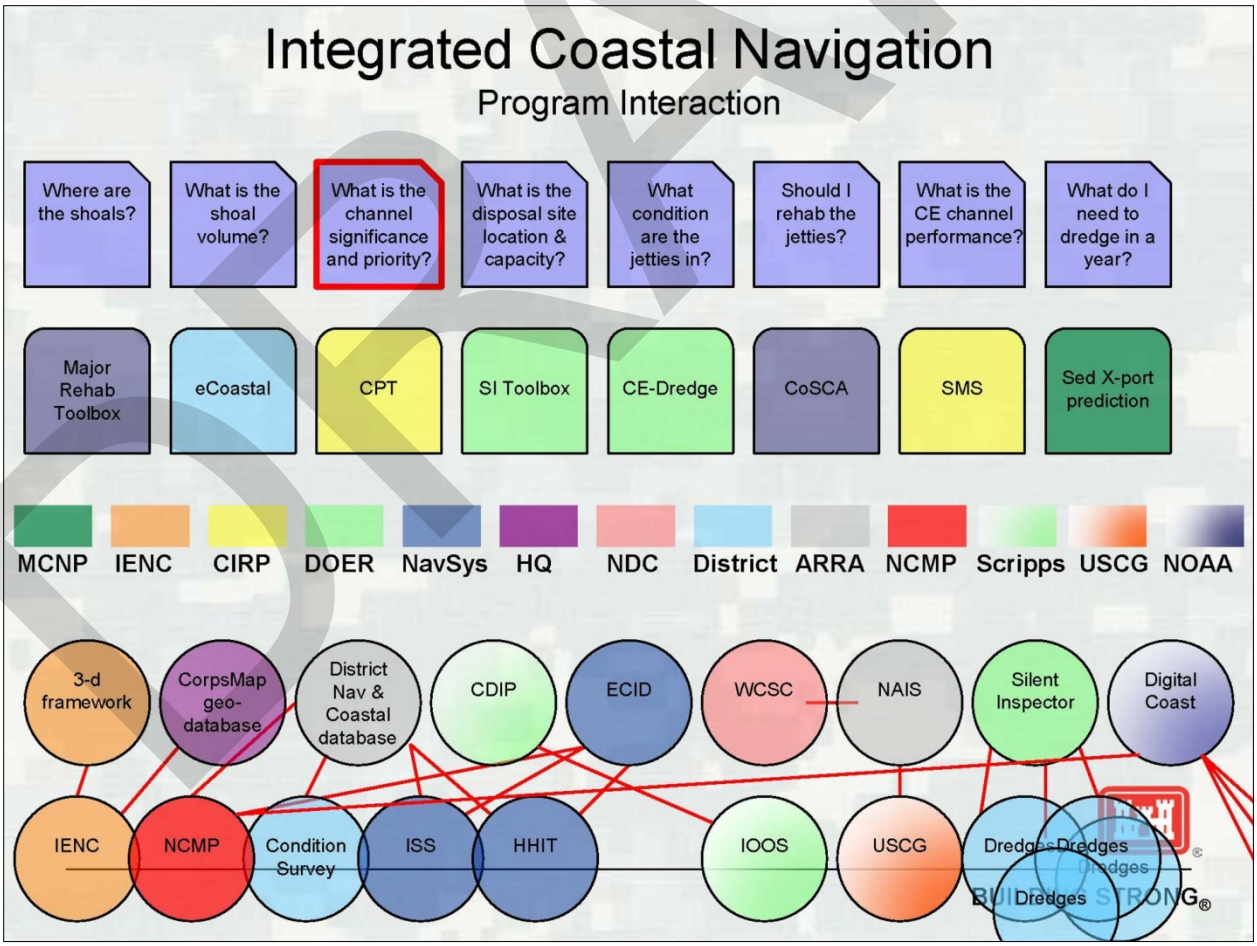
US Army Corps of Engineers

Navigation Data Integration Framework Concept and Implementation Plan

US Army Corps of Engineers
Navigation Business Line



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Executive Summary

The Navigation Data Integration Framework (NDIF) is fully compliant with US Army Corps of Engineers (USACE) policy, guidance, and intent regarding data, security, and information technology (IT) infrastructure, and it represents the distillation of these policies and guidance into a best practices approach to effectively and efficiently implement them. It brings order and a detailed methodology to link Navigation Business Line data and tools across the business line, across other USACE Civil Works missions, and with our stakeholders.

The USACE Districts and Centers across the country maintain multiple databases related to navigation, and new applications and tools are regularly developed to display, mine, analyze, distribute, and use data to inform decisions. The existence of multiple similar applications and databases is, in itself, not a problem—personnel typically have easy access to the data they use on a recurring basis. However, the lack of connection of the databases with other USACE and stakeholder applications and data results in several challenges, including redundant manual data entry, multiple values for the same field, inconsistency in data format, lack of data availability, and data timeliness. One goal of the NDIF is to collect data once and use it many times.

To address these challenges, the USACE Navigation Business Line initiated development of a Data Integration Framework (DIF)—a combination of processes, standards, people, and tools used to transform disconnected data into useful, easily accessible information for strategic analysis and informing decisions. A DIF is not a physical object but, rather, a blueprint illustrating how all of the pieces interact and establishing a set of procedures and best business practices for data management. Through the use of business rules and technical conversions, a good DIF architecture turns data scattered among different databases and locations into data that is consistent across databases, that can be easily accessed by applications, and that—when combined for analysis and reporting—can generate more insights into navigation status, effectiveness, and efficiency than each piece of data could individually.

Due to the size and complexity of the data, applications, and tools that currently exist within the USACE Navigation Business Line, the NDIF initiative has been divided into multiple components—Dredging, River Information Services (RIS), Surveying and Mapping, Infrastructure and Asset Management, Engineering With Nature (EWN) and Regional Sediment Management (RSM), and the Marine Transportation System. The data identified will first be linked separately within each category and then linked into a single DIF for the entire Navigation Business Line. Dredging was selected for the first test case because the dredging data sets are among the most mature of the navigation data sets. Each of the dredging systems will retain its key mission requirements, but linking systems into a single virtual system will address the vertical and horizontal requirements of USACE and lessen the potential for human errors; reduce the time and effort required for data entry and maintenance; provide cross-system quality assurance and quality control (QA/QC); and deliver both the real-time and historical data and reports required by USACE Headquarters (HQUSACE) and USACE Districts.

The NDIF architecture is comprised of five parts—1) Source Databases—the individual databases that store navigation data, 2) Hub Catalog—the central catalog that connects each of the individual databases, 3) Tools—applications which visualize, analyze or, in some other way, use the source data accessed through the hub catalog, 4) Web Service Layer—a collection of web services, which allow the exchange of data between databases over the Internet and which provide a method for querying and/or updating data in the hub catalog,

and 5) Portal—a website that links data, tools, and best practices for Navigation and that can retrieve information from multiple databases through the hub catalog and provide access to a wide range of resources.

The objectives of the NDIF were designed to assist those who collect, enter, and distribute USACE navigation data as well as those who use it. In general, these objectives center on compiling complete and accurate data by integrating data creation with workflows in the District, making the data available faster, providing easier access to those who use the data, and enabling the data to be used across specific functional boundaries. In other words, the NDIF will remove the insularity that currently characterizes so much USACE data. These objectives fully comply with USACE's data policies, including its enterprise geospatial program, as defined in ER 1110-1-8156, *Policies, Guidance, and Requirements for Geospatial Data and Systems*, and EM 1110-1-2909, *Geospatial Data and Systems*, but they are not limited to geospatial data. The NDIF will expose and make discoverable decentralized data through a centralized hub catalog and, in the process of linking disparate databases, provide a geospatial component to data that previously had none. The ultimate goal of the NDIF is to develop an integrated data system across the Navigation Business Line.

Concept

Introduction

The US Army Corps of Engineers (USACE) Districts and Centers across the country maintain multiple databases related to navigation and regularly develop new applications and tools to display, mine, analyze, distribute data, and use that data to inform decisions. Dredging data, for example, is collected and stored in four different systems—the Dredging Information System (DIS), the Dredging Manager (DH), the Dredging Quality Management (DQM) Program, and the Resident Management System (RMS). River Information Services accesses or collects data from several sources, including the Inland Electronic Navigation Charts (IENC), the Lock Operations Management Application (LOMA), the Lock Performance Monitoring System (LPMS), and Master Docks Plus (MDP) as well as the US Coast Guard's Nationwide Automatic Identification System (NAIS). A number of other databases store data for Surveying and Mapping, Infrastructure and Asset Management, Engineering With Nature (EWN) and Regional Sediment Management (RSM), and the Marine Transportation System. Some of the data comes from enterprise data systems while other data comes from best practices across the USACE or other agencies and stakeholders. This data is displayed on workstations and/or the Internet; mined through queries, reports, and/or spreadsheets; and distributed via paper, email, and/or the Internet.

Applications to use these data are also created across the USACE, in Districts, Labs, and Centers, and via contract. While most are single-purpose applications with narrow uses, others are developed with an enterprise view or, with modification, they could be adopted for enterprise use. The more these applications can be shared, the faster our capabilities grow and the fewer resources are used to recreate good tools. In addition, linking applications with data increases their efficiency and reduces the level of training necessary to make them work. This, in turn, increases the value of the applications, encouraging their adoption throughout the USACE.

In an effort to address these challenges, the Navigation Business Line has created the concept of a Navigation Data Integration Framework (NDIF) to better link navigation tools, data, and technical resources. While this framework is "owned" by the Navigation Community of Practice, anyone who needs navigation data and tools can use and expand it. The overall concept is to empower users across the USACE to create, innovate, and share. This document summarizes the NDIF concept, presents the current implementation plan, and provides detailed appendices on implementation.

What is the Problem?

Across the USACE Navigation Business Line, similar decisions are being made daily about projects that rely on similar data and calculations, but these same decisions are typically based on a range of analysis approaches, data, tools, and processes developed individually at each office. If data, tools, and processes were shared across Navigation, a number of efficiencies could be made.

The existence of multiple databases is, in itself, not a problem—personnel typically have easy access to the data they use on a recurring basis. However, it is the relative insularity of each of these databases—their lack of connection with other databases within the USACE and with stakeholders—that causes several problems, mostly centered on data duplication.

While each database contains much unique data, it also includes some duplicate information (for example, contract number, project name, and contractor) that is also recorded in other databases, which introduces the following issues:

- **Data Entry Errors**—Manual data entry provides the opportunity for human error; the more data that is entered by hand, especially when typing numbers (such as CWIS [Civil Works Information System] or contract numbers), the greater the possibility of mistyping, regardless of how careful the typist is.

- **Data Inconsistency**—When different staff members enter the same data (for example, project or contractor names) in different locations, they may enter it differently.

- **Time and Effort**—Manual data entry requires time and effort; the more data that must be entered manually, the more time and effort required.

- **Participation**—When users have to enter data needlessly (that is, when it could be prepopulated for them) or when they *think* they have to enter it needlessly (that is, when they do not see it as a benefit to themselves), they are less likely to do so—either initially or when updates are required. In addition, understanding the value of the data they enter may cause them to be more diligent, thus increasing the accuracy of their entries.

- **Data Availability**—USACE Navigation data is used by several groups of people—USACE staff, other Federal and non-Federal agencies, and the general public. However, this data is not always easy to find and seldom available in a single location. Instead, it is stored in different types of databases on different servers and personal computers across the USACE. In addition, it is rarely available on any type of smart device.

- **Data Timeliness**—Data may not be available to those who need it *when* they need it. The process to discover, access, and transform data for analytical use is time consuming and, therefore, the data is not as useful as it might be.

- **Data Format**—Data may be published in a format convenient for the group that collected and published it, but not necessarily for others who need to use it. Because data is collected by many sources for different uses, there has been little standardization in data format.

The problem of insularity and duplication also extends to the applications developed by or for USACE Districts, Labs, and Centers to view, manipulate, analyze, and use data. While some of these applications have been developed with the ultimate goal of adoption across the USACE, others remain "hidden," used only by a small fraction of USACE staff. Thus, regardless of their value to certain personnel, their overall effectiveness is diminished because they do not benefit the USACE as a whole. Rather, when another office is faced with similar data viewing and analysis requirements , it may unnecessarily consume USACE resources to develop another application that is essentially a clone of the first. If existing applications could be shared, with or without modification, across the entire Navigation Business Line, the entire USACE would benefit through increased efficiencies, lower operating costs, and access to a more comprehensive dataset.

How can this Problem be Solved?

In recognition of these issues, the Navigation Data Integration Framework (NDIF) was prioritized as a Top 10 initiative for the Navigation Business Line at the USACE Navigation Program Strategic Vision Workshop held on March 13–15, 2012. Then, at a navigation stakeholders meeting held on April 23-25, 2012, the USACE Mobile District, Spatial Data Branch (CESAM-OP-J)—in conjunction with the USACE Engineer Research and Development Center (ERDC) and the USACE Navigation Data Center (CEIWR-NDC)—was tasked with developing an NDIF to integrate the data, applications, and tools used across the USACE Navigation Business Line.

What is a Data Integration Framework?

A data integration framework (DIF) is a combination of processes, standards, people, and tools used to transform disconnected enterprise data into useful, easily accessible information for strategic analysis and reporting. It is not a physical object in itself but, rather, a blueprint identifying how all of the pieces interact and forming a set of standards and best business practices. Through the use of business rules and technical conversions, a good DIF architecture turns data scattered among different databases and locations into data that is consistent across databases, that can be easily accessed, and that—when combined for visualization, analysis, and reporting—can generate more insights into navigation status, effectiveness, and efficiency than each piece of data could individually.

What is the Scope of the Navigation Data Integration Framework?

Due to the size and complexity of the data, applications, and tools that currently exist within the USACE Navigation Business Line, the Navigation Data Integration Framework (NDIF) initiative has been subdivided into six categories. The data, applications, and tools identified for each category will be linked first within that category and then, after all categories have been completed, linked across categories to create the DIF for the entire Navigation Business Line. Lessons learned within each category will be applied across the NDIF.

Each navigation system linked within the NDIF will retain its key mission requirements, but synergy between systems will lessen the potential for human errors; reduce the time, and effort required for data entry and

maintenance; provide cross-system QA/QC; and deliver both the real-time and historical data and reports required by HQUSACE and USACE Districts.

Dredging

Dredging was selected as the first case of the NDIF because the dredging data sets are among the most mature of the navigation data sets. This category encompasses the development of a Dredging Data Information Framework Portal "front end" to the dredging databases—the Dredging Information System (DIS), the CE-Dredge Dredging Manager (DM; previously known as Dredging Histories [DH]), the Dredging Quality Management (DQM) Program, and the Resident Management System (RMS)—their connection to the portal and each other, and the portal's connection to the USACE Districts' Navigation and Coastal Data Bank (NCDB).

River Information Services

This category includes the Inland Electronic Navigation Charts (IENC), Lock Operations Management Application (LOMA), Lock Performance Monitoring System (LPMS), and Master Docks Plus (MDP) tools and data sets as well as the Consolidated US Coast Guard (USCG) Web Service and the US Coast Guard's Nationwide Automatic Identification System (NAIS).

Surveying and Mapping

The Surveying and Mapping category includes eHydro Hydrographic Survey tools, the National Channel Framework (NCF), the National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), and the Navigation and Coastal Data Bank (NCDB) tools and data sets.

Infrastructure and Asset Management

This category includes the coastal and inland structures in the Channel Portfolio Tool (CPT); Coastal Structures Management, Analysis, and Ranking Tool (CSMART); Enterprise Coastal Inventory Database (ECID); Lock Characteristics; Lock Performance Monitoring System (LPMS), Master Docks Plus (MDP); National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX); Navigation and Coastal Databank (NCDB); and Port and Waterways Facilities tools and data sets.

Engineering With Nature and Regional Sediment Management

The Engineering With Nature and Regional Sediment Management category includes the Civil Works Project Mitigation Database (CWPMD), Ecosystem Restoration Business Line (ERBL), eHydro Hydrographic Survey, Engineering with Nature (EWN), National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), National Channel Framework (NCF), Navigation and Coastal Data Bank (NCDB), Ocean Disposal Database (ODD), and Sediment Budget Analysis System (SBAS) tools and data sets.

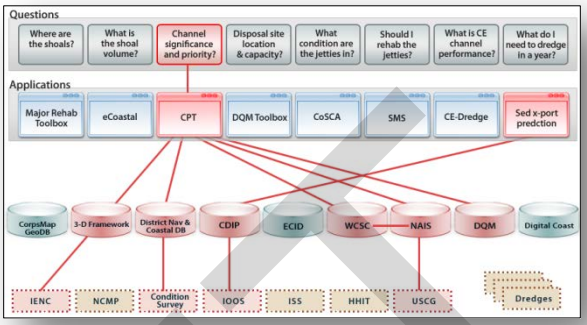
Marine Transportation System

This category includes the Commodity Code Cross Reference File, Flag Master File, Foreign Cargo (Inbound/Outbound), Foreign Traffic Vessel Entrances and Clearances, Hazardous Commodity Code Cross Reference File, International Classification of Ships by Type (ICST), Master Docks Plus (MDP), Principal Ports of the United States, Schedule K Classification of Foreign Ports, and Waterborne Commerce of the United States (WCUS) tools and data sets.

How does the Navigation Data Integration Framework Work?

The ultimate goal of the NDIF is to link navigation tools, data, and technical resources across functional and geographic boundaries to provide easy access and enhance decision-making.

For example, as illustrated in this graphic, a USACE staff member who needs to determine the significance and priority of a certain USACE-maintained channel could discover that information through the NDIF, which would use the Channel Portfolio Tool (CPT) to pull the relevant data from multiple linked databases.



Architecture

The NDIF architecture is comprised of five parts:

- **Source Databases**—The individual databases that store the navigation data—for example, the Dredging Information System (DIS), the Lock Performance Monitoring System (LPMS), the Navigation and Coastal Data Bank (NCDB), and the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) databases.
- **Hub Catalog**—The central catalog that facilitates data discovery and connects users to the individual databases.
- **Tools**—Applications which analyze or, in some other way, use the source data accessed through the hub catalog.
- **Web Service Layer**—A collection of web services, each of which provides a method for querying and/or updating data in the hub catalog. A web service is a means of exchanging data between applications (in this case, databases) over the Internet.
- **Portal**—A website that offers data, information, tools, and best practices from multiple databases (in this case, through the hub catalog) and provides access to a wide range of resources.

Source Databases

The most fundamental part of the NDIF is the data. In the case of dredging, four main databases contain the bulk of information produced by USACE during new and Operations & Maintenance (O&M) dredging—the Dredging Information System (DIS), the Dredging Manager (DM), the Dredging Quality Management (DQM) Program, and the Resident Management System (RMS).

Database—A collection of information on a particular topic organized into one or more records or tables.

Field—The intersection of a row and column in a table, which stores a single piece of data.

Table—Data repository, consisting of rows and columns, within a database.

A *database* is a collection of information on a particular topic organized into one or more records or *tables*, which consist of rows and columns. The intersection of each row and column is called a *field* and provides storage for a single piece of data. For example, in the DQM database, a particular field may store the weight of a dredge with no material in the hopper (this is known as a "lightship").

A *relational database* is a database structured to recognize relationships between tables by matching a key value in one table to the same key value in another table. Information from both tables can be accessed through this linkage. Using the example in the previous paragraph, if a field in two different DQM tables contains a dredge name, the relational database can use this common field to create a third table that includes the information from both of those tables.

These relationships are created through the use of primary and foreign keys. A *primary key* is a field or combination of fields that uniquely identifies each record in a table. (A table can have only one primary key.) A *foreign key* is a column or group of columns in a table that corresponds to or represents the value of a primary key in another table in the database (or to a table in another database).

Foreign Key—A column or group of columns in a table that corresponds to or represents the value of a primary key in another table in the database (or to a table in another database).

Primary Key—A field or combination of fields that uniquely identifies each record in a table.

Relational Database—A database structured to recognize relationships between tables by matching a key value in one table to the same key value in another table.

Hub Catalog

Located on a server in the Central Processing Center (CPC) in Vicksburg, MS, a single, centralized *hub catalog* serves as the common discovery and connection point for the individual databases by functioning as the management system that interacts with the source databases.

Hub Catalog—A single, central catalog whose function is to discover and connect individual, dispersed databases.

Translation Table—A table that equates the primary keys of common tables in separate databases.

Within each individual source database there is a primary key that uniquely identifies each record. But since the primary key values differ among databases, there must be a way to link appropriate records (for example, a contract number record in one database with the same contract number in another database). Therefore, the hub catalog contains *translation tables* that equate the primary keys of common tables in the separate databases. This allows the individual source databases to share common data elements (and thus eliminate duplicate data entry).

The hub approach provides the following advantages:

- **High availability**—Installation on a mirrored server in the Central Processing Center enables 24/7 data access.
- **Ease of implementation**—Developing a hub to which other databases connect is less complicated, time-consuming, and costly than connecting multiple databases to each other and maintaining permissions on objects within each database.
- **Scalability**—In the future, additional databases can connect to the hub without affecting the source databases.

Hub Tables

The hub will allow as many tables as necessary to be shared. These tables will contain the core datasets identified as having the most common data across the databases and will provide the means to navigate into any of the databases for additional data.

Materialized View—A virtual table in a relational database that contains the results of a query. It differs from a *view* because it records the query results from only a single point in time; it may be updated, but until it is, it remains static.

Although referred to as hub tables, these tables are actually *materialized views*, which provide a regularly refreshed snapshot of the source data. (The frequency with which these snapshots are updated can be determined on a per-table basis although once a day is often enough for most tables.) As additional commonalities are identified, materialized views can be created to share that data.

Some benefits of materialized views include the following:

- **Reliability**—If the connection to the datasource is lost, the materialized view contains the last "good" snapshot.
- **Responsiveness**—Querying over the network can be slow; using a cached version (snapshot) of the data is faster.
- **Network loads**—Queries over the network to the actual base tables are done less frequently, reducing the overall load on the network.

Tools

Once the databases are connected through the hub, there must be a way to access the information in them. One way is through the use of tools. While some new tools still need to be developed, many already exist. The big problem is that these tools are located in so many places that they may not be reaching their intended audiences. Therefore, they must be catalogued and made discoverable through the portals. One way to do this is to tag them with the appropriate filters.

The following list identifies some currently available tools and some of the data that either feed these tools or are produced by them. These and other tools can be designed to access the data using web services.

Tools	Data
• Boussinesq (BOUSS-2D) • CE-Dredge DM (Dredging Manager) • CE-Dredge portal • CMS (Coastal Modeling System) • CPT (Channel Portfolio Tool) • CSMART (Coastal Structures Management, Analysis, and Ranking Tool) • CSTAR (Collaborative Science, Technology, and Applied Research) • DOER (Dredging Operations and Environmental Research) Program-developed tools • DQM (Dredging Quality Management) Online Viewer • DQM (Dredging Quality Management) Multi-Load Exports	• Beach nourishment data • Channel Condition Reports (CCRs) • Channel framework • Dredge track point data • Dredging records • Georeferenced imagery • Habitat shapefiles • Lidar data (bathymetry, topology, structures) • Modeling outputs • Navigation channel and non-channel dredging volumes • Near-shore bathymetry • Operational lists (contractors, contracts, dredges)

Tools	Data
• eHydro Hydrographic Survey • GenCade (GENESIS + Cascade) • IIAB (Impacts of Inlets on Adjacent Beaches) • Inlet Reservoir Model • NCMP (National Coastal Mapping Program) Map • Near-Shore Berm Calculator • RMAP (Regional Morphology and Analysis Package) • RSM (Regional Sediment Management) • SBAS (Sediment Budget Analysis System) • Shoaling Toolbox • US Navy Dredging Quantities • WaveNet	• Physical dimensions of inlets and berms • Post-storm navigation channel surveys • Pre- and post-dredging surveys • Project, dredging, and placement area spatial data • Sediment data • Shoaling/fate model binary data • Shoreline position • Structure position (jetties, etc.) • Survey data

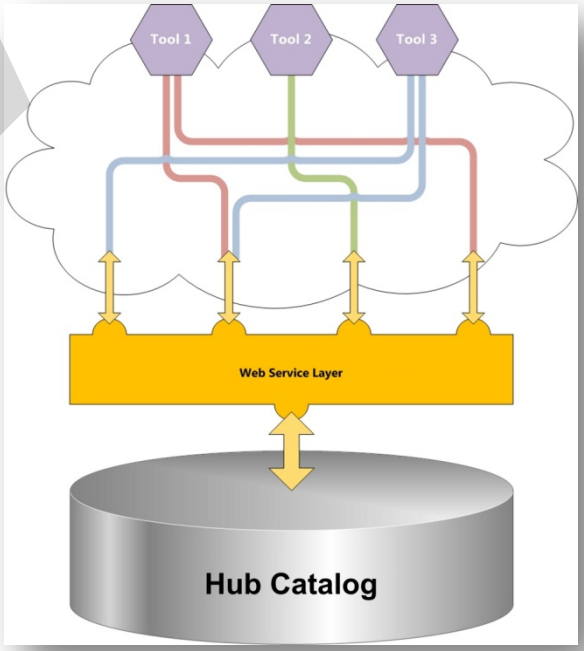
The process to discover, access, and transform data for use in numerical models and decision support tools is time consuming, and information is often used once and then discarded. In addition, some tools should work together—that is, the output of one tool may be the input of another tool. Therefore, the NDIF architecture must be able to store large amounts of data and to support tool integration.

Web Service Layer

Simply speaking, a web service is a means of exchanging data between applications (in this case, databases) over the Internet. The web service layer provides a number of methods for querying and updating data in the hub catalog.

Web Service—A means of exchanging data between applications over the Internet.

In other words, it allows navigation tools to communicate requests for data from the appropriate databases without connecting directly to the databases. This allows new tools to come online and easily access and share the same view of the data.



For example, a web service might include a request for a list of dredges disposing in an area, the results of a particular fate model run, or pre- or post-survey results for a project area and timeframe.

Tools consume and publish to these services. New tools can be written to access hub data via existing web service calls, and new web service calls can be added to the web service layer as needed, making this a very scalable approach to accessing data and providing tools.

There are also many web services available from sources outside the hub. Like the tools described earlier, these web services can be registered through the portals, catalogued, and made discoverable to the users who need them.

Portal

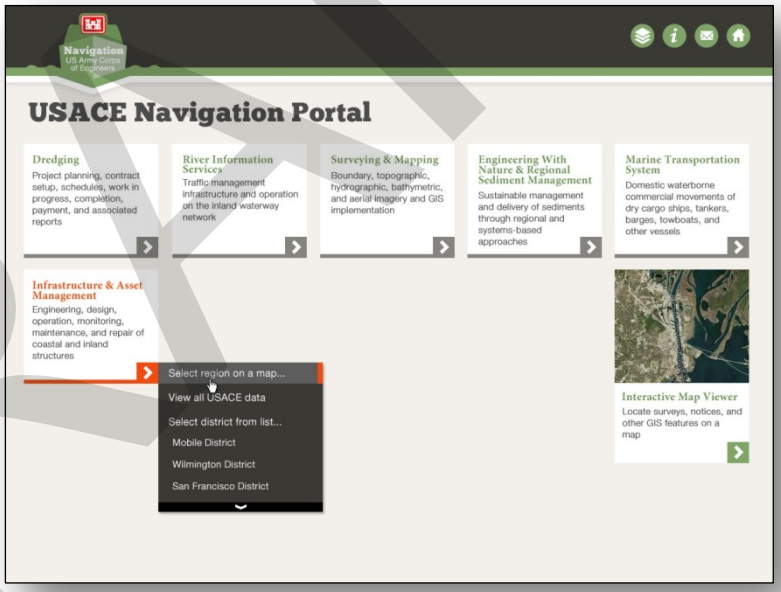
The final product for each category of the NDIF project will be a *portal* that provides easy access to and data sharing among the relevant databases and tools. Since all of the above parts of the NDIF occur in the background, the portal will provide a Graphical User Interface (GUI) to allow users access to the data and tools.

Portal— A website that offers data, information, tools, and best practices from multiple databases and that provides access to a wide range of resources.

More specifically, the portal will provide a data explorer that helps users locate the required data and, if appropriate, view its related details. In addition, the portal provides a means of resource discovery, so users can find websites, tools, and services to help them access and analyze data, including resources they may not have known about previously. Finally, the portal provides a series of summaries designed for HQUSACE and other USACE staff who want rolled-up summaries rather than details. (A mockup of the Dredging Portal is provided in Appendix A, "Dredging.")

Each portal accesses the hub the same way the tools do. Because of this, users can take advantage of the portal to find answers to questions they ask on a daily basis. For example, "What condition are the jetties in?" "What is the shoal volume?" "What type of contract is being used?" "How much will dredging cost?" and "What are the channel significance and priority?"

Each of the components of this project will be completed separately with its own portal, and then they will be rolled up into a single Navigation Portal similar to the one pictured here. Some of the datasets and tools will span multiple categories, so they will be discoverable from more than one portal.



Each component available from the Navigation Portal will allow users to view all USACE data for that component, select a region on a map to view data for that region, or select a specific USACE District to visit that District's website.

Who will Provide the Data, and Who will Maintain It?

For each navigation category, the data is already available, and additional data is being added to the databases every day. Ongoing data maintenance will be no different than it is now—users will input and modify data the same way they do currently. The only difference is that through the use of the hub and its tables, some data shared across databases will be automatically prepopulated from the authoritative source.

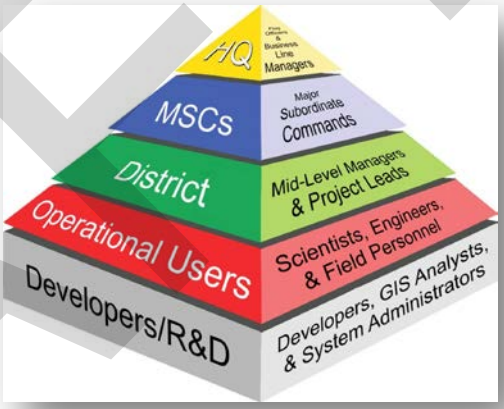
Ongoing maintenance and support of the hub and portal will be accomplished by the Navigation Business Line in concert with resources across USACE. Obviously, changes will need to be made during the project, but after each category is complete, maintenance will be minimal. Users will be able to discover and use

tools and web services with little assistance. The only maintenance required will be to link new databases to the hub catalog and create the associated web services. The NDIF is decentralized, relying on the backbone USACE IT system, and it is designed to empower users to create, innovate, and share.

Who will Use the Data?

The Navigation Data Integration Framework (and, specifically, the portal) will be used by several different types of users throughout USACE and, potentially, our partners in other federal and non-federal agencies and organizations.

Basically, the audience is pyramid-shaped, based on the level of detail they require. They may need quick, accurate, and concise answers with rolled-up data and information, or they may need raw data with all of the details.



- **HQUSACE**—HQUSACE users may include business line managers and other headquarters personnel, department heads, and flag officers. They need rolled-up National and regional information based on accurate, authoritative data. Vast amounts of data are stored in the source databases, but these users require information that is refined, focused, and summarized, and they use the available resources to make broad policy decisions.

- **Major Subordinate Commands (MSCs)**—Like HQUSACE users, MSCs users are mostly interested in refined, focused, and summarized information rather than details, and they use the tools to make decisions related to Division-wide goals.

- **District Managers**—District users are typically mid-level managers and project managers. The information they need is filtered, processed, and categorized at project and regional scales. Tools help these users discover trends and patterns to guide future operations.

- **District Operational Users**—These users are typically scientists, engineers, and field personnel, and they require data that is raw, detailed, and broad. Tools allow them to perform specific operational and analytical tasks at sub-project, project, and regional scales to make informed decisions to implement projects.

- **Developers/R&D**—The users who need the broadest and most detailed information are the developers and R&D staff, who use the data to create new tools and applications.

Is the Data Secure?

Yes. All of the data will be secure because it resides on and leverages CorpsNet and the ACE-IT infrastructure. Source databases will read hub catalog data directly via materialized views. Source applications and tools will read hub data via web services, which pull data from materialized views. All data will be edited in their respective databases, as they are now; no data will be edited by hub catalog or portal users.

How does the Navigation Data Integration Framework Fit into the USACE's Enterprise Geospatial Program?

The NDIF complements and adheres to USACE's enterprise geospatial policies and intent, as defined in ER 1110-1-8156, *Policies, Guidance, and Requirements for Geospatial Data and Systems*, and EM 1110-1-2909, *Geospatial Data and Systems*. Firmly based on a number of federal documents, including Executive Order (EO) 12906, *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure* (NSDI), which "promotes geospatial data sharing across the Federal Government in cooperation with state and local governments and private industry,"[1] EM 1110-1-2909 emphasizes "a unified and comprehensive set of geospatial technologies across USACE" and "outlines a corporate approach to implementing geospatial technology that meets functional business process requirements in harmony with state, local, and Federal agency programs to more efficiently produce geospatial products and serve customers."[2]

EM 1110-1-2909 continues, noting "the data needed for geospatial analysis make up the most expensive part of a geospatial system. Geospatial data are an integral part of the USACE business process, from project planning to operation and maintenance. A huge potential for loss exists through data mismanagement. Data become easily outdated simply because they cannot be retrieved or may not have been documented properly at the time of collection. The importance of standardizing, documenting, and providing easy access to geospatial data cannot be overstated."[3]

As can be seen here, the geospatial data issues described by EM 1110-1-2909 echo the navigation data issues identified earlier in this paper. Outdated and inaccessible data are useless. One of the NDIF's goals is to expose and make discoverable decentralized data through a centralized hub catalog and, in the process of linking disparate databases, provide a geospatial component to data that previously had none. At the same time, this process will help the NDIF meet "an important goal of the EGES [Enterprise Geospatial Engineering System] initiative—to deliver a tangible product."[4]

How will the Navigation Data Integration Framework Benefit USACE Navigation?

The objectives of the NDIF were designed to assist those who collect, enter, and distribute USACE navigation data as well as those who use it. In general, these objectives center on compiling complete and accurate data, making it available faster, providing easier access to those who use it, and enabling it to be used across specific functional boundaries. In other words, it will remove the insularity that currently characterizes so much USACE data.

- **Data Purpose**—One of the main goals of the NDIF is to acknowledge that the reason behind collecting navigation data is to help users find answers to their questions.

  For example, the following dredging and inland waterway questions may all be answered by fast and easy access to collected data linked to tools that accurately analyze data. Keeping these questions in mind helps solidify other project goals.

[1] ER 1110-1-8156, *Policies, Guidance, and Requirements for Geospatial Data and Systems*, 1 September 2012, 3.
[2] EM 1110-1-2909, *Geospatial Data and Systems*, 1 September 2012, 1-1.
[3] EM 1110-1-2909, *Geospatial Data and Systems*, 1 September 2012, 2-1.
[4] EM 1110-1-2909, *Geospatial Data and Systems*, 1 September 2012, 5-5.

Typical dredging questions:

- Where do we need to dredge? (Where, specifically, is the channel shoaled?)
- When do we need to dredge?
- Why do we need to dredge? (What is the value of the channel?)
- How much shoaling is there in the channel?
- How should we dredge?
- What dredges are available?
- How much will the dredging cost?
- What are the environmental considerations?
- Where can we place the dredged sediment?
- What are the options for Beneficial Use? Regional Sediment Management? Engineering With Nature?
- What are the historical dredging trends for the channel?
- Who was awarded the dredging contract?
- How many bidders were there for the dredging project?
- How much was the contract for?
- What is the dredging window?
- And others . . .

Typical inland waterway questions:

- Where is my vessel?
- What currents exist at the lock entrance?
- How long do I have to wait at the lock?
- What traffic is approaching the lock?
- When is it coming into the lock?
- What cargo is on the vessel (commodity/hazard)?
- What is the status of the infrastructure?
- What condition is the lock in?
- And others . . .

- **Data Entry**—By linking systems and allowing the data steward (authority) for each data set to cross-populate other databases, single-point data entry is achieved, which in turn reduces the likelihood of data entry errors.

- **Data Consistency**—Establishment of a data steward for each data set and then cross-population of other databases provides internal QA/QC and ensures that data remains consistent across systems. If the data steward changes during the project, data continues to cross-populate as necessary and always remains up to date.

- **Time and Effort**—The more data that is automatically prepopulated, the less time and effort are required to comprehensively document navigation activities.

- **Participation**—When data entry personnel are able to reduce the time they spend in a database because they are required to enter only unique data, they are more likely to make the effort to keep the database complete and up to date. They receive a solid return on their time investment.

- **Data Availability**—For data to be effective, it must be easy to locate and use. This project aims to implement transparency across USACE Divisions and Centers. Users will be provided with a "one-stop shop," where they can find the data they need regardless of the group that collected it or the database in which it is stored. In addition, the data will be made available on smart devices to enhance its usefulness in the field.

- **Data Timeliness**—Publishing the data in these databases in near real time will make it more useful to both navigation stakeholders and those they serve.

- **Data Format**—Normalizing data fields among navigation databases will make data sharing possible.

- **Geospatial Data**—Although some navigation databases already include geospatial data, others do not. Extending geospatial data across navigation databases will enhance their usefulness for planning and analysis.

How will the Navigation Data Integration Framework Benefit the USACE as a Whole?

The ultimate goal of the NDIF is to develop an integrated data system across the Navigation Business Line, which will serve as a model of what ultimately might be accomplished across the entire USACE business lines and missions.

Who is Developing the Navigation Data Integration Framework?

Navigation Stakeholders

Navigation stakeholders are found throughout the USACE. The following list identifies many of the Divisions, Districts, Centers, and Laboratories in which they are located:

- Army Geospatial Center (CEAGC)

- Civil Works Directorate (CECW)
    - Construction-Operations Division (CECW-CO)

- Engineer Research and Development Center (CEERD; ERDC)
    - Coastal and Hydraulics Laboratory (CEERD-CHL)
        - Flood & Storm Protection Division (CEERD-HF)
        - Navigation Division (CEERD-HN)
        - Technical Programs Office (CEERD-HV-T)
    - Environmental Laboratory (CEERD-EL)

- Great Lakes and Ohio River Division (CELRD)
    - Louisville District (CELRL-OP)
    - Pittsburgh District (CELRP)

- Headquarters (HQUSACE)

- Institute for Water Resources (CEIWR)
    - Navigation Data Center (CEIWR-NDC)
        - Waterborne Commerce Statistics Center (CEIWR-NDC-C; CEWCSC)

- Mississippi Valley Division (CEMVD)
    - Programs Division (CEMVD-PD)

- North Atlantic Division (CENAD)
    - Planning Division (CENAD-PD)
    - Philadelphia District (CENAP)

- Northwestern Division (CENWD)
    - Portland District (CENWP)

- Pacific Ocean Division (CEPOD)
    - Alaska District (CEPOA)

- South Atlantic Division (CESAD)
    - Mobile District (CESAM)
    - Wilmington District (CESAW)

- South Pacific Division (CESPD)
    - Los Angeles District (CESPL)
    - San Francisco District (CESPN)

- Southwestern Division (CESWD)
    - Galveston District (CESWG)

External navigation stakeholders include the following:

- National Geodetic Survey (NGS)

- National Oceanic and Atmospheric Administration (NOAA)

- National Oceanographic and Atmospheric Administration (NOAA)

- Naval Oceanographic Office (NAVOCEANO)

- US Coast Guard (USCG)

- US Naval Meteorology and Oceanography Command (NMOC)

Product Delivery Teams

Execution of the NDIF relies on Product Delivery Teams (PDTs), which consist of both functional and technical Subject Matter Experts (SMEs) and whose members differ according to navigation category. (See the appropriate Action Plan for a list of each category's PDT members.)

Specifically, PDTs are responsible for the following tasks within each navigation category:

- Review the schemas of the databases to look for commonalities and then work toward the elimination of duplicate data fields

- Determine the source(s) and consumer(s) of each data field

- Agree on the authoritative source for each data field, so that authority can cross-populate identical fields in the other databases

- Establish standard naming conventions and then normalize data fields

- Research the workflows at appropriate USACE Districts in order to determine common processes and to ensure that the product being developed will address their requirements
- Compile a list of questions for which DIF users need answers
- Modify applications and tools to consume web services
- Develop the hub catalog, portal, web services, and other required tools and implement the appropriate database connections

Who is Overseeing the Navigation Data Integration Framework?

The Navigation Data Integration Framework Steering Committee consists of the following people.

Name	Title	Agency	Phone	Email
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Implementation Plan

Introduction

The previous section of this paper identified the challenges resulting from the existence of multiple, unconnected navigation databases that USACE staff face on a daily basis and then explained how these challenges can be met—and, indeed, how the usefulness of the data itself can be enhanced—through the development of a Navigation Data Integration Framework (NDIF). This NDIF would link disparate databases through the development of a hub catalog and then would fulfill various data needs through the use of a web portal and web services.

Product Delivery Teams

The process to implement the NDIF begins with the formation of a Product Delivery Team (PDT), consisting of both functional and technical Subject Matter Experts (SMEs), for each navigation category. While the databases and tools available within each category differ, the DIF implementation process is relatively the same. Each PDT is responsible for the following tasks within its specific category:

- Review the schemas of the databases to look for commonalities and then work toward the elimination of duplicate data fields
- Determine the source(s) and consumer(s) of each data field
- Agree on the authoritative source for each data field, so that authority can cross-populate identical fields in the other databases
- Establish standard naming conventions and then normalize data fields
- Research the workflows at appropriate USACE Districts in order to determine common processes and to ensure that the product being developed will address their requirements
- Compile a list of questions for which DIF users need answers
- Modify applications and tools to consume web services
- Develop the hub catalog, portal, web services, and other required tools and implement the appropriate database connections

Dredging Data Integration Framework Product Delivery Team

The work that has already been completed on the Dredging Data Integration Framework (DDIF) provides a good illustration of how PDTs work to accomplish their responsibilities. PDTs responsible for the other NDIF categories will perform relatively the same tasks.

1. At the NDIF kickoff meeting at the USACE Institute for Water Resources (CEIWR) on April 23-25, 2012, navigation stakeholders identified the four main USACE databases in which dredging information is recorded and selected the dredging functional and technical SMEs who would serve on the DDIF PDT.

2. The functional SMEs mapped out the timeline of a typical dredging project—from project planning through advertising, contract award, dredging start and end, and contract payment—to determine the full scope of the project and then agreed to divide it into three phases: Planning to Contract Setup, In-Progress to Completion, and Reports and Dredging Portal.

3. The functional SMEs reviewed the schemas of the four dredging databases and then developed a matrix of common data fields. They also defined key concepts (such as "project," "subproject," "waterway," and "waterway system) because such terminology may have different meanings in different databases. This ensures that all PDT members use these terms in the same way so as not to impede implementation.

4. Once the functional SMEs had identified all database commonalities, they agreed on the source(s) and consumer(s) of each of the common data fields. This aided the determination of which databases could—and should—cross-populate identical data fields in the other databases and helped the technical SMEs work toward eliminating duplicate data fields.

5. The technical SMEs established standard naming conventions across the databases and then normalized the common data fields. They also developed a dredging ontology from the perspective of a single contract and task order in order to help them visualize the relationships between all of the data entities (for example, contract, contractor, dredge equipment, dredge area, project area, and placement area).

6. The technical SMEs also researched the workflows at several USACE Districts in order to ensure the products they developed would address the requirements these Districts and, by extension, all other UASCE Districts.

7. The functional SMEs compiled a list of questions for which DIF users need answers. These questions helped to define the summary data that needed to be rolled up and the reports that needed to be created.

8. The technical SMEs designed the DDIF architecture and reviewed it with the functional SMEs. The goal was to augment workflows and link databases across Districts, Divisions, Labs, and HQUSACE in order to make data easily available.

9. The technical SMEs modified the necessary applications and tools to consume web services.

10. Using the defined architecture, the technical SMEs developed the dredging hub catalog, portal, web services, and other required tools and implemented the appropriate database connections.

Navigation Categories

The following appendices apply the NDIF concept to specific aspects of the USACE Navigation Business Line. Once all NDIF components have been completed, they will be linked to create the data integration framework for the entire Navigation Business Line.

- **Appendix A—Dredging**

  USACE has been responsible for maintaining US inland and coastal waterways, ports, and harbors through new and Operations and Maintenance (O&M) dredging since the US Congress first appropriated money for dredging the Ohio and Mississippi Rivers in 1824. A typical dredging project goes through several phases, and data is collected during each: Project planning, advertising, bidding, contract award, contractor, dredge equipment, dredging, placement, inspection, timekeeping, project completion, and payment.

  The following dredging databases include USACE navigation data: the Dredging Information System (DIS), Dredging Manager (DM), Dredging Quality Management (DQM), and Resident Management System (RMS).

  This appendix is the most fully developed because dredging is the first category to be documented as part of the NDIF, and the dredging DIF is already well underway. It lists and describes each of USACE's dredging databases and then discusses the work done to date to integrate them and develop a unified dredging portal.

- **Appendix B—River Information Services (RIS)**

  River Information Services (RIS) involve traffic management infrastructure on the inland waterway network and include the establishment of an interoperable, intelligent traffic and transport system to enhance the capacity and safety of these waterways.

  The following River Information Services databases include USACE navigation data: Consolidated US Coast Guard (USCG) Web Service, Inland Electronic Navigation Charts (IENC), Lock Operation Management Application (LOMA), Lock Performance Monitoring System (LPMS), Master Docks Plus (MDP), and Nationwide Automatic Identification System (NAIS).

- **Appendix C—Surveying and Mapping**

  USACE surveying and mapping services include boundary, topographic, hydrographic, terrestrial lidar, multispectral and hyperspectral aerial imagery collection, and airborne topographic and bathymetric lidar acquisition as well as project-level GIS implementation, development of file-based geodatabases, and GIS tool development.

  The following surveying and mapping databases include USACE navigation data: eHydro Hydrographic Survey, the National Channel Framework (NCF), the National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), and the Navigation and Coastal Data Bank (NCDB).

- **Appendix D—Infrastructure and Asset Management**

  Infrastructure and asset management involve the engineering, design, operation, monitoring, maintenance, and repair of locks and dams, jetties, breakwaters, anchorages, and other coastal and inland structures.

The following infrastructure and asset management databases include USACE navigation data: Channel Portfolio Tool (CPT), Coastal Structures Management, Analysis, and Ranking Tool (CSMART), Enterprise Coastal Inventory Database (ECID), Lock Characteristics, Lock Performance Monitoring System (LPMS), Master Docks Plus (MDP), National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), Navigation and Coastal Data Bank (NCDB), and Port and Waterways Facilities.

- **Appendix E—Engineering With Nature (EWN) and Regional Sediment Management (RSM)**

  Engineering With Nature (EWN) is a USACE initiative to enable more sustainable delivery of the economic, social, and environmental benefits associated with water resources infrastructure. EWN directly supports USACE's "Sustainable Solutions to America's Water Resources Needs: Civil Works Strategic Plan 2011 – 2015" and contributes to the achievement of its Civil Works mission and goals.

  The Regional Sediment Management (RSM) Program is a collaborative, systems-based approach to optimizing sediment use and project management on a regional, rather than local, scale. It works closely with EWN to improve the management and use of sediments through application of regional or systems approaches along coastal, estuarine, and riverine environments.

  The following Engineering With Nature and Regional Sediment Management databases include USACE navigation data: Civil Works Project Mitigation Database (CWPMD), Ecosystem Restoration Business Line (ERBL), eHydro Hydrographic Survey, Engineering With Nature (EWN), National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), National Channel Framework (NCF), Navigation and Coastal Data Bank (NCDB), Ocean Disposal Database (ODD), and Sediment Budget Analysis System (SBAS).

- **Appendix F—Marine Transportation System**

  Under federal law, companies must report the domestic waterborne commercial movements of their vessels to USACE. These vessels include dry cargo ships and tankers, barges (both loaded and empty), fishing vessels, towboats (with or without barges in tow), tugboats, crew boats and supply boats to offshore locations, and newly constructed vessels from the shipyards to the point of delivery. Vessels remaining idle during the monthly reporting period must also be reported.

  The following marine transportation databases include USACE navigation data: Commodity Code Cross Reference File, Flag Master File, Foreign Cargo (Inbound/Outbound), Foreign Traffic Vessel Entrances and Clearances, Hazardous Commodity Code Cross Reference File, International Classification of Ships by Type (ICST), Master Docks Plus, Principal Ports of the United States, Schedule K Classification of Foreign Ports, and Waterborne Commerce of the United States (WCUS).

Appendix A
Dredging

Introduction

Since the US Congress first appropriated money in May 1824 to improve navigation on the Ohio and Mississippi Rivers by removing sandbars, snags, and other obstacles, the US Army Corps of Engineers has been responsible for the development and maintenance of navigable inland and coastal waterways, ports, and harbors in the United States. Safe, reliable, efficient, and environmentally sustainable waterborne transportation systems are a major means of commercial transportation, important to recreation, and integral to national defense.

Yet only a few of the nation's waterways, ports, and harbors are naturally deep. In most of them, channels must first be excavated to a Congressionally mandated depth and then dredged periodically so they will remain clear and safe for navigation. Without dredging, many waterways, ports, and harbors would be impassable to commercial and recreational vessels. More than 25,000 miles of navigation channels and 400 ports and harbors are dredged throughout the United States to keep marine traffic operating safely and efficiently.

With responsibility for the navigability of so many waterways, ports, and harbors—and with limited funding—it is imperative that USACE maintain comprehensive and accurate dredging records. A typical dredging project goes through several phases, and data is collected during each: Project planning, advertising, bidding, contract award, contractor, dredge equipment, dredging, placement, inspection, timekeeping, project completion, and payment.

The USACE Navigation Business Line maintains four main dredging databases to record this contract-, contractor-, and project-related information: the Dredging Information System (DIS), Dredging Manager (DM), Dredging Quality Management (DQM), and Resident Management System (RMS). Using these databases and related tools, such as the DM Inspector website and the DQM Viewer, users can record data, monitor dredging activities, and find answers to these and other dredging-related questions:

- Where do we need to dredge? (Where, specifically, is the channel shoaled?)
- When do we need to dredge?
- Why do we need to dredge? (What is the value of the channel?)
- How much shoaling is there in the channel?
- How should we dredge?
- What dredges are available?
- How much will the dredging cost?
- What are the environmental considerations?
- Where can we place the dredged materials?
- What are the historical dredging trends for the channel?
- Who was awarded the dredging contract?

- How many bidders were there for the dredging project?
- How much was the contract for?
- What is the dredging window?

Current Problem

With so much data spread among the four dredging databases—some of it unique to a single database and some of it repeated across multiple databases—how can users access all of the information they need without going into each separate database? And can they be assured that data available in multiple databases is consistent?

Purpose

This appendix describes the components and development of the Dredging Data Integration Framework (DDIF), one part of the overall Navigation Data Integration Framework (NDIF).

Dredging Databases

The following dredging databases include USACE navigation data:

- Dredging Information System (DIS)
- Dredging Manager (DM)
- Dredging Quality Management (DQM)
- Resident Management System (RMS)

All four databases are *relational databases*, databases structured to recognize relationships between tables by matching information from a field in one table to information from a field in another table to produce a third table that includes information from both tables. For example, if a field in two different DQM tables contains a dredge name, the relational database can use the common dredge name field to create a third table that contains the information from both of those tables.

Relational Database—A database structured to recognize relationships between tables by matching information from a field in one table to information from a field in another table to produce a third table that includes information from both tables.

Dredging Information System

The Dredging Information System (DIS) is the central database for all USACE-performed and contracted dredging from project advertisement to project completion. It was developed and is maintained by the USACE Institute for Water Resource's Navigation Data Center (CEIWR-NDC) although each District is responsible for entering and maintaining its own District data in the central database. DIS is used by all USACE Districts.

Data includes advertising, bid open, award, estimated start of dredging and end of dredging dates; winning bid and bidder; contract number; government cost estimate; project name and location; contract and dredge type; quantity of dredged material; method of disposal; and a number of other details.

This information is essential to both USACE Headquarters and the Division coordinators for efficient overall planning and program management. It also assures Districts that their dredging programs and schedules are correctly represented in the database.

Dredging Manager

Previously known as Dredging Histories (DH), the Dredging Manager (DM) provides two websites, one where users can spatially monitor and manage dredging activities within their project areas and a second where inspectors can record their inspections. DM was a joint effort—it was funded by the Mobile District's Operations Division (CESAM-OP) and the Engineer Research and Development Center's (ERDC) Dredging Operations and Environmental Research (DOER) Program and Regional Sediment Management (RSM) Program (under CE-Dredge), and it was developed and is maintained by the Mobile District's Spatial Data Branch (CESAM-OP-J). While it is currently used only by the Mobile District, the Philadelphia District (CENAP) and the Portland District (CENWP)—and possibly other Districts—will implement it later this year.

Among other data, DM includes dredging contracts, contract numbers, daily logs of operations, contractor timesheets, consolidated history cards, beneficial usage agreements, and disposal area placement and maintenance.

Information in DM is useful to both project engineers and dredging inspectors, and the websites provide efficient use of available dredging resources and daily workflows of information.

Dredging Quality Management

The National Dredging Quality Management (DQM) Program is a partnership between USACE and the dredging industry. As the replacement for the original Silent Inspector (SI) desktop tools, DQM provides timely web-based dredging monitoring, analysis, and documentation for hopper and scow dredging projects; support for pipeline and mechanical dredges is planned. Onboard sensors continuously document dredging activities, operations, and efficiency. The data collected by these sensors is routed to the DQM Center for processing, storage, and publishing. DQM is a joint effort between the Mobile District's Spatial Data Branch (CESAM-OP-J) and the Engineer Research and Development Center (ERDC). It is used by all USACE Districts.

Among other data, DQM includes the contract number; start of dredging date; dredge name, type, owner, and description; dredge point data (such as longitude and latitude, heading, and speed), hopper and scow sensor data (such as draft, ullage, displacement, and volume); and placement site name.

The data gathered by DQM is used by USACE dredging managers nationwide to monitor and document USACE dredging projects. In addition, DQM's suite of web-based tools provides the ability to view project operations, produce disposal plots, and export and analyze dredge operation data.

Resident Management System

The Resident Management System (RMS) is a comprehensive construction information management system developed by USACE to control construction quality management and contract administration. It provides the ability to plan, accomplish, and control contract management by integrating job-specific requirements, corporate technical knowledge, and management policies. RMS was developed and is maintained by the RMS Center in the USACE Los Angeles District (CESPL). RMS's dredging functionality is being actively used by only 16 USACE Districts.[1]

RMS is used for all USACE construction projects, not just dredging. For dredging projects it includes solicitation, bid open, and estimated dredging window start and end, actual dredging start and end, and

[1] For the purpose of this document, we loosely define "active use" as having more than 10 dredging contracts entered into RMS. USACE Districts and the number of dredging contracts in RMS as of February 5, 2013, follow: Portland District (CENWP) 12, New York District (CENAN) 19, St. Paul District (CEMVP) 19, Chicago District (CELRC) 22, Philadelphia District (CENAP) 24, San Francisco District (CESPN) 27, Savannah District (CESAS) 28, Buffalo District (CELRB) 31, New England District (CENAE) 32, Charleston District (CESAC) 38, Mobile District (CESAM) 69, New Orleans District (CEMVN) 90, Jacksonville District (CESAJ) 92, Detroit District (CELRE) 117, Galveston District (CESWG) 126, Wilmington District (CESAW) 201.

demobilization dates; estimated cost and quantity; contractor name and other information; bid item names, units, and quantities; and dredge name, type, owner, and description; dredge equipment details; and a number of other details.

RMS is used by USACE field engineers, inspectors, construction representatives, contractor staff, and office personnel to manage all facets of construction contracts from contract award through project inspection and completion. It allows front-line field personnel to concentrate on their primary job functions—such as quality assurance, customer care, preparation of modifications, and safety regulations—while also accomplishing necessary routine administrative tasks, and it provides management with an objective view of project status.

Dredging Data Integration Framework Solution

Project Scope

This project encompasses the entire dredging lifecycle, from project advertisement to project completion, and it includes all four dredging databases—the Dredging Information System, the Dredging Manager, the Dredging Quality Management Program, and the Resident Management System. Ultimately, the project has three goals:

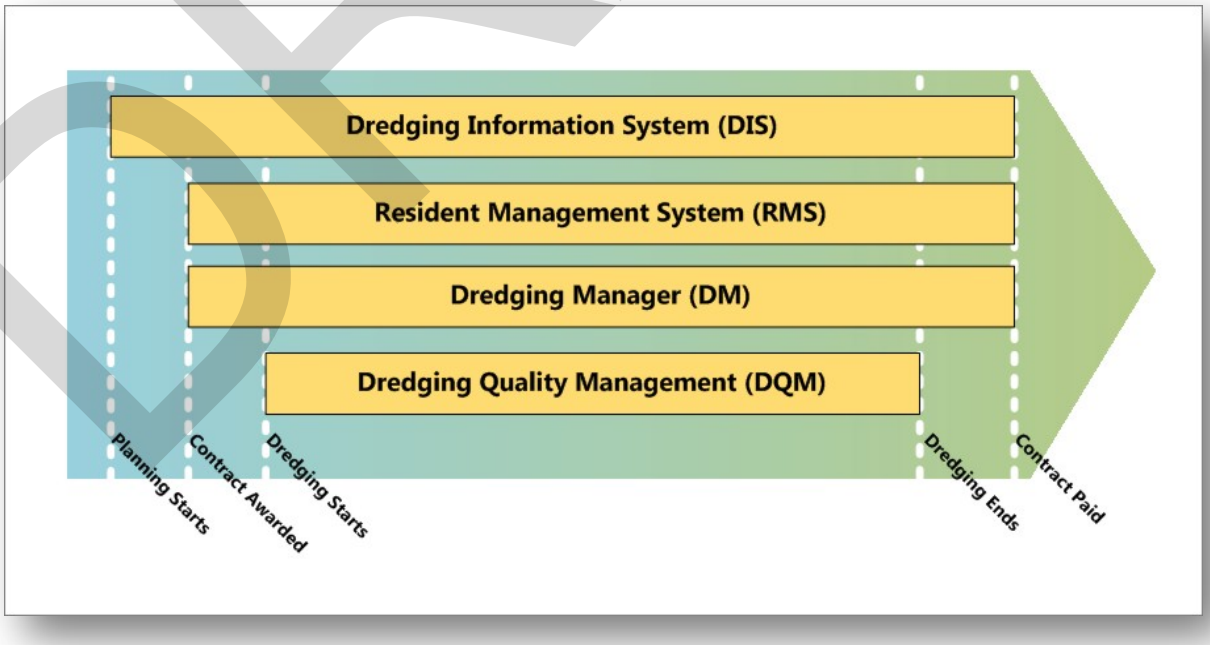
1. Allow the databases to share common data elements, thus eliminating duplicate data entry and increasing data integrity.

2. Develop a framework that makes data accessible and readily available to applications and tools.

3. Build a dredging portal, or website, that can access information from each of the databases and that provides a place where users can discover dredging resources, such as data and tools.

Typical Dredging Project Timeline

In order to better understand the dredging process and the purview of each of the dredging databases, the Dredging Project Delivery Team (PDT) first mapped out the timeline of a typical dredging project.



US Army Corps of Engineers

This graphic shows the period of activity of each of the four dredging databases during a typical dredging project. It is important to note two things here:

1. The overlap among data databases within the phases of a dredging project. Since these four databases do not currently share data, each dredging project must be set up separately in each dredging database. This leads to the data entry, inconsistency, and inaccessibility issues described earlier in this paper.

2. The fact that this activity exists on a continuous timeline. In other words, because navigation channels are dredged periodically, these databases experience regular periods of activity and inactivity over the lifetime of each channel.

Additional dredging data may also be included in other USACE databases— for example, the Corps of Engineers Financial Management System (CEFMS), the Operations and Maintenance Business Information Link (OMBIL), the Program and Project Management System (P2), the Quality Control System (QCS), and the Standard Procurement System (SPS). These data are generally also included in one of these four dredging databases and are, therefore, not included in this project. The graphic on the following page shows at which dredging project milestones data is entered into several of these databases.

Project Phases

To manage development and testing more effectively, the DDIF project was divided into three phases. Work on subsequent phases begins upon completion of the previous phase.

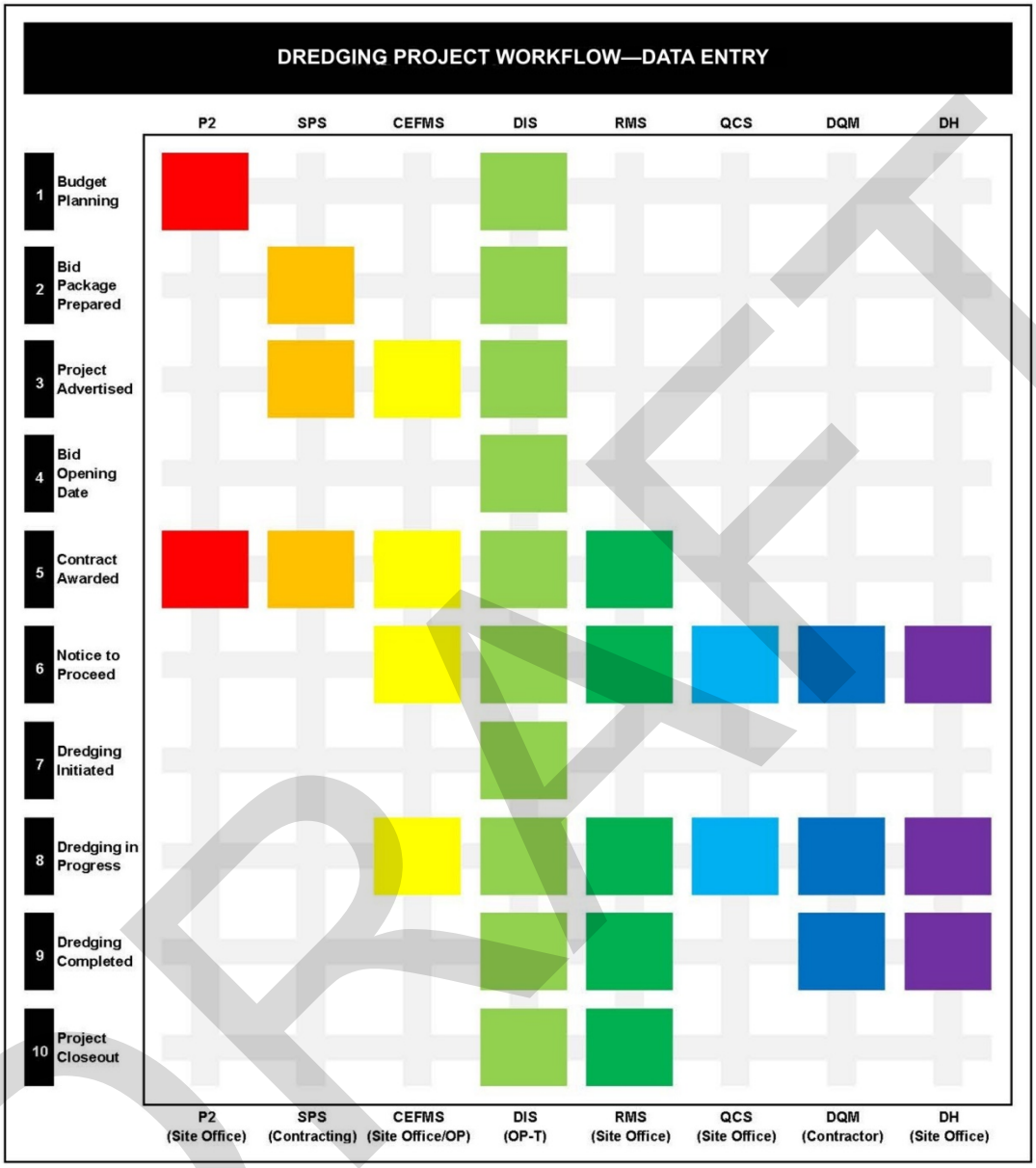
- **Phase 1**—Planning to Contract Setup
- **Phase 2**—In-Progress to Completion
- **Phase 3**—Reports and Dredging Portal

Database Review

In order to understand the amount of data overlap among the dredging databases, the functional experts on the DDIF Product Delivery Team (PDT) studied the schemas of the four dredging databases and developed a matrix of common data fields for Phase 1, Planning to Contract Setup. This allowed them to identify the authoritative source for each data field. (The full dredging database commonalities matrix is reprinted on the following pages after the Dredging Project Workflow.)

Data Categories	Commonalities Phase I: Planning to Contract Setup Pre-Contract				Contract				x=data field s=data source "Contract"=Date of contract award
	DIS	RMS	DQM	DH	DIS	RMS	DQM	DH	Definition
Dredges (Lookup)									
Dredge name					x	s	x	x	Name of the dredge
Dredge type					x	s	x	x	Type of dredge: hopper, bucket/pipeline, scow
District Owning Dredge					x	s	x	x	Government only; RMS (currently only SAW and NAP)
Dredge Description					x	s	x	x	
Dredge Equipment (Lookup)									
Bucket Size						s	x		The size of the bucket or dipper
Dredge Capacity						s	x		The capacity of the dredge
Suction Pipe Jet Size						s	x		The size of the suction pipe jet
Attendant Plant						s	x		Supporting equipment for mothership
Placement Sites (Lookup)									
Placement site name							x	s	Name of Placement Site
Placement site number						x		s	Numbering scheme currently used differs among systems; centralized scheme is the NCDB Placement Area PKID - implementation in progress in DQM
Placement site type					x			s	The site is designated for beneficial use; does not refer to the designated use of the dredged material
Benefical use of dredge material					x			s	Material is designated for beneficial use; does not refer to the designated use of the site itself
Dredging Sites (Lookup)									
Location, name or description of dredging site							x	s	Look for definition within the National Channel Framework project
Stations								s	Look for definition within the National Channel Framework project

Also, since dredging terminology could have different meanings in different databases, the team developed a list of definitions to ensure that they were viewing each dredging concept (for example, "project") in the same way.



US Army Corps of Engineers

Data Categories	Commonalities Phase I: Planning to Contract Setup												x=data field s=data source "Contract"=Date of contract award		
	Pre-Contract				Contract				Post-Contract						
	DIS	RMS	DQM	DH	DIS	RMS	DQM	DH	DIS	RMS	DQM	DH	Definition	Units/Lookup Values	Notes
Job Planning															
Fiscal year (10/1 - 9/30)	s					x							FY contract will be awarded; also in SPS & CEFMS	Year	Can be derived from other field
CWIS	s	x						x					Corps of Engineers Civil works number		RMS pulls from SPS
IFB (Invitation For Bid) number - last 7 characters	s	x		x									Solicitation number		
Date Bids are opened	s	x													
Time bids will be opened (military time)	s	x													
Total number of bidders for job	s														Used for dredging question
Corps of Engineers District Code	s	x	x											3 Alpha	
Solicitation Date	s	x											Date Solitication occurred		
Est quantity of units of measure for contract	s	x											Estimated units for required for dredging	Hours or cu yd	
Unit of measure (for above field)	s	x											Unit of measure for previous field	Hours or cu yd	
Multiple project indicator (Y/N)	s			x									Identification of multiple CWIS numbers		
Items added after bidding (Y/N)		s			x								Modifications ("mods") after contract award; changes before contract award are "amendments"		
Dredging window end	x	s											Date by which dredging must be completed; environmental; per contract		
Dredging window start	x	s											Date dredging can start; environmental; per contract		
Class of work (Code)	s					x							Functional class of work	Maintenance/New Work/Non-Nav Beach Nournishment; Non-Nav Wetlands	Used for dredging question
Yards before dredge		s		x									Yards to be dredged determined by a Before Dredge ("BD") survey		
Government estimate	s	x		x									Gov't estimate for contract at bid opening	Dollars	Used for dredging question
Status of job	s	x											Indication to the contractor of the status of the job	Proposed/On Hold/Complete (see DIS Lookup list)	
Job Awarded															
Contractor awarded					x	s		x							Used for dredging question
Subcontractors awarded						s		x							
Arrival of contractor on site—actual					x	s							Date dredge arrives on site		
Mobilized					x	s							Date of mobilization		
Dredging start—actual					x	s	x						The date the dredging actually starts		
Method of disposal						s	x						Tracked by load, not by disposal site	Pump, Dump, Off Load	
Dredging end—actual					x	s	x						The date the dredging actually ends -Actual date dredge releases from site		
Demobilized					x	s							Date of demobilization-Actual departure date of contractor from site		
Bid Items (these become CLINs)															
Bid Item Name	s	x													turn into CLINs
Bid Item Units	s	x												see DIS Lookup List	turn into CLINs
Bid Item Quantity	s	x													turn into CLINs
Contract Line Items (CLINs)															
CLIN Name					x	s									Bid items become CLINs after contract award
CLIN Units					x	s								Cu yds, linear feet, square feet, lump sum (see DIS Lookup list)	Bid items become CLINs after contract award
CLIN Quantity					x	s		x						Quantity of hours/yards	Bid items become CLINs after contract award
Dredges (Lookup)															
Dredge Name					x	s	x	x					Name of the dredge		
Dredge Type					x	s	x	x					Type of dredge: hopper, bucket/pipeline, scow		
District Owning Dredge					x	s	x	x					Government only; RMS (currently only SAW and NAP)		
Dredge Description					x	s	x	x							

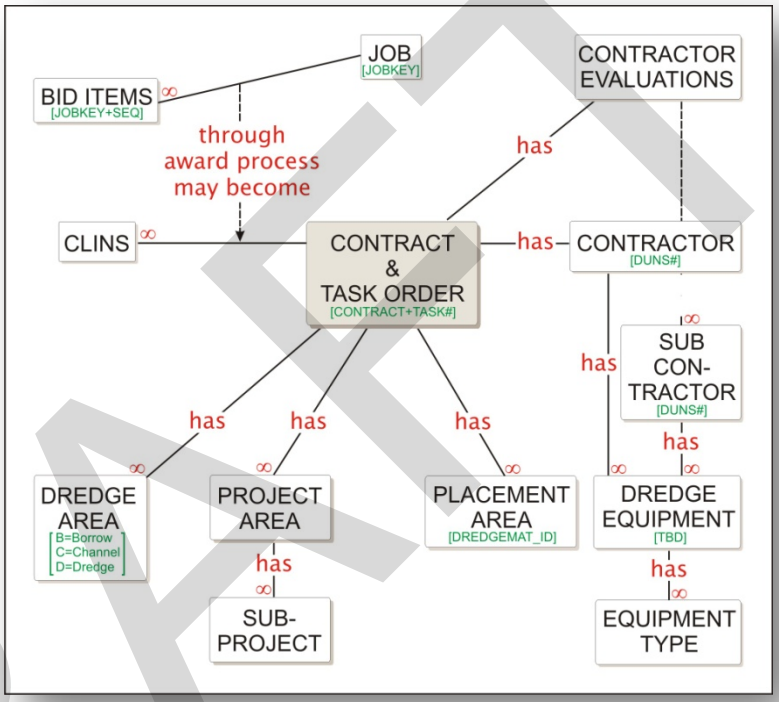
Data Categories	Pre-Contract				Contract				Post-Contract				x=data field s=data source "Contract"=Date of contract award		
	DIS	RMS	DQM	DH	DIS	RMS	DQM	DH	DIS	RMS	DQM	DH	Definition	Units/Lookup Values	Notes
Dredge Equipment (Lookup)															
Bucket Size						s	x						The size of the bucket or dipper		
Dredge Capacity						s	x						The capacity of the dredge		
Suction Pipe Jet Size						s	x						The size of the suction pipe jet		
Attendant Plant						s	x						Supporting equipment for the dredge		
Placement Sites (Lookup)															
Placement site name							x	s	x				Name of Placement Site		DIS tracks only government-owned placement sites
Placement site number						x		s	x				Numbering scheme currently used differs among systems; centralized scheme is the NCDB Placement Area PKID - implementation in progress in DQM		
Placement site type					x			s					The site is designated for beneficial use; does not refer to the designated use of the dredged material		Used for dredging question
Benefical use of dredge material					x			s					Material is designated for beneficial use; does not refer to the designated use of the site itself	Yes/No	
Dredging Sites (Lookup)															
Location, name or description of dredging site							x	s					Look for definition within the National Channel Framework project		
Stations								s					Look for definition within the National Channel Framework project		Used for dreding question
Contracts (Lookup)															
Contract number					x	s	x	x							
Task Order/Delivery No.						s		x					MATOC (Multiple Award Task Order Contract) - results in a separate task order for each dredging activity; in DIS, task order number is often embedded in the title		
Contract Type (Rental, Unit Price, Lump Sum)					s			x					Contract payment method		Can be derived from unit descriptor (hours/yards)
Contract awarded—actual					x	s		x						Date	
Contract duration					x	s		x						Days	
Notice to Proceed					x	s		x						Date	
Primary dredge type used on contract					x	s		x						B-Bucket;D-Dustpan;H-Hopper;I-Water Injection;N-Nonconventional Type;P-Pipeline;S-Sidecaster;U-Unknown;W-All;X-PipeLine & Bucket;Y-Pipeline & Hopper;Z-Pipeline & Bucket	
Projects (Lookup)															
Project Long Name					x	s		x					Name used on the Dredging Contract ("long name")		
Project Short Name						s	x	x					Project name input by District		
Scope of Work					x	s		x							
Contractors (Lookup)															
Contractor DUNS						s							DUNS number required to bid		possible id
Contractor NAICS						s							North American Industry Classification System		
Contractor city					x	s		x							
Contractor name					x	s		x							
Contractor parent company name if applicable						s		x							
Contractor phone number					x	s		x							
Contractor point of contact					x	s	x	x					Email address		
Contractor state					x	s		x							
Contractor street address					x	s		x							
Contractor zip code					x	s		x							

Dredging Ontology

Building upon the work of the functional team, the technical experts on the DDIF PDT developed a dredging *ontology* from the perspective of a single contract and task order. It was important to map out these relationships because they helped the technical team visualize the relationships between all of the data entities.

Ontology—A data model that describes the functional relationship that exists among a set of concepts..

Ontologies are important to data integration because they provide a common understanding of the data and how to facilitate communication between people and information systems. By leveraging this concept, developers can more easily organize and share data among data sources.



Legend

BLACK text=Data entity

Red text = Entity relationships (∞ indicates a one-to-many relationship)

[Green] text = Database key

Dredging Hub Catalog

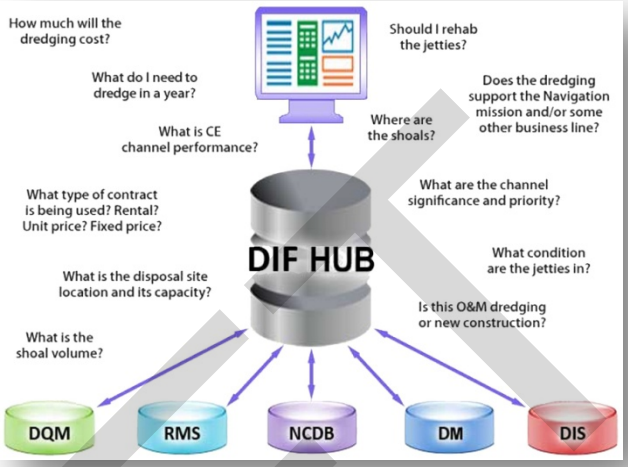
Once the database commonalities, authoritative data sources, data terminology, and dredging ontology were established, the DDIF technical team determined that the most effective way to link the records in the four dredging databases would be to create a single, centralized view, or *hub catalog*, which serves as the common access point to the databases and a conduit for the data.

Hub Catalog—A single, central catalog whose function is to discover and connect individual, dispersed databases.

The hub catalog will be located in the Central Processing Center (CPC) in Vicksburg, MS, that acts as a management system, interacting with data from the four dredging databases, which are located at the Institute for Water Resources' Navigation Data Center (CEIWR-NDC; DIS) in Alexandria, VA; the USACE Los Angeles District's RMS Center (CESPL; RMS) in Los Angeles, CA; and the USACE Mobile District's Spatial Data Branch (CESAM-OP-J; DM and DQM) in Mobile, AL.

The hub approach provides the following advantages:

- **Elimination of data duplication**—Because databases share common data elements, duplicate data entry is eliminated.
- **Increased data availability**—More detailed answered to common dredging questions can be provided because data from multiple sources can be combined—transparently—within a single query.
- **High availability**—Installation on a mirrored server in the CPC enables 24/7 data access.



- **Ease of implementation**—Development of a hub to which the four other dredging databases connect is less complicated than connecting four databases to each other and maintaining the permissions on objects within each database.
- **Scalability**—In the future, additional data sources can connect to the hub without affecting the source databases.

Hub Tables

Based on the review of the database schemas, the resulting list of database commonalities, and the dredging ontology, it was determined that the hub catalog should include seven tables to be shared. These tables will contain the core datasets identified as having the most duplicated data across the databases and will provide the means to navigate into any of the databases for additional data.

Primary Key—A field or combination of fields that uniquely identifies each record in a table.

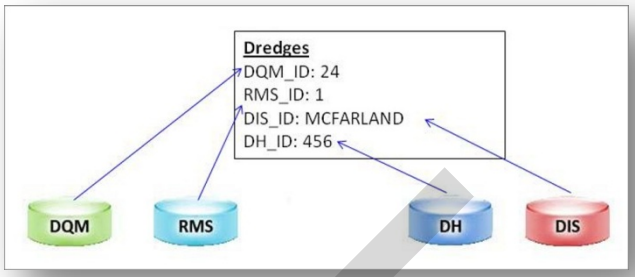
Translation Table—A table that equates the primary keys of common tables in separate databases.

This navigation will be accomplished using a translation table to link primary keys. A *primary key* is a field or combination of fields that uniquely identifies each record in a table. (A table can have only one primary key.) A *translation table* is a table that equates the primary keys of common tables in separate databases.

For example, we need to retrieve data about the dredge pictured here. However, these data are recorded in all four dredging databases. Some of the data are unique to a single database, but some of it is repeated (but perhaps not consistently) across multiple databases. How can we access all of this information without going into each separate database? While each record in each of the databases includes a primary key, the value of each primary key differs, so there is currently no way to link the records.

A translation table is created for each data entity in the hub. This table connects related dredge information from the separate databases based on primary keys.

The following list identifies the associated primary keys and the authoritative datasource for each hub table:



	Hub Table*	Primary Key	Datasource
1	Contracts**	Contract + Task#	RMS
2	Contractors	DUNS#	Outside Source/RMS
3	Dredge Areas	[B=borrow; C=channel; D=dredge] + sequence #	DM/DQM
4	Dredges	TBD	Outside Source/RMS
5	Placement Areas	DREDGE_MAT_ID	DM/DQM
6	Project Areas (Waterway Systems)	PROJECT_ID	DM/DQM
7	Sub-Project Areas (Waterway Features)	PROJECT_ID	DM/DQM

* *Only the datasource can update the table data within the hub*

** *Contains a JobKey field to associate contracts with planned jobs*

Materialized Views

Although referred to here as "hub tables," the tables containing the primary keys and datasources for each data entity these tables can actually be materialized views, which provide a regularly refreshed snapshot[2] of the source data. A *materialized view* is a virtual table in a relational database that contains the results of a query. It differs from a *view* because it records the query results from only a single point in time; it may be updated, but until it is, it remains static.

Materialized View— A virtual table in a relational database that contains the results of a query. It differs from a *view* because it records the query results from only a single point in time; it may be updated, but until it is, it remains static.

As additional commonalities are identified, materialized views can be created to share that data. Some benefits of materialized views include the following:

- **Reliability**—If the connection to the datasource is lost, the materialized view contains the last good snapshot.
- **Responsiveness**—Querying over the network can be slow; using a cached version of the data is faster.
- **Network loads**—Queries over the network to the actual base tables are done less frequently, decreasing the network load.

[2]The frequency with which these snapshots are updated can be determined on a per-table basis although the DDIF PDT agreed once a day is often enough for most tables.

Hub Security

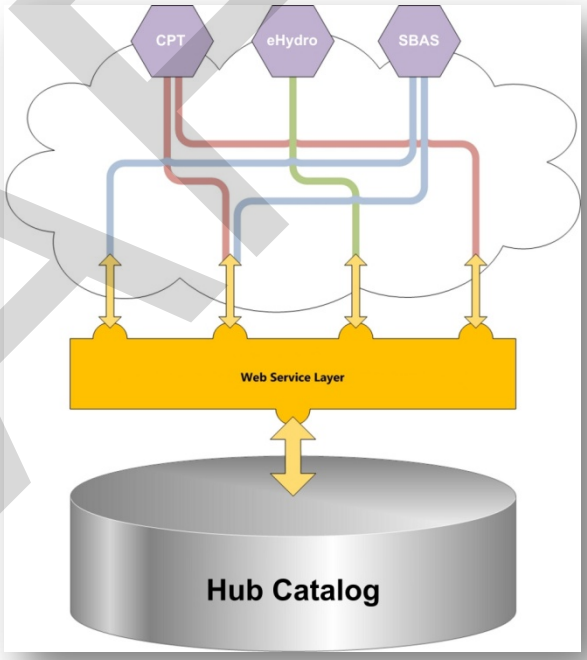
Source databases will read hub data directly via materialized views and perform create, update, and delete operations via stored procedures. A *stored procedure* is a subroutine (set of instructions) that performs a specific task and that is available to applications that access a relational database.

Stored Procedure—A subroutine (set of instructions) that performs a specific task and that is available to applications that access a relational database.

Source applications and tools will read hub data via web services which pull data from materialized views. They will perform create, update, and delete operations via web services which call stored procedures within the hub.

Tools

Once the databases are connected through the hub, there needs to be a way to access the information in them. One way is through the use of tools. Some new tools need to be developed , but many already exist—for example the Channel Portfolio Tool (CPT), the Coastal Modeling System (CMS), Dredging Operations and Environmental Research (DOER), eHydro, the Inlet Reservoir Model, the Sediment Budget Analysis System (SBAS), and the Shoaling Toolbox. The problem is that because these tools are located in a number of places, they may not be reaching their intended audience. Therefore, they must be catalogued and made discoverable through a dredging portal.



These and tools can be designed to access the necessary dredging data through the use of web services. In addition, some must be integrated, so the output of one tool can provide the input of another.

Web Service Layer

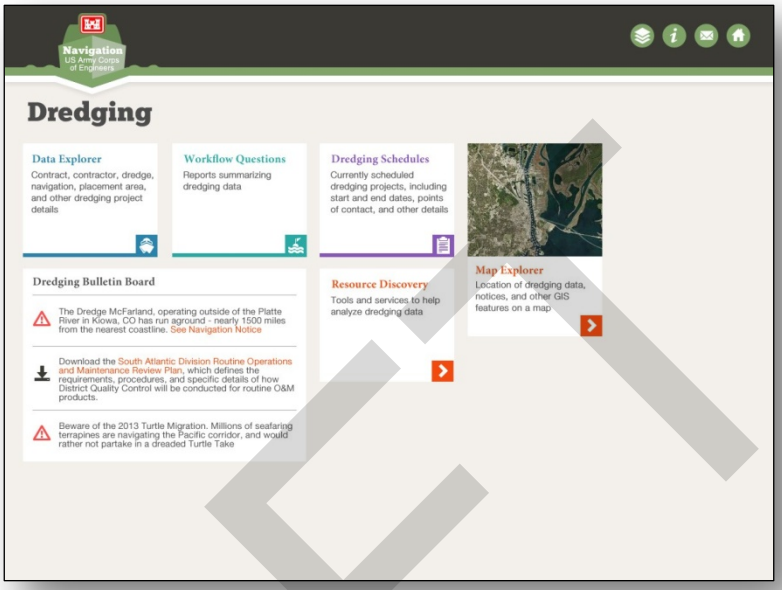
Rather than connecting the tools directly to the one or more dredging databases, or to the dredging hub, they will use a web service layer to communicate data requests. For example, the hub might "serve out" (make available) a list of dredges (which includes such details as name, type, and owner) that any tool needing dredge data can "consume" (use). Simply speaking, a *web service* is a means of exchanging data between applications (in this case, databases) over the Internet. The web service layer provides a number of methods for querying and updating data in the hub catalog.

Web Service—A means of exchanging data between applications over the Internet.

Tools will also publish to these web services, thus enriching the collection of dredging data available for research and analysis. New tools can be written to access hub data via existing web service calls, and new web service calls can be added to the web service layer as needed. All tools and web services will be catalogued so they are discoverable by all USACE users. One way to do this is to tag them with the appropriate filters. Then users will be able to discover them through the dredging portal.

Dredging Portal

The final product of the DDIF will be a Dredging Data Integration Framework Portal that provides easy access to and data sharing among the four dredging databases. Since all of the previously discussed parts of the DDIF occur behind the scenes, the portal will provide a Graphical User Interface (GUI) to allow users access to the data and tools. A portal is basically a website that that can access information from one or more databases in a uniform way and that provides access to a wide range of tools.



More specifically, the viewer will provide a Data Explorer that helps the user locate the required data and, if appropriate, view its related details. The portal also provides a series of Workflow Questions designed for HQUSACE and other staff who want just summarized data rather than details. In addition, it provides access to Dredging Schedules for current projects and a means of Resource Discovery, so users can find tools and services to help them analyze data, including resources they may not have known about previously. Finally, the portal provides a Map Explorer, a geospatial component that allows all spatial data to be viewed through an online viewer, and a Bulletin Board to keep users abreast of the latest bulletins and alerts.

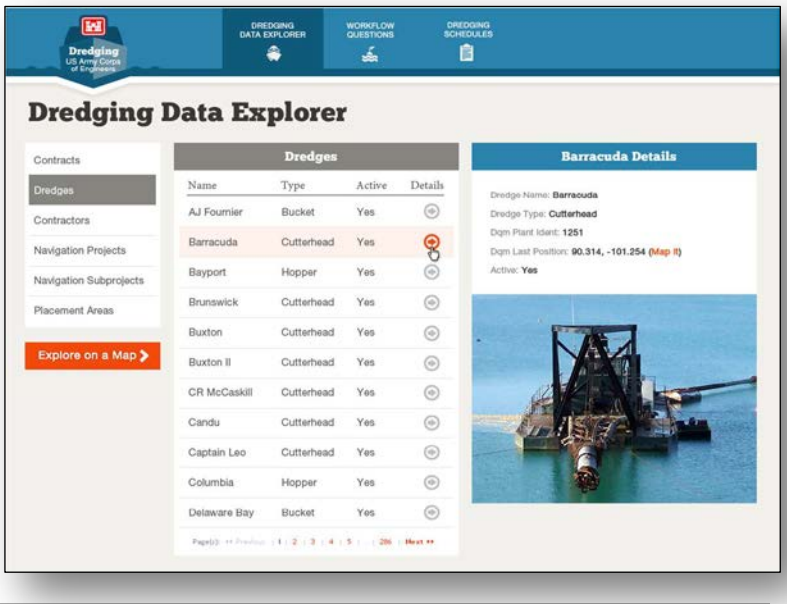
The portal accesses the hub the same way tools do. Because of this, users can use the portal to find answers to their questions. For example, What is the shoal volume? What type of contract is being used? How much will dredging cost? What are the channel significance and priority?

The following sections describe the current vision of the DDIF Dredging Portal design. However, this design is sure to evolve as DDIF development continues and as DDIF team members and navigation stakeholders QA/QC the product.

Data Explorer

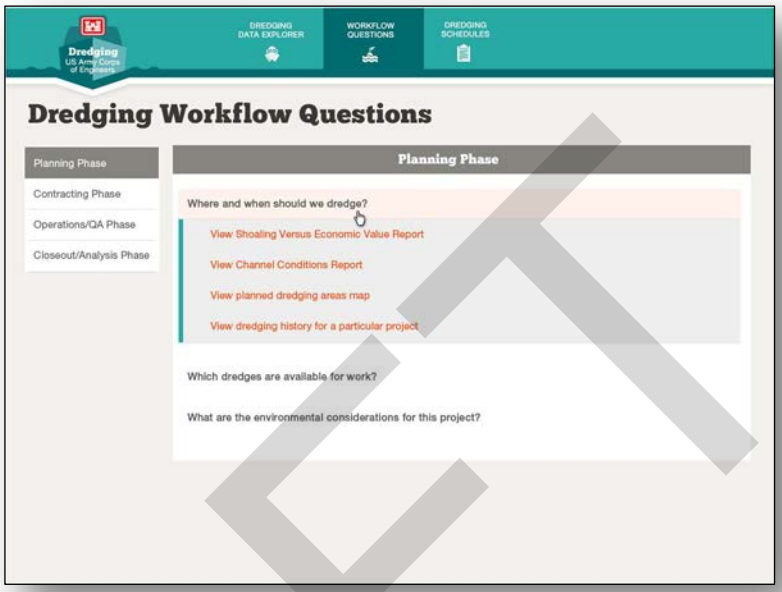
The Data Explorer screen provides access to several lists related to dredging projects: Contracts, Dredges, Contractors, Navigation Projects, Navigation Subprojects, and Placement Areas. Each list item is a link, so additional details are only a click away.

In this example, clicking the Dredging link displays a list of dredges, and clicking the Barracuda link, in turn, displays a picture and details about the cutterhead dredge *Barracuda*.



Workflow Questions

The Workflow tab provides the information that HQUSACE and managers at different levels require. Rather than detailing specifics, it summarizes data—in report format, on a timeline, or on a map—to deliver high-level overviews that answer specific dredging questions. Clicking a question provides one or more links to sources that will help answer the question.



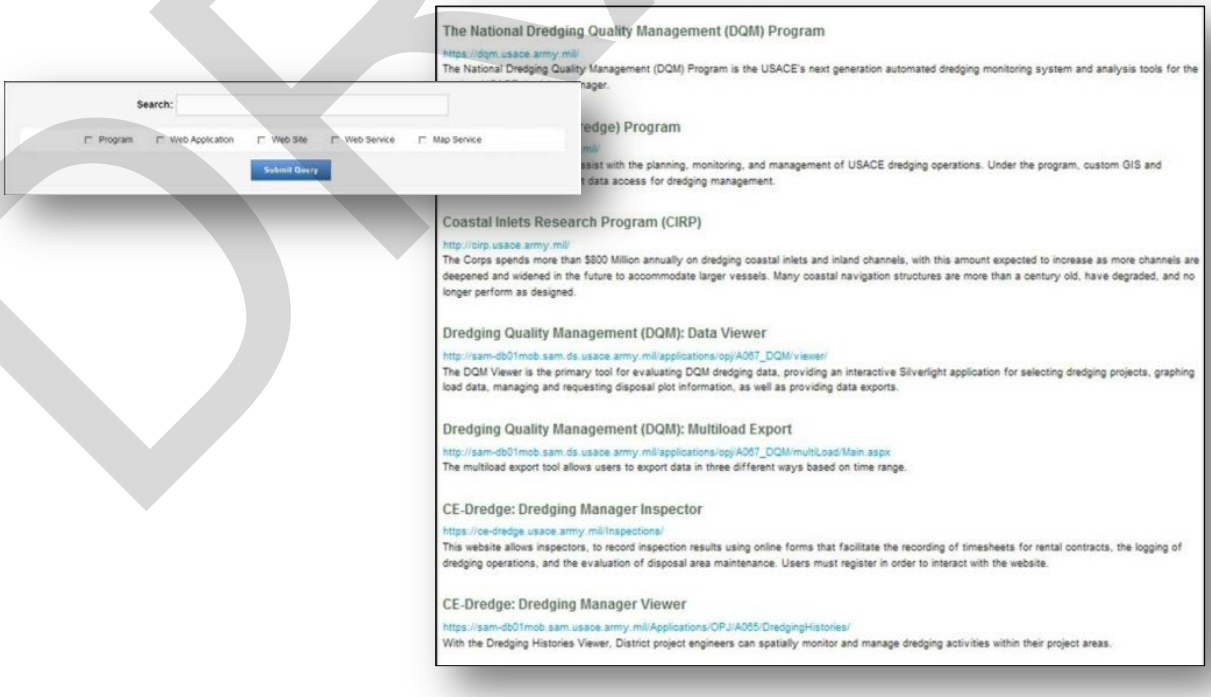
For quick access, the questions have been pre-filtered by dredging project phase—Planning, Contracting, Operations/QA, and Closeout/Analysis.

Dredging Schedules

The Dredging Schedules page provides an easy way to find the starting and ending dates and the location of current and future dredging projects. Additional details may also be available, such as the contractor, dredge name and type, contract cost and point of contact, dredging depth and estimated quantity, and placement site.

Resource Discovery

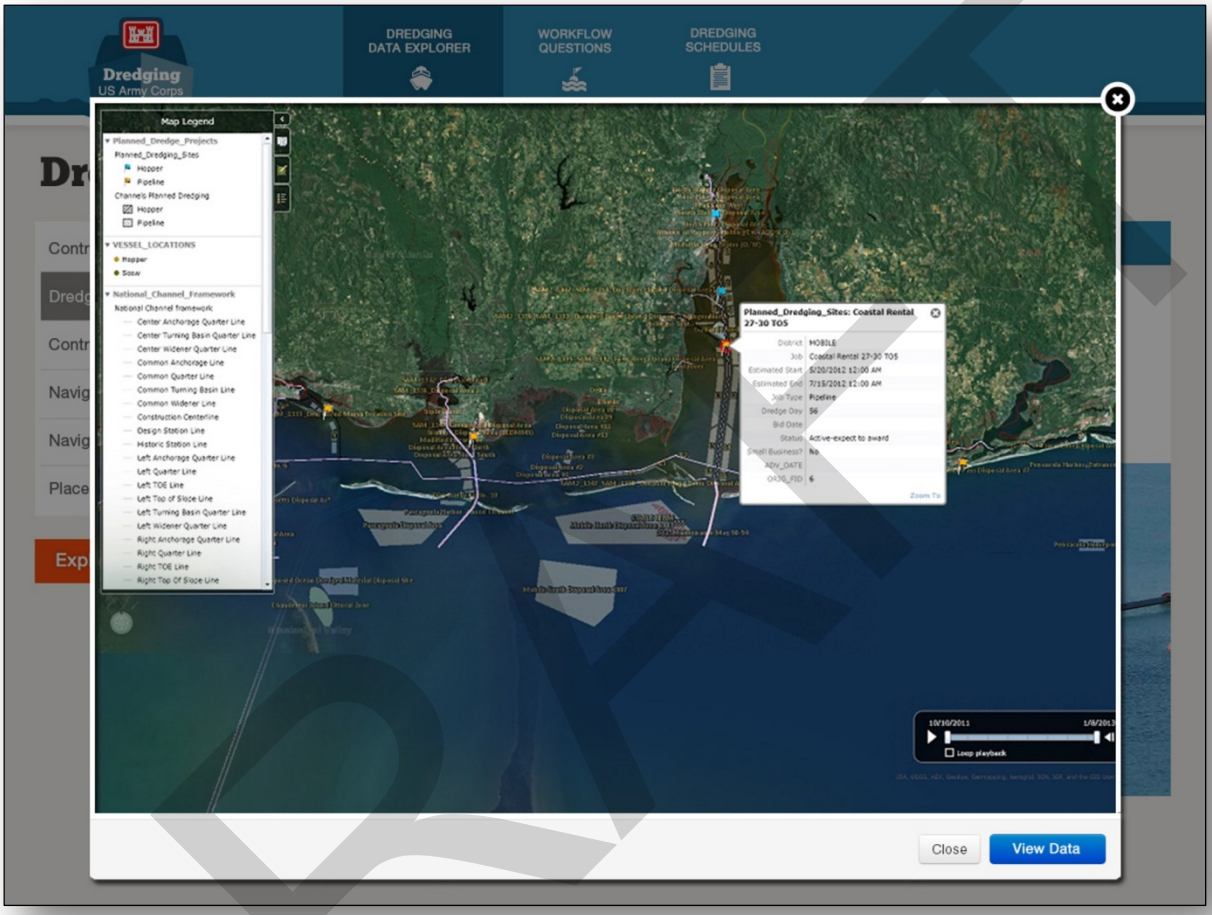
Resource Discovery is a central location for finding USACE map services, programs, web applications, web services, and websites. Searching for the term "dredging," for example, might "discover" the results (web applications, websites, and map services) shown below.



Data Map Viewer

The Data Map Viewer allows users to search for a location and then view project and other related dredging data spatially.

This example shows planned dredging sites in the Mobile (AL) Harbor, additional details about one of the sites, current vessel locations, the National Channel Framework (NCF), and established placement sites.



Project Delivery Team

Agency	Name	Project Role	Phone	Email
Dredging Information System (DIS)				
CEIWR-NDC	Roger Perta	Technical SME	(315) 732-3951	roger@rogerperta.com
	Virginia Pankow	Functional SME	(703) 428-9047	Virginia.R.Pankow@usace.army.mil
	Tom Verna	Functional SME	(703) 428-8562	Thomas.M.Verna@usace.army.mil
Dredging Manager (DM)				
CEERD-HN-C	Linda Lillycrop	Functional SME	(202) 761-1837	Linda.S.Lillycrop@usace.army.mil
CESAM-OP-J	Mike McFarland	Technical SME	(850) 484-6968	Michael.E.McFarland@usace.army.mil
	Teresa Parks	Technical SME	(251) 690-2035	Teresa.C.Parks@usace.army.mil
Dredging Quality Management (DQM)				
CESAM-OP-J	Vern Gwin	Functional SME	(251) 690-2045	William.V.Gwin@usace.army.mil
	Brenda Allen	Technical SME	(251) 690-3282	Brenda.P.Allen@usace.army.mil
Resident Management System (RMS)				
CESPL-CD-RV	Ken Avila	Technical SME	(760) 247-0217	Kenneth.P.Avila@usace.army.mil
CESAW	Sheilla Figgins	Functional SME	(910) 251-4582	Sheilla.G.Figgins@usace.army.mil

Appendix B
River Information Services (RIS)

Introduction

River Information Services (RIS) involves traffic management infrastructure on the inland waterway network and includes the establishment of an interoperable, intelligent traffic and transport system to enhance the capacity and safety of these waterways.

This appendix identifies and describes USACE's River Information Services (RIS) databases.

River Information Services Databases

The following River Information Services databases include USACE navigation data:

- Consolidated US Coast Guard (USCG) Web Service
- Inland Electronic Navigation Charts (IENC)
- Lock Operation Management Application (LOMA)
- Lock Performance Monitoring System (LPMS)
- Master Docks Plus (MDP)
- Nationwide Automatic Identification System (NAIS)

Consolidated US Coast Guard Web Service

The US Coast Guard (USCG) possesses a large amount of data related to ship locations and ship history that it makes available through various web services. The USACE Mobile District's Spatial Data Branch has developed a web service that consolidates the data available from the multiple USCG web services and has made it available on the CorpsNet.

This web service consolidates the following USCG web services:

- **Vessel History**—Voyage history details for the specified vessel
- **Vessel Identity**—Vessel names that include the specified string within a specified period of time
- **Vessel Position**—Most current position of the specified vessel

- **Vessel Position Aggregated List**—Specified number of positions (in increments of 5 minutes or greater) for the specified vessel over a specific period of time
- **Vessel Position in Area**—Vessels currently located within a specified polygon
- **Vessel Position List**—Specified number of positions for the specified vessel over a specified period of time
- **Vessel Track Line**—Specified number of positions for the specified vessel
- **Vessel Transit**—Vessels that were in a specified polygon within a specified period of time and (optional) traveling within a specified range of speed

Inland Electronic Navigation Charts (IENC)

The Inland Electronic Navigation Charts (IENC) database is a unified navigation information tool that supports safe and efficient navigation on 8,200 miles of inland waterways in 22 states and through the 276 lock chambers maintained by the USACE. Using modern software, mapping, Geographic Information System (GIS), and Global Positioning System (GPS) technologies, it transforms traditional paper river charting data into digital navigation charts.

Electronic chart systems can offer significant benefits to vessels, including accurate and real-time display of vessel position relative to waterway features, voyage planning and monitoring, training tools for new personnel and integrated display of river charts, radar, and Automatic Identification Systems (AISs).

Lock Operation Management Application (LOMA)

The Lock Operations Management Application (LOMA) is a tool designed to increase the situational awareness of lock operators, vessel pilots, USACE management, and other users of US inland waterways to improve inland waterway safety, efficiency, and reliability. It uses the Automatic Identification System (AIS) to gather information to gather information about the vessels operating on these waterways and to transmit information that these same vessels can automatically display on their navigation systems.

LOMA data provide lock operators and management with traffic overviews, industry with vessel positions, and vessel operators with restrictions.

Lock Performance Monitoring System (LPMS)

The Lock Performance Monitoring System (LPMS) encompasses the collection, editing, maintenance, and analysis of data collected at all USACE-owned and -operated locks. The information describes the traffic through the locks as well as the physical aspects of lockages. It provides lock operators and management with lock statistics and traffic forecasts, vessel operators with lock queues, and the USACE Institute for Water Resources' Navigation Data Center with lock and cargo statistics.

More specifically, the data include lock names, river locations, and dimensions; the number of tows, commercial vessels other than tows, recreational vessels, and barges (empty and loaded), all by direction and total; the number and dates of commercial and recreational lockages; barge type, size, and commodity type; tonnages; summaries of both approach and entry chambering and exit times (maximum, minimum and average); the number of delays as well as the total, maximum, and average delay time; and durations of and causes for periods of lock unavailability.

The Lock Performance Monitoring System database is maintained by the USACE Institute for Water Resources' Navigation Data Center (CEIWR-NDC).

Master Docks Plus (MDP)

The Master Docks Plus database includes data on over 40,000 port-and-waterway facilities and other navigation points of interest of the coastal, Great Lakes, and inland ports of the United States as well as for facilities in Alaska, Hawaii, Puerto Rico, the US Virgin Islands, and the trust territories of the Pacific. The physical and inter-modal (infrastructure) characteristics data include, but are not limited to, location (latitude/longitude, waterway, mile, bank), operations (name, owner, operator, purpose, handling equipment, rates, details of open-and-covered storage facilities), type and dimension of construction (length of berthing space for vessels and/or barges, depth, apron width, deck elevation, details of rail-and-highway access), and utilities available (water, electricity, and fire protection).

The Master Docks Plus database is maintained by the USACE Institute for Water Resources' Navigation Data Center (CEIWR-NDC).

Nationwide Automatic Identification System (NAIS)

The Coast Guard's Nationwide Automatic Identification System (NAIS) enhances maritime domain awareness with a focus on improving security, navigational safety, search and rescue, and environmental protection services. NAIS is based on the Automatic Identification System (AIS), a technology sanctioned by the International Maritime Organization as a global standard for ship-to-ship, ship-to-shore and shore-to-ship communications. NAIS uses digital VHF wave forms to continually transmit and receive voiceless data.

Appendix C
Surveying and Mapping

Introduction

With today's budget constraints and the emphasis on the timely collection and distribution of data from common Civil Works processes, it is more important than ever to ensure that data collected by one USACE District or Division, especially geospatial data, is available to be shared by other Districts and Divisions as well as by HQUSACE and other federal agencies.

It is imperative that data and data products be available to both the originator and other users in near real time and in a consistent format. For example, outside navigation interests and NOAA critically need the most current and timely hydrographic survey data to assess channel conditions for safety and efficiency of navigation. HQUSACE and Divisions need derived information from hydrographic surveys to determine priority of dredging needs across project and District boundaries. HQUSACE also needs channel condition information to establish corporate performance-based budgeting for dredging and to communicate economic impacts of under-maintained channels.

This appendix identifies and describes USACE's surveying and mapping databases.

Surveying and Mapping Databases

Surveying and mapping databases that include USACE navigation data include the following:

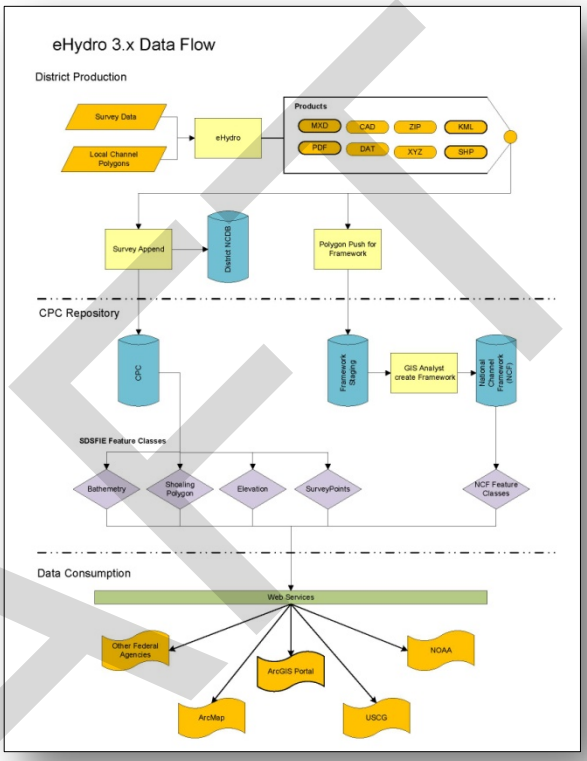
- eHydro Hydrographic Survey
- National Channel Framework (NCF)
- National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX)
- Navigation and Coastal Data Bank (NCDB)

eHydro Hydrographic Survey

Hydrographic survey, or hydrography, according to the International Hydrographic Organization, is "the branch of applied sciences which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic

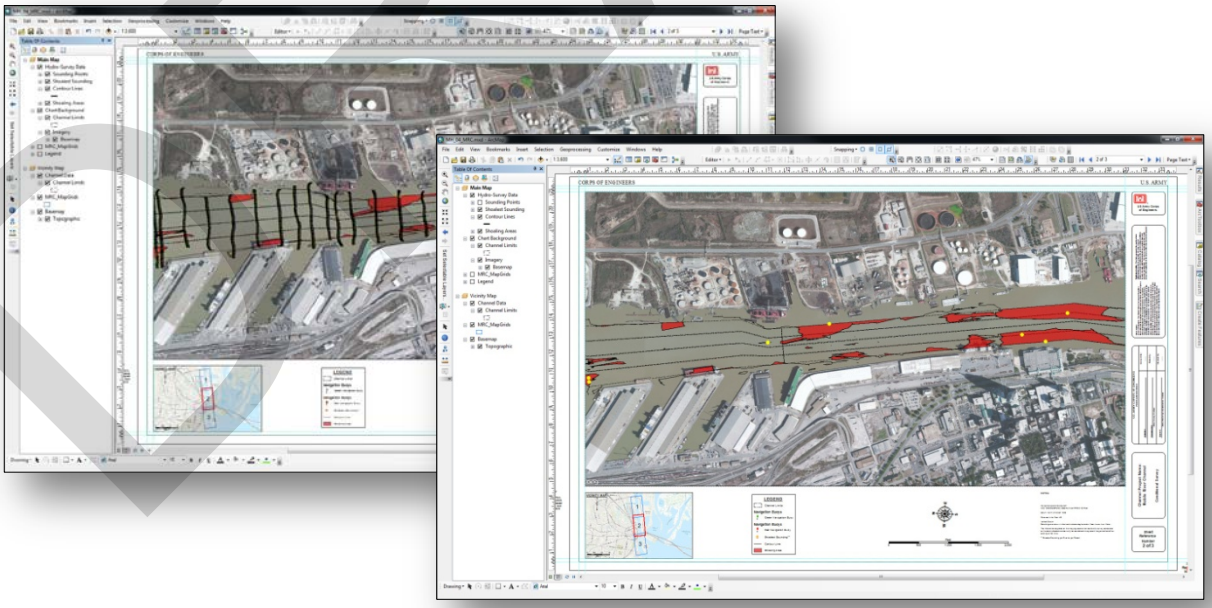
development, security and defence [sic], scientific research, and environmental protection."[1] Hydrographic survey charts serve a number of purposes, including assistance in locating navigable channels, determination of dredging requirements, verification of dredging accuracy, and maintenance of harbors and rivers.

USACE developed the eHydro hydrographic survey application for the purpose of producing and disseminating consistent and reliable enterprise hydrographic data to USACE staff, the National Oceanic and Atmospheric Administration (NOAA), and the navigation community. Raw XYZ hydrosurvey soundings are plotted within a GIS framework of channel boundaries, project depths, stationing, and channel quarters.



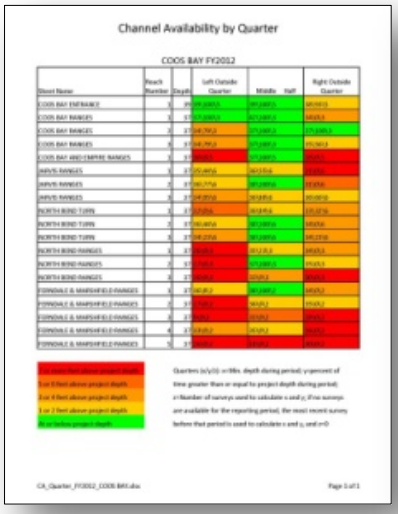
eHydro places the resulting contour lines, contour polygons, shoaling polygons, and shoalest points in a file geodatabase, which is stored on a server in the Central Processing Center (CPC) in Vicksburg, MS, and integrated into the National Channel Framework (NCF).

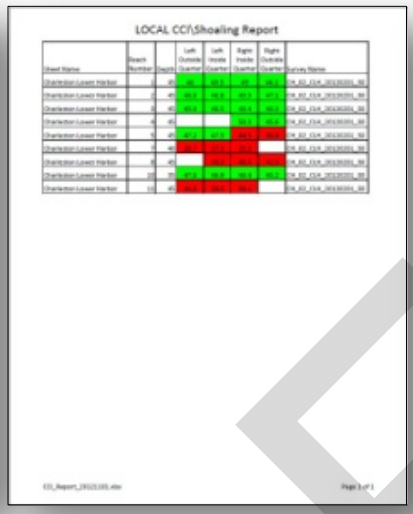
In addition to the file geodatabase, eHydro also produces a hydrographic survey map in both MXD and PDF formats. The user can decide which data layers are displayed on the map—for example, with or without the soundings. If data-driven pages are used, the single map document is converted into a series of layout sheets, and the coverage of each sheet is indicated within an inset vicinity map.

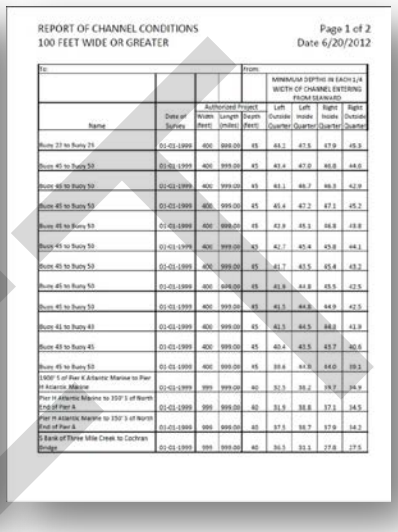


[1] International Hydrographic Organization. (n.d.). Definition of Hydrography. In International Hydrographic Organization. Retrieved July 1, 2013, from http://www.iho.int/srv1/index.php?option=com_content&view=article&id=299&Itemid=289.

Other eHydro products include Channel Availability by Quarter (CAQ) reports, Channel Condition Indices (CCIs), and Channel Condition Reports (CCRs), all pictured below, as well as Channel Availability (CHA) reports, Summary Planning Quantities (SPQ) reports, and Survey Aging (AGE) reports.

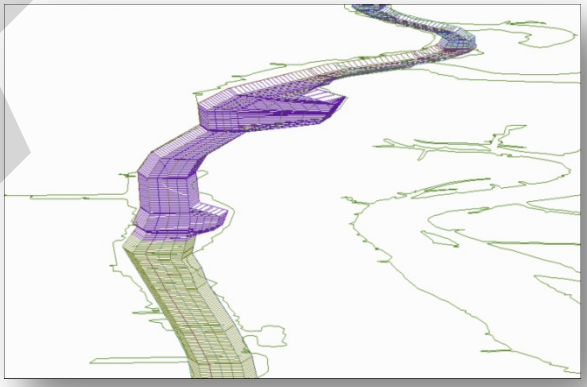






In addition, bathymetry, shoaling polygon, elevation, survey point, and channel line data are served out to NOAA and other navigation consumers through web services, allowing outside users to analyze the data and develop their own information products. eHydro is currently being used in 21 USACE Districts.

National Channel Framework (NCF)

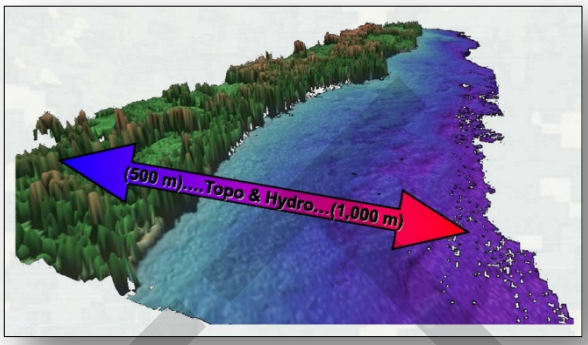


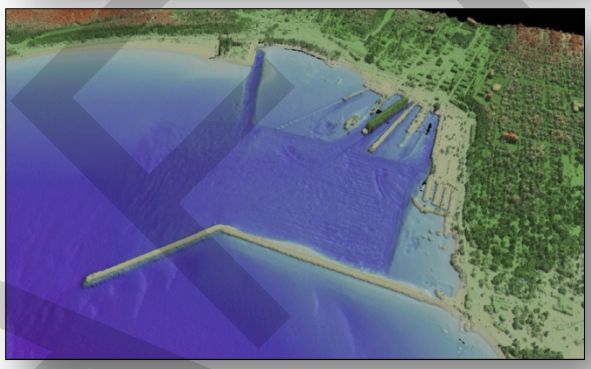
Until fairly recently, USACE and the National Oceanic and Atmospheric Administration (NOAA) fulfilled their responsibility to provide navigation information to the maritime community through the use of CAD to build and maintain framework data for all congressionally authorized navigation channels. The National Channel Framework (NCF) is an enterprise GIS geodatabase that includes information on all 61 high-tonnage channels maintained by USACE. Simply speaking, it is a 3D waterway roadmap.

The NCF database includes the outside channel limits, TOELINES, construction centerlines, top of slope lines, TOSLINES, channel reach positions, and inside channel quarters for all USACE-maintained navigation channels. It serves to provide the required data to update National Oceanic and Atmospheric Administration (NOAA) paper and electronic navigation charts (ENC); it provides foundational data for eHydro, the Dredging Quality Management (DQM) Program, and other applications; and it connects to the USACE Corps Project Notebook (CPN) and provides a consistent inventory of projects and subprojects across the USACE Navigation Business Line.

National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetric Technical Center of Expertise (JALBTCX)

The National Coastal Mapping Program (NCMP) is designed to provide high-resolution elevation and imagery data along US shorelines on a recurring basis to support USACE regional sediment management, construction, operations, and regulatory functions in the coastal zone.





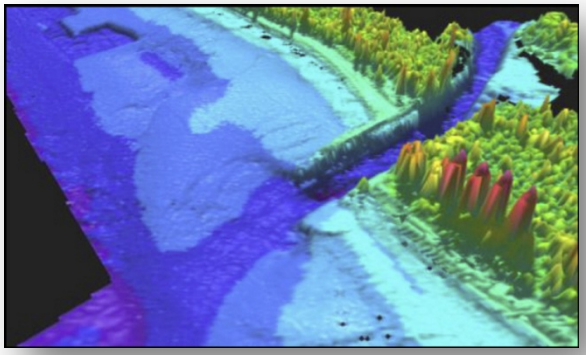
The NCMP is executed by the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), using its in-house survey capability, the Coastal Zone Mapping and Imaging Lidar (CZMIL) system, which integrates topographic and bathymetric lidar sensors, a digital camera, and a hyperspectral scanner on a single remote sensing platform.

The NCMP database includes bathymetric data collected from the shoreline to 1 km offshore at 5 m spacing, topographic data collected from the shoreline 0.5 km onshore at 1 m spacing, RGB digital imagery with a ground resolution of 20 cm/pixel, and Compact Airborne Spectrographic Imager (CASI) imagery with a ground resolution of 0.5-2 m/pixel.

These data are used to support the coastal mapping and charting requirements of USACE, the US Naval Meteorology and Oceanography Command (NMOC), and the National Oceanic and Atmospheric Administration (NOAA). JALBTCX staff includes engineers, scientists, hydrographers, and technicians from the USACE Mobile District, the Naval Oceanographic Office (NAVOCEANO), the USACE Engineer Research and Development Center (ERDC), and the National Oceanographic and Atmospheric Administration (NOAA) National Geodetic Survey (NGS). The many GIS products provided with these data include seamless bathymetric/topographic grids, bare earth bathymetric/topographic grids, building footprints, shoreline position, seafloor reflectance images, basic landcover classifications, and RGB and hyperspectral image mosaics. At least one cycle of data has been collected for the entire US coastline; a second cycle of data was collected along the US coast of the Great Lakes.

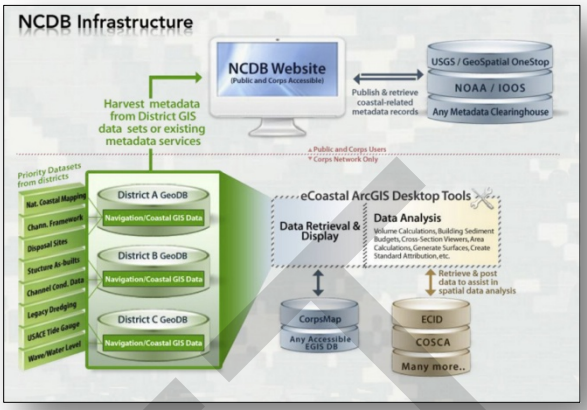
Navigation and Coastal Data Bank (NCDB)

The Navigation and Coastal Data Bank (NCDB), managed by the USACE Mobile District, consolidates priority USACE data, allowing access to new and existing navigation and coastal data through the District geodatabase and, ultimately, through a single portal.



The NCDB's function is four-fold: to manage data at the Districts where it is collected, to organize Districts to bring their coastal data online as a corporate asset, to create a web portal and search engine for navigation and coastal information, and to participate in Data.gov's US Geospatial One-Stop.

The site connects to a national collection of servers that maintains spatial and temporal navigation and coastal data, including the following main data sets. This ensures that USACE staff have easy access to the basic navigation and coastal features they use daily in a GIS-ready format.



- National coastal mapping products
- Channel framework
- Disposal sites
- Structure as-builts
- Hydrosurveys
- Channel condition surveys
- Legacy dredging data
- USACE tide gauge data
- Wave/water level data

Two critical components of the NCDB are Navigation Channel Framework and channel survey data, and a critical function is the display and dissemination of channel condition data to users internal and external to USACE. Currently, 22 coastal USACE Districts are participating in this project.

Appendix D
Infrastructure and Asset Management

Introduction

USACE is responsible for over 12,000 miles of navigation channels, 195 navigation locks, and hundreds of jetties, breakwaters, and anchorages. Each year tens of millions of dollars are spent repairing these structures. However, fiscal constraints are forcing the USACE to make difficult decisions concerning allocation of limited Operations and Maintenance (O&M) funds across its vast portfolio of coastal and inland navigation projects. Therefore, it is imperative that these limited resources be optimally distributed and that benefits to the nation are maximized. The solution is navigation asset management.

This appendix identifies and describes USACE's surveying and mapping databases.

Infrastructure and Asset Management Databases

The following infrastructure and asset management databases include USACE navigation data:

- Channel Portfolio Tool (CPT)
- Coastal Structures Management, Analysis, and Ranking Tool (CSMART)
- Enterprise Coastal Inventory Database (ECID)
- Lock Characteristics
- Lock Performance Monitoring System (LPMS)
- Master Docks Plus (MDP)
- National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX)
- Navigation and Coastal Data Bank (NCDB)
- Port and Waterways Facilities

Channel Portfolio Tool (CPT)

The Channel Portfolio Tool (CPT), a web-based decision-support package, uses the proprietary, dock-level tonnage database maintained by the Waterborne Commerce Statistics Center (CEWCSC) for determining

the extent to which dredged channel depths are used by commercial shipping. It provides way to analyze waterway network flow patterns on an objective and consistent basis in order to compare and, subsequently, prioritize waterway and channel importance. The CPT covers the entire navigation portfolio of USACE waterway projects, both coastal and inland.

The CPT provides navigation managers and project engineers with justification for annual O&M dredging budget requests. It also allows both USACE Headquarters and divisions to better allocate limited dredging funds across regions according to a rational, consistent methodology using readily available performance metrics. In addition, it helps them see navigation channel portfolio management as a systems-based approach.

Coastal Structures Management, Analysis, and Ranking Tool (CSMART)

Coastal Structures Management, Analysis, and Ranking Tool (CSMART), a decision-support package for prioritizing coastal structures for annual maintenance funding, was developed within the Coastal Inlets Research Program's (CIRP's) Coastal Navigation Portfolio Management (CNPM) work unit.

Using commercial tonnage data from the Waterborne Commerce Statistics Center (CEWCSC), commercial fishing data from the National Oceanic and Atmospheric Administration-National Marine Fisheries Service (NOAA-NMFS), US Coast Guard (USCG) incident reports, USACE dredging records, and US Department of Transportation (USDOT) cruise and ferry statistics, CSMART sorts and filters pertinent data to produce a prioritized ranking of structures that gives USACE staff a clear idea of each structure's navigational significance.

Enterprise Coastal Inventory Database (ECID)

The Enterprise Coastal Inventory Database application and database provides basic information on over 900 USACE coastal structures as well as associated inlet data. It uses a Google Earth interface to provide basic project information, aerial photographs, project and inspection reports, bathymetry and lidar data, and wave and water level data.

For the most part, it has been superseded by Coastal Navigation Structures Asset Management activities. However, it was also used to record more detailed information on 23 structures that were specifically monitored as part of the Monitoring Completed Navigation Project's (MCNP's) Periodic Inspection work unit ("Tier 2" inspection). This data includes materials used in construction, structure purpose, cross section makeup, rating information, above and below water metrics, crest elevation and slope ratings, etc. These ratings feed a risk model that considers normal and extreme events with consequences to navigation, sediment and channel.

Lock Characteristics

The Lock Characteristics database contains information on the physical aspects of all USACE-built, -maintained, -owned, and -operated locks. These data include location (river name, river mile point, latitude/longitude, town, county, Congressional district, USACE District and Division), physical characteristics (length, width, lift, depth, gate type, and number of chambers), site information (lock operator, mailing address, phone/fax number, and radio call sign), site characteristics (channel length and width, lake pool, pool length and elevation, waterway project and segment, mooring, multiple uses), historical change (lock name, location, construction, replacement, transfers), and management Information (fiscal year budget, number of full-time federal employees, CWIS number, EROC code, authorized document, USACE District contact).

The Lock Characteristics database is maintained by the USACE Institute for Water Resources' Navigation Data Center (CEIWR-NDC).

Lock Performance Monitoring System (LPMS)

The Lock Performance Monitoring System (LPMS) encompasses the collection, editing, maintenance, and analysis of data collected at all USACE-owned and -operated locks. The information describes the traffic through the locks as well as the physical aspects of lockages. It provides lock operators and management with lock statistics and traffic forecasts, vessel operators with lock queues, and the USACE Institute for Water Resources' Navigation Data Center with lock and cargo statistics.

More specifically, the data include lock names, river locations, and dimensions; the number of tows, commercial vessels other than tows, recreational vessels, and barges (empty and loaded), all by direction and total; the number and dates of commercial and recreational lockages; barge type, size, and commodity type; tonnages; summaries of both approach and entry chambering and exit times (maximum, minimum and average); the number of delays as well as the total, maximum, and average delay time; and durations of and causes for periods of lock unavailability.

The Lock Performance Monitoring System database is maintained by the USACE Institute for Water Resources' Navigation Data Center (CEIWR-NDC).

Master Docks Plus (MDP)

The Master Docks Plus database includes data on over 40,000 coastal, Great Lakes, and inland US port-and-waterway facilities and other navigation points of interest. Data on facilities in Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and the trust territories of the Pacific is also included. The physical and intermodal (infrastructure) characteristics data include location (latitude/longitude, waterway, mile, bank), operations (name, owner, operator, purpose, handling equipment, rates, details of open-and-covered storage facilities), type and dimension of construction (length of berthing space for vessels and/or barges, depth, apron width, deck elevation, details of rail-and-highway access), utilities available (water, electricity, and fire protection, and other details.

The Master Docks Plus database is maintained by the USACE Institute for Water Resources' Navigation Data Center (CEIWR-NDC).

National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX)

The National Coastal Mapping Program (NCMP) is designed to provide high-resolution elevation and imagery data along US shorelines on a recurring basis to support USACE regional sediment management, construction, operations, and regulatory functions in the coastal zone.

The NCMP is executed by the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), using its in-house survey capability, the Coastal Zone Mapping and Imaging Lidar (CZMIL) system, which integrates topographic and bathymetric lidar sensors, a digital camera, and a hyperspectral scanner on a single remote sensing platform.

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bathymetric/topographic grids, bare earth bathymetric/topographic grids, building footprints, shoreline position, seafloor reflectance images, basic landcover classifications, and RGB and hyperspectral image mosaics. At least one cycle of data has been collected for the entire US coastline; a second cycle of data was collected along the US coast of the Great Lakes.

Navigation and Coastal Data Bank (NCDB)

The Navigation and Coastal Data Bank (NCDB), managed by the USACE Mobile District, consolidates priority USACE data, allowing access to new and existing navigation and coastal data through the District geodatabase and, ultimately, through a single portal.

The NCDB's function is four-fold: to manage data at the Districts where it is collected, to organize Districts to bring their coastal data online as a corporate asset, to create a web portal and search engine for navigation and coastal information, and to participate in Geospatial One-Stop and the IOOS interface to USACE navigation and coastal data.

The site connects to a national collection of servers that maintains spatial and temporal navigation and coastal data, including the following main data sets. This ensures that USACE staff have easy access to the basic navigation and coastal features they use daily in a GIS-ready format.

- National coastal mapping products
- Channel framework
- Disposal sites
- Structure as-builts
- Hydrosurveys
- Channel condition surveys
- Legacy dredging data
- USACE tide gauge data
- Wave/water level data

Two critical components of the NCDB are Navigation Channel Framework and channel survey data, and a critical function is the display and dissemination of channel condition data to users internal and external to USACE. Currently, 22 coastal USACE Districts are participating in this project.

Port and Waterways Facilities

The data in the Port and Waterways Facilities database consist of the physical and intermodal characteristics of more than 9,500 facilities at more than 200 coastal, Great Lakes, and inland ports in the United States. Facility data include, but are not limited to location (latitude/longitude, Navigation Data Center [CEIWR-NDC) codes, mile, and bank); operations (name, owner, operator, purpose, handling equipment, rates, and details of open and covered storage facilities); type and dimension of construction (length of berth space for vessels and/or barges, depth, apron width, deck elevation, and details of rail and highway access); and utilities available (water, electricity, and fire protection). Other data include extensive descriptive material, including project authorization, bridge/tunnel/railroad infrastructure data, meteorological information, and anchorage descriptions. All viable commodity handling and maritime service wharves are included, as are aerial maps and photos of individual facilities.

The Port and Waterways Facilities database is maintained by the USACE Institute for Water Resources' Navigation Data Center (CEIWR-NDC).

Appendix E
Engineering With Nature (EWN) and Regional Sediment Management (RSM)

Introduction

Sustainable development and maintenance of water resources infrastructure requires solutions that beneficially integrate engineering and natural systems, and consider these solutions within a regional or systems context. Success in identifying and implementing these solutions requires communication and collaboration with other Federal and State agencies as well as with stakeholders and partners. The USACE Engineering With Nature and Regional Sediment Management initiatives provide the bases to work collaboratively to identify and implement such solutions.

This appendix introduces Engineering With Nature and Regional Sediment Management and then identifies and describes the databases used by each initiative.

Engineering With Nature (EWN)

Engineering With Nature (EWN) is a USACE initiative to enable more sustainable delivery of the economic, social, and environmental benefits associated with water resources infrastructure. EWN directly supports USACE's "Sustainable Solutions to America's Water Resources Needs: Civil Works Strategic Plan 2011–2015" and contributes to the achievement of its Civil Works mission and goals.

Within the USACE Navigation Business Line, the EWN vision began working for increased environmental, economic, and social value at the local, regional, and system levels in 2011. Its cost-effective approach will enable the navigation community to achieve sustainable navigation systems, increased navigation safety and efficiency, and an expanded range of benefits through the harmonious alignment of navigation, engineering, and ecosystem functions.

Over the next 5 to 7 years, EWN will be implemented in USACE navigation and dredging operations by building on its base of support within USACE and with key external stakeholders through a dialogue on EWN principles and opportunities, by focusing research and development investments to expand technical and communication science capabilities required for successful EWN, by demonstrating the EWN approach through concrete case examples, and by establishing leadership on EWN through the development and dissemination of a range of EWN applications.

EWN opportunities include strategic placement of sediments for the beneficial use of dredged material (using hydrodynamics and natural transport processes to build near-shore habitats), use of engineering features to focus natural processes (minimizing navigation channel infilling and transport and focusing sediments for positive benefits), cost-efficient engineering practices (enhancing the habitat value of infrastructure), optimized use of natural systems, such as wetlands (reducing the effects of storm processes

and sea level rise on shorelines and coasts), and science-based communications processes (significantly improving stakeholder engagement, collaboration, and communication).

Regional Sediment Management (RSM)

The Regional Sediment Management (RSM) Program works closely with the EWN initiative to improve the management and use of sediments through application of regional or systems approaches. Benefits of an integrated EWN and RSM approach are improved partnerships with stakeholders, integrated sediment management with environmental management, improved environmental stewardship, and reduced overall lifecycle costs.

The USACE initiated implementation of the RSM Program in 1999. The purpose of the program is to improve the management of sediments and projects through a systems-based approach, manage sediments as a regional-scale resource, and support sustainable navigation and dredging, flood and storm, and environmental practices, which increase benefits while reducing costs. RSM strives to enhance the planning, construction, and operation and maintenance of navigation, shore protection, and environmental restoration projects while protecting natural resources. RSM is also a means of involving stakeholders to leverage resources, share technology and data, identify needs and opportunities, and develop solutions to improve the management of sediments. The main focus is to better understand the region through integration of regional data and application of tools which improve our knowledge of the region, understand and share demands for sediment, and identify and implement adaptive management strategies to streamline dredging projects, improve placement of dredged sediment, and enhance channel reliability. Benefits of this approach are improved partnerships with stakeholders, improved sediment and project management on a regional scale, improved environmental stewardship, and reduced overall lifecycle costs.

Engineering With Nature and Regional Sediment Management Databases

The following Engineering With Nature and Regional Sediment Management databases include USACE navigation data:

- Civil Works Project Mitigation Database (CWPMD)
- Ecosystem Restoration Business Line (ERBL)
- eHydro Hydrographic Survey
- Engineering With Nature (EWN)
- National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX)
- Navigation and Coastal Data Bank (NCDB)
- Ocean Disposal Database (ODD)
- Sediment Budget Analysis System (SBAS)

Civil Works Project Mitigation Database (CWPMD)

The Civil Works Project Mitigation Database (CWPMD) is a USACE-wide integrated tool designed to consolidate and report information on civil works mitigation projects. It provides information about

required ecological mitigation for civil works projects, serves as a learning tool for ecosystem restoration practitioners, facilitates long-term management of mitigation sites, and functions as a reporting tool for outside requirements and interested parties. More specifically, it facilitates the preparation of the reports required by Section 2036, Water Resources Development Act of 2007, which amends Section 906(d) of the Water Resources Development Act of 1986 [33 U.S.C. 2283(d)].

Some of the data in this database are downloaded directly from the Program and Project Management System (P2) while other data are entered directly by users.

CWPMD benefits USACE practitioners of ecosystem restoration and USACE managers who need to compile and document results as well as, eventually, cost-sharing partners, other agencies, and the public.

Ecosystem Restoration Business Line Database (ERBL)

The Ecosystem Restoration Business Line Database (ERBL) is designed to provide ecosystem restoration study and project information, facilitate knowledge sharing among staff working on ecosystem tracking studies and restoration projects, streamline reporting activities to various queries regarding content and output, and provide information to help program-level adaptive management. Its ultimate goals are to serve as a USACE-wide integrated tool to consolidate and report information on ecosystem restoration projects and to serve as a streamlined learning tool.

Some of the data in this database are downloaded directly from the Program and Project Management System (P2) while other data are entered directly by users. Information gathered in this database is shared with other systems, including CorpsMap, Corps Project Notebook (CPN), and the Ecosystem Restoration Gateway.

ERBL benefits USACE practitioners of ecosystem restoration and USACE managers who need to compile and document results as well as, eventually, cost-sharing partners, other agencies, and the public.

eHydro Hydrographic Survey

Hydrographic survey, or hydrography, according to the International Hydrographic Organization, is "the branch of applied sciences which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic development, security and defence [sic], scientific research, and environmental protection."[1] Hydrographic survey charts serve a number of purposes, including assistance in locating navigable channels, determination of dredging requirements, verification of dredging accuracy, and maintenance of harbors and rivers.

USACE developed the eHydro hydrographic survey application for the purpose of producing and disseminating consistent and reliable enterprise hydrographic data to USACE staff, the National Oceanic and Atmospheric Administration (NOAA), and the navigation community. Survey soundings are plotted within a GIS framework of channel boundaries, project depths, stationing, and channel quarters. Products include hydrographic survey maps, Channel Condition Indices (CCIs), Channel Condition Reports (CCRs), Summary Planning Quantities (SPQ) reports, and Survey Aging reports as well as web services that export soundings and contours, so outside users can analyze the data and develop their own information products. eHydro is currently being used in 21 USACE Districts.

[1] International Hydrographic Organization. (n.d.). Definition of Hydrography. In International Hydrographic Organization. Retrieved February 19, 2013, from http://www.iho.int/srv1/index.php?option=com_content&view=article&id=299&Itemid=289.

Engineering with Nature (EWN)

Engineering With Nature (EWN) is the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits. It is a holistic, ecosystem approach for planning, designing, constructing, and operating projects that focuses on the long-term sustainability of projects and their benefits over time.

The web-based EWN Viewer, developed by the US Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory (CEERD-EL), features a base map overlaid by background base layers (such as Primary Project Objective; Physical Project Type; and Primary, Secondary, and Tertiary Engineering with Nature Goals) and data layers containing coordinate data and several site attribute fields for each EWN example. The database currently includes about 200 entries.

National Channel Framework (NCF)

Until fairly recently, USACE and the National Oceanic and Atmospheric Administration (NOAA) fulfilled their responsibility to provide navigation information to the maritime community through the use of CAD to build and maintain framework data for all congressionally authorized navigation channels. The National Channel Framework (NCF) is an enterprise GIS geodatabase that includes information on all 61 high-tonnage channels maintained by USACE. Simply speaking, it is a 3D waterway roadmap.

The NCF database includes the outside channel limits, TOELINES, construction centerlines, top of slope lines, TOSLINES, channel reach positions, and inside channel quarters for all USACE-maintained navigation channels. It serves to provide the required data to update National Oceanic and Atmospheric Administration (NOAA) paper and electronic navigation charts (ENC); it provides foundational data for eHydro, the Dredging Quality Management (DQM) Program, and other applications; and it connects to the USACE Corps Project Notebook (CPN) and provides a consistent inventory of projects and subprojects across the USACE Navigation Business Line.

National Coastal Mapping Program (NCMP)/Joint Airborne Lidar Bathymetric Technical Center of Expertise (JALBTCX)

The National Coastal Mapping Program (NCMP) is designed to provide high-resolution elevation and imagery data along US shorelines on a recurring basis to support USACE regional sediment management, construction, operations, and regulatory functions in the coastal zone.

The NCMP is executed by the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), using its in-house survey capability, the Coastal Zone Mapping and Imaging Lidar (CZMIL) system, which integrates topographic and bathymetric lidar sensors, a digital camera, and a hyperspectral scanner on a single remote sensing platform.

The NCMP database includes bathymetric data collected from the shoreline to 1 km offshore at 5 m spacing, topographic data collected from the shoreline to 0.5 km onshore at 1 m spacing, RGB digital imagery with a ground resolution of 20 cm/pixel, and Compact Airborne Spectrographic Imager (CASI) imagery with a ground resolution of 0.5-2 m/pixel.

These data are used to support the coastal mapping and charting requirements of USACE, the US Naval Meteorology and Oceanography Command (NMOC), and the National Oceanic and Atmospheric Administration (NOAA). JALBTCX staff includes engineers, scientists, hydrographers, and technicians from the USACE Mobile District, the Naval Oceanographic Office (NAVOCEANO), the USACE Engineer Research and Development Center (ERDC), and the National Oceanographic and Atmospheric Administration (NOAA) National Geodetic Survey (NGS). The many GIS products provided with these data include seamless bathymetric/topographic grids, bare earth bathymetric/topographic grids, building footprints, shoreline position, seafloor reflectance images, basic landcover classifications, and RGB and hyperspectral image

mosaics. At least one cycle of data has been collected for the entire US coastline; a second cycle of data was collected along the US coast of the Great Lakes.

Navigation and Coastal Data Bank (NCDB)

The Navigation and Coastal Data Bank (NCDB), managed by the USACE Mobile District, consolidates priority USACE data, allowing access to new and existing navigation and coastal data through the District geodatabase and, ultimately, through a single portal.

The NCDB's function is four-fold: to manage data at the Districts where it is collected, to organize Districts to bring their coastal data online as a corporate asset, to create a web portal and search engine for navigation and coastal information, and to participate in Data.gov's US Geospatial One-Stop.

The site connects to a national collection of servers that maintains spatial and temporal navigation and coastal data, including the following main data sets. This ensures that USACE staff have easy access to the basic navigation and coastal features they use daily in a GIS-ready format.

- National coastal mapping products
- Channel framework
- Disposal sites
- Structure as-builts
- Hydrosurveys
- Channel condition surveys
- Legacy dredging data
- USACE tide gauge data
- Wave/water level data

Two critical components of the NCDB are Navigation Channel Framework and channel survey data, and a critical function is the display and dissemination of channel condition data to users internal and external to USACE. Currently, 22 coastal USACE Districts are participating in this project.

Ocean Disposal Database (ODD)

The Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA), also known as the Ocean Dumping Act, established environmental guidance for all ocean disposal activities. Ocean disposal cannot occur unless a permit is issued under the MPRSA. In the case of dredged material, the decision to issue a permit is made by the USACE, using environmental criteria established by the Environmental Protection Agency (EPA) and subject to the EPA's concurrence.

The Ocean Disposal Database (ODD) compiles information on all ocean dredged-material disposal activities since 1976 at Environmental Protection Agency (EPA)-designated or USACE-selected sites. Data includes the name, coordinates, management, and monitoring of each ocean disposal site name as well as the name; location, type, dredging and disposal method, frequency and volume of disposal, and disposal site for each project. Physical, chemical, biological data on the dredged material is also recorded.

Sediment Budget Analysis System (SBAS)

Sediment budgets provide a conceptual and quantitative understanding of the magnitudes and pathways of sediment transport over a given region over a specified timeframe. They are fundamental planning and design tools for projects concerned with sediment transport, deposition, and erosion. More specifically, a sediment budget is a tallying of sediment gains (sources) and losses (sinks) within a specified control volume (cell or series of connecting cells) over a given period of time. By conservation of mass (volume) of sediment, the difference between the sediment sources and the sinks in each cell, and over the entire budget, must equal the rate of change in sediment volume occurring within that region, accounting for pertinent engineering activities, such as sand placement and dredging.

The Sediment Budget Analysis System (SBAS) provides a framework for formulating and documenting regional sediment budgets, including estimation of uncertainty. Because it is visually based, it provides an integrated picture of the processes while archiving detailed calculations within the system, and it allows variations in the sediment budget to be rapidly examined. SBAS provides the capability to create both quantitative "micro" (local) and "macro" (regional) sediment budgets.

Appendix F
Marine Transportation System

Introduction

Under federal law, companies must report the domestic waterborne commercial movements of their vessels to USACE. These vessels include dry cargo ships and tankers, barges (both loaded and empty), fishing vessels, towboats (with or without barges in tow), tugboats, crew boats and supply boats to offshore locations, and newly constructed vessels from the shipyards to the point of delivery. Vessels remaining idle during the monthly reporting period must also be reported.

This vessel trip and cargo data is collected, processed, distributed, and archived by the Waterborne Commerce Statistics Center (CEWCSC), a division of the USACE Institute for Water Resource's Navigation Data Center (CEIWR-NDC). Data collected include domestic and foreign vessel trips and tonnages by commodity for ports and waterways in the United States. Foreign waterborne commerce between the United States and foreign countries is summarized by US port, foreign port, foreign country, commodity group, and tonnage. Data summaries include origin to destination information of foreign and domestic waterborne cargo movements by region and state as well as waterborne tonnage for principal ports, states, and territories. The CEWCSC also maintains listings of domestic vessel operators and their address, type and physical description of the vessels, principal service, location, and commodity served; details their equipment; and references their service areas. These databases include data from multiple sources; however, each cargo and vessel movement record contains a destination code referencing a geocoded entry in the Master Docks Plus database.

This appendix identifies and describes USACE's marine transportation databases.

Marine Transportation Databases

The following marine transportation databases include USACE navigation data:

- Commodity Code Cross Reference File
- Flag Master File
- Foreign Cargo (Inbound/Outbound)
- Foreign Traffic Vessel Entrances and Clearances
- Hazardous Commodity Code Cross Reference File

- International Classification of Ships by Type (ICST)
- Master Docks Plus
- Principal Ports of the United States
- Schedule K Classification of Foreign Ports
- Waterborne Commerce of the United States (WCUS)

Commodity Code Cross Reference File

The Commodity Code Cross Reference File database cross-references the commodity codes and names used in the Waterborne Commerce of the United States (WCUS) database with the commodity codes used in the Public Domain Database and the Lock Performance Monitoring System (LPMS) database.

This database is maintained by the USACE Waterborne Commerce Statistics Center (CEWCSC).

Flag Master File

The Flag Master File database records the flags of all vessels.

This database is maintained by the USACE Waterborne Commerce Statistics Center (CEWCSC).

Foreign Cargo (Inbound/Outbound)

The Foreign Cargo (Inbound/Outbound) database identifies the cargo flows between US ports and waterways and foreign ports.

This database is maintained by the USACE Waterborne Commerce Statistics Center (CEWCSC).

Foreign Traffic Vessel Entrances and Clearances

The Foreign Traffic Vessel Entrances and Clearances database includes the following data for each major US port and waterway: the vessel's full name, type (by one-digit rig type or ICST [International Classification of Ships by Type] code), flag of registry, last or next port of call (whether domestic or foreign), net and gross tonnage, and draft as well as the date it entered or cleared the US Customs port.

This database is maintained by the USACE Waterborne Commerce Statistics Center (CEWCSC).

Hazardous Commodity Code Cross Reference File

The Hazardous Commodity Code Cross Reference File database cross references the commodity codes used in the Waterborne Commerce of the United States (WCUS) database with the North American Emergency Response Guide (NAERG) guide numbers and hazard classes.

This database is maintained by the USACE Waterborne Commerce Statistics Center (CEWCSC).

International Classification of Ships by Type (ICST)

The International Classification of Ships by Type (ICST) database records the ICST code for all vessels.

This database is maintained by the USACE Waterborne Commerce Statistics Center (CEWCSC).

Master Docks Plus

The Master Docks Plus database includes data on over 40,000 coastal, Great Lakes, and inland US port-and-waterway facilities and other navigation points of interest. Data on facilities in Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and the trust territories of the Pacific is also included. The physical and intermodal (infrastructure) characteristics data include location (latitude/longitude, waterway, mile, bank), operations (name, owner, operator, purpose, handling equipment, rates, details of open-and-covered storage facilities), type and dimension of construction (length of berthing space for vessels and/or barges, depth, apron width, deck elevation, details of rail-and-highway access), utilities available (water, electricity, and fire protection, and other details.

The Master Docks Plus database is maintained by the USACE Institute for Water Resources' Navigation Data Center (CEIWR-NDC).

Principal Ports of the United States

The Principal Ports of the United States database records USACE port codes, geographic locations (longitude and latitude), names, and commodity tonnage summaries (total tons, domestic, foreign, imports and exports) for principal USACE ports.

This database is maintained by the USACE Waterborne Commerce Statistics Center (CEWCSC).

Schedule K Classification of Foreign Ports

The Schedule K Classification of Foreign Ports database lists the numeric codes for the major seaports of the world that directly handle waterborne shipments in the foreign trade of the United States.

This database is maintained by the USACE Navigation Data Center (CEIWR-NDC).

Waterborne Commerce of the United States (WCUS)

Waterborne Commerce of the United States (WCUS) provides statistics on the domestic and foreign waterborne commerce moved on US waters. It includes data on the movements of commodities at the ports and harbors and on the waterways and canals of the United States and its territories. Excluded movements include cargo carried on general ferries; coal and petroleum products loaded from shore facilities directly into bunkers of vessels for fuel; and insignificant amounts (less than 100 tons) of government materials moved on government-owned equipment in support of USACE projects. Import and export shipments for the use of US Armed Forces abroad are also not included.

This database is maintained by the USACE Waterborne Commerce Statistics Center (CEWCSC).

Appendix G
Glossary

This glossary provides a list of acronyms and definitions of important concepts used in this document.

Acronyms

- **ACE-IT**—US Army Corps of Engineers, Information Technology
- **AIS**—Automatic Identification System
- **BOUSS-2D**—Boussinesq
- **CAD**—Computer-Assisted Drawing
- **CASI**— Compact Airborne Spectrographic Imager
- **CCI**—Channel Condition Indices
- **CCR**—Channel Condition Report
- **CE-Dredge**—US Army Corps of Engineers Dredge
- **CEAGC**—US Army Corps of Engineers Army Geospatial Center
- **CECW**—US Army Corps of Engineers Civil Works Directorate
- **CECW-CO**—US Army Corps of Engineers Civil Works Directorate, Construction-Operations Division
- **CEERD**—US Army Corps of Engineers, Engineer Research and Development Center
- **CEERD-EL**—US Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory
- **CEERD-HF-CI**—US Army Corps of Engineers, Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Flood & Storm Protection Division, Coastal Processes Branch, Inlets Group
- **CEERD-HN-C**—US Army Corps of Engineers, Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Navigation Division, Coastal Engineering Branch
- **CEERD-HN-H**— US Army Corps of Engineers, Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Navigation Division, Harbors, Entrances, & Structures Branch
- **CEERD-HN-N**—US Army Corps of Engineers, Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Navigation Division, Navigation Branch
- **CEERD-HV-T**— US Army Corps of Engineers, Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Technical Programs Office
- **CEFMS**— US Army Corps of Engineers Financial Management System
- **CEIWR**— US Army Corps of Engineers, Institute for Water Resources
- **CEIWR-NDC**— US Army Corps of Engineers, Institute for Water Resources, Navigation Data Center
- **CEIWR-NDC-C**—US Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, Waterborne Commerce Statistics Center
- **CELRL-OP-E**—US Army Corps of Engineers, Great Lakes and Ohio River Division, Louisville District, Operations Division
- **CELRP**—US Army Corps of Engineers, Great Lakes and Ohio River Division, Pittsburgh District
- **CEMVD-PD**—US Army Corps of Engineers, Mississippi Valley Division, Programs Division

- **CENAD-PD**—US Army Corps of Engineers, North Atlantic Division, Planning Division
- **CENAP**—US Army Corps of Engineers, North Atlantic Division, Philadelphia District
- **CENWP**—US Army Corps of Engineers, Northwestern Division, Portland District
- **CEPOA**—US Army Corps of Engineers, Pacific Ocean Division, Alaska District
- **CESAD**—US Army Corps of Engineers, South Atlantic Division
- **CESAM**—US Army Corps of Engineers, South Atlantic Division, Mobile District
- **CESAM-OP-J**—US Army Corps of Engineers, South Atlantic Division, Mobile District, Operations Division, Spatial Data Branch
- **CESAW—**US Army Corps of Engineers, South Pacific Division, Wilmington District
- **CESPL—**US Army Corps of Engineers, South Pacific Division, Los Angeles District
- **CESPN—**US Army Corps of Engineers, South Pacific Division, San Francisco District
- **CESWG**—US Army Corps of Engineers, Southwestern Division, Galveston District
- **CEWCSC**—US Army Corps of Engineers, Waterborne Commerce Statistics Center
- **CMS**—Coastal Modeling System
- **CPC**—Central Processing Center
- **CPT**—Channel Portfolio Tool
- **CSMART**—Coastal Structures Management, Analysis, and Ranking Tool
- **CSTAR**—Collaborative Science, Technology, and Applied Research
- **CWIS**—Civil Works Information System
- **CWPMD**—Civil Works Project Mitigation Database
- **CZMIL**— Coastal Zone Mapping and Imaging Lidar
- **DH**—Dredging Histories (obsolete, replaced by Dredging Manager [DM])
- **DDIF**—Dredging Data Integration Framework
- **DIF**—Data Integration Framework
- **DIS**—Dredging Information System
- **DM**—Dredging Manager (previously known as Dredging Histories [DH])
- **DMMA**— Dredge Material Management Area
- **DOER**—Dredging Operations and Environmental Research
- **DQM**—National Dredging Quality Management Program
- **ECID**—Enterprise Coastal Inventory Database
- **EGES**—Enterprise Geospatial Engineering System
- **EM**—Engineering Manual
- **ENC**—Electronic Navigation Chart
- **EO**—Executive Order
- **ER**—Engineering Regulation
- **ERBL**—Ecosystem Restoration Business Line
- **ERDC**—US Army Corps of Engineers, Engineer Research & Development Center
- **EROC**—Engineering Reporting Organization Code
- **EWN**—Engineering With Nature
- **EWNDIF**—Engineering With Nature Data Integration Framework
- **GenCade**—GENESIS + Cascade
- **GENESIS—**Global Environmental & Earth Science Information System
- **GIS**—Geographic Information System
- **GUI**—Graphical User Interface
- **HQUSACE**—Headquarters, US Army Corps of Engineers
- **IAMDIF**—Infrastructure and Asset Management Data Integration Framework
- **ICST**—International Classification of Ships by Type
- **ID**—Identification
- **IENC**—Inland Electronic Navigation Chart
- **IIAB**—Impacts of Inlets on Adjacent Beaches
- **IT**—Information Technology

- **JALBTCX**—Joint Airborne Lidar Bathymetry Technical Center of Expertise
- **LOMA**—Lock Operations Management Application
- **LPMS**—Lock Performance Monitoring System
- **MDP**—Master Docks Plus
- **MMSI**—Maritime Mobile Service Identity
- **MTDIF**—Marine Transportation Data Integration Framework
- **NAERG**—North American Emergency Response Guide
- **NAIS**—Nationwide Automatic Identification System
- **NAVOCEANO**—Naval Oceanographic Office
- **NCDB**—Navigation and Coastal Data Bank
- **NCF**—National Channel Framework
- **NCMP**—National Coastal Mapping Program
- **NDC**—Navigation Data Center
- **NDIF**—Navigation Data Integration Framework
- **NGS**—National Geodetic Survey
- **NOAA**—National Oceanic and Atmospheric Administration
- **NSDI**—National Spatial Data Infrastructure
- **NSV**—Navigation Strategic Vision
- **O&M**—Operations & Maintenance
- **ODD**—Ocean Dumping Database
- **P2**—Program and Project Management System
- **PDT**—Product Delivery Team
- **PMP**—Project Management Plan
- **POC**—Point of Contact
- **QA/QC**—Quality Assurance/Quality Control
- **RMAP**—Regional Morphology and Analysis Program
- **R&D**—Research and Development
- **RGB**—Red, Green, Blue
- **RIS**—River Information Services
- **RISDIF**—River Information Services Data Integration Framework
- **RMS**—Resident Management System
- **RSM**—Regional Sediment Management
- **SBAS**—Sediment Budget Analysis System
- **SMDIF**—Survey & Mapping Data Integration Framework
- **SME**—Subject-Matter Expert
- **SPQ**—Summary Planning Quantities
- **SPS**—Standard Procurement System
- **USACE**—US Army Corps of Engineers
- **USCG**—US Coast Guard
- **VHF**—Very High Frequency
- **WCSC**—Waterborne Commerce Statistics Center
- **WCUS**—Waterborne Commerce of the United States

Definitions

- **Database**—A collection of information on a particular topic organized into one or more records or tables.

- **Field**—The intersection of a row and column in a table, which stores a single piece of data.

- **Foreign Key**—A column or group of columns in a table that corresponds to or represents the value of a primary key in another table in the database (or to a table in another database).

- **Hub Catalogue**—A single, central catalog whose function is to discover and connect individual, dispersed databases.

- **Materialized View (MV)**—A virtual table in a relational database that contains the results of a query. It differs from a *view* because it records the query results from only a single point in time; it may be updated, but until it is, it remains static.

- **Metadata Reference Table**—A table that equates the primary keys of common tables in separate databases.

- **Ontology**—A data model that describes the functional relationship that exists among a set of concepts.

- **Portal**—A website that offers data, information, tools, and best practices from multiple databases and provides access to a wide range of resources.

- **Primary Key**—A field or combination of fields that uniquely identifies each record in a table. A table can have only one primary key.

- **Relational Database**—A database structured to recognize relationships between tables by matching a key value in one table to the same key value in another table. Information from both tables can be accessed through this linkage.

- **Stored Procedure (proc)**—A subroutine (set of instructions) that performs a specific task and that is available to applications that access a relational database.

- **Table**—A collection of data in a relational database organized into records (rows) and fields (columns) that defines an entity (for example, contractors).

- **View**—A virtual table in a relational database that contains the results of a query. It differs from a table because it has no independent existence of its own; it exists only to store the query results, which may be pulled from one or multiple tables. It also differs from a materialized view because it is generated on the fly each time it is accessed and, therefore, remains current.

- **Web Service**—A means of exchanging data between applications over the Internet.