very limited due to capacity constraints and currently, acceptable lands do not exist for the creation of new confined disposal sites. Creation of new upland disposal sites would dedicate large upland areas for that use, which are unavailable due to MOTSU's mission requirements.

Part 227.16 Basis for Determination of Need for Ocean Dumping

The previous section addresses this determination. Additionally, there are no practical improvements which can be made in process technology or overall waste treatment to reduce the adverse impacts of the waste on the total environment. There are also no practicable alternative locations and methods of disposal or recycling available which have less environmental impact or potential risk to other parts of the environment than ocean dumping.

4.3.4 Subpart D – Impacts of the Proposed Dumping on Aesthetic, Recreational, and Economic Values

Part 227.17 Basis for Determination

The impact of proposed dumping on aesthetic, recreational and economic values were evaluated according to the factors in 40 CFR Part 227 Subpart D.

Part 227.18 Factors Considered

The following factors were considered in the assessment of the impacts of the proposed ocean dumping on aesthetic, recreational, and economic values of the marine environment.

a. Nature and extent of present and potential recreational and commercial use of areas affected by the proposed dredging – The proposed ocean dumping does not impact the recreational or commercial use of the marine environment provided that the New Wilmington ODMDS SMMP is utilized.
b. Existing water quality – Ocean disposal of dredged material has short term temporary impacts on water quality, specifically turbidity. The suspended material is expected to quickly settle to the bottom following disposal. The temporary increase in turbidity is not expected to have an adverse impact on the marine environment as evident by the result of the ADDAMS modeling.
c. Applicable water quality standards – will not be contravened.
d. Visible characteristics of the materials which could result in unacceptable aesthetic nuisance in recreational areas – same as b.
e. Presence of pathogenic organisms which may cause a public health concern – No known pathogenic organisms in sediment materials from MOTSU facilities.
f. Presence of toxic chemical constituents which may affect humans – The dredged materials do not contain chemical constituents which could be released in volumes that may adversely affect humans.
g. Presence of material which may be bioaccumulated or persistent and may have adverse effects on humans directly or through food chain interaction – Testing indicated that these sediments meet the criteria established in EPA’s Ocean Dumping Regulations and Criteria for environmental acceptability for ocean dumping. No adverse interactions are expected.
h. Presence of material which may significantly affect living marine resources or recreational or commercial value – The proposed materials for ocean dumping are similar to those existing in and around the existing New Wilmington ODMDS and constituents which may adversely impact living marine resources are not known to be present in quantities predicted to harm those resources.

Part 227.19 Assessment of Impact

The proposed ocean disposal of dredged material is not expected to have significant adverse impacts on recreational use, and values of ocean water, inshore waters, beaches, and shorelines.

4.3.5 Subpart E – Impact of Proposed Dumping on Other Uses of the Ocean

Part 227.20 Basis for Determination

An evaluation was made of the impact of the proposed dumping on long-term impacts on other uses of the ocean in accordance with criteria established in 40CFR Part 227 Subpart E. The other uses defined in this section are specific uses of the ocean.

Part 227.21 Uses Considered

	Use	Expected Impact
a.	Commercial fishing in open ocean areas	None
b.	Commercial fishing in coastal areas	None
c.	Commercial fishing in estuarine areas	None
d.	Recreational fishing in open ocean areas	None
e.	Recreational fishing in coastal areas	None
f.	Recreational fishing in estuarine areas	None
g.	Recreational use of shorelines and beaches	None
h.	Commercial navigation	None
i.	Recreational navigation	None
j.	Exploitation of living marine resources	None
k.	Exploration of non-living marine resources	None
l.	Scientific research and study	None

Part 227.22 Assessment of Impact

The proposed ocean dumping of material from MOTSU is not expected to have significant adverse impacts on other ocean uses, considering both temporary and long-term effects. Based on the above review, the dredged material meets the criteria for acceptability established in 40 CFR Part 227, provided all material is handled in accordance with the approved New Wilmington ODMDS SMMP.

5.0 Conclusions

2011 and 2007, and 2013 and 2004 sediment testing events for MOTSU and Wilmington Harbor Federal Navigation Project, respectively, showed that the sediments were in full compliance with USEPA's Ocean Dumping Regulations and Criteria. Based on existing and readily available, assembles, and interpreted information, again for MOTSU and the Wilmington Harbor Federal Navigation Project, respectively, the physical and chemical characteristics of sediments in the MOTSU vicinity have not changed significantly over time. There have been no significant spills in waters near MOTSU or in surrounding waters that would impair waters or sediments in the vicinity. Therefore, based on the above review, the weight of evidence shows that MOTSU sediments are still in full compliance with USEPA's Ocean Dumping Regulations and Criteria.

6.0 References

Buchman, M.F., 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.

U.S. Army Corps of Engineers. 1995. Trophic Transfer and Biomagnification Potential of Contaminants in Aquatic Ecosystems. Environmental Effects of Dredging Technical Notes, EEDP-01-33, January 1995.

U.S. Army Corps of Engineers. 2012. Section 103 Evaluation of Dredged Material Proposed for Ocean Disposal, Military Ocean Terminal Sunny Point, North Carolina. USACE, South Atlantic Division, Wilmington District, Wilmington, NC.

U.S. Army Corps of Engineers. 2013. Section 103 Evaluation of Dredged Material Proposed for Ocean Disposal, Wilmington Harbor, Wilmington, North Carolina. USACE, South Atlantic Division, Wilmington District, Wilmington, NC.

U.S. Environmental Protection Agency. 2002. National Recommended Water Quality Criteria. EPA 822-R-02-047. EPA, Office of Science and Technology, Health and Ecological Criteria Division, Washington D.C.

U.S. Environmental Protection Agency. 1999. Protocol for Screening Level Ecological Risk Assessment. Appendix H, Toxicological Profiles, Screening Level Ecological Risk Assessment Protocol. August 1999. From: http://www.epa.gov/region6/6pd/rcra_c/protocol/apph-all.pdf. Accessed 10/7/2014.

U.S. Environmental Protection Agency. Ecological Toxicity Information. http://www.epa.gov/R5Super/ecology/toxprofiles.htm. Accessed on 10/7/2014.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1991. Evaluation of Dredged Material Proposed for Ocean Disposal, Testing Manual [Green Book]. EPA 503-8-91-001. EPA, Office of Marine and Estuarine Protection, Washington D.C.; and Department of the Army, USACE, Washington, D.C.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1998. Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual, Inland Testing Manual. EPA 823-B-98-004. EPA, Office Water, Office Of Science and Technology, Washington D.C.; and Department of the Army, USACE, Operations, Construction, and Readiness Division, Washington, D.C.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 2008. Southeast Regional Implementation Manual (SERIM), Requirements and Procedures for Evaluation of the Ocean Disposal of Dredged Material in Southeast U.S. Atlantic and Gulf Coast Waters. EPA 904-B-08-001. EPA Region 4, Atlanta, GA, and USACE South Atlantic Division, Atlanta, GA.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 2012. New Wilmington Ocean Dredged Material Disposal Site, Site Management and Monitoring Plan (SMMP). EPA Region 4, Atlanta, GA, and USACE South Atlantic Division, Atlanta, GA.