ERDC TN-EWN-15-1
July 2015

ENGINEERING WITH NATURE

Engineering With Nature Geographic Project Mapping Tool (EWN ProMap)

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PURPOSE: This document summarizes the development, information content, and basic operation of a geography-based mapping resource for projects that fit within the Engineering With Nature (EWN) context (Bridges 2012). The purpose of the EWN Project Mapping Tool (EWN ProMap) is to assist users in their search for case study information that can be valuable for developing EWN ideas during the planning phase of projects. The development of EWN ProMap was sponsored by the Dredging Operations and Environmental Research (DOER) Program.

BACKGROUND AND PROBLEM: Engineering With Nature is defined as the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits associated with water resource projects through collaborative processes (Figure 1). Essential elements of EWN include: (1) using science and engineering to produce operational efficiencies supporting sustainable delivery of project benefits; (2) using natural processes to maximum benefit, thereby reducing demands on limited resources, minimizing the environmental footprint of projects, and enhancing the quality of project benefits; (3) broadening and extending the base of benefits provided by projects to include substantiated economic, social, and environmental benefits; and (4) using science-based collaborative processes to organize and focus interests, stakeholders, and partners to reduce social friction, resistance, and project delays while producing more broadly acceptable projects (Bridges 2012).

The EWN concept is relatively new to many project planners such as biologists, engineers, and project managers. One of the key hindrances to implementation of the EWN concept is documentation of projects in terms of both project descriptions and information that documents success (Fredette et al. 2011, Bridges 2012). The EWN ProMap tool is intended to make the information for projects applying EWN principles more readily assessable. For example, the EWN ProMap database provides numerous case studies for infrastructure projects such as breakwaters, river engineering dikes, and seawalls that have provided benefits to support fish, invertebrate, avian, and plant communities.

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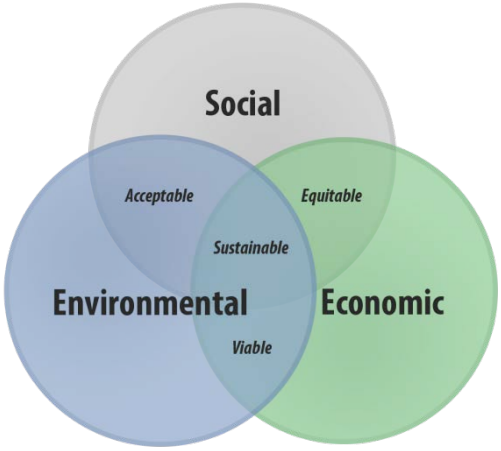

Figure 1. EWN promotes triple-win outcomes by providing the practical means for systematically integrating economic, environmental, and social benefits throughout project development.

DEVELOPMENT OF THE EWN PROMAP

Need for a Spatially Explicit Visualization Tool. The growth of internet-based Geographic Information Systems (GIS), data visualization services, and the emergence of greater public use of on-line map services has prompted many government agencies to adopt web-enabled GIS (WebGIS) frameworks as a crucial tool for delivering essential information to users (Fu and Sun 2011). As GIS expanded into the online landscape, maps created by overlaying data from multiple sources — such as restaurant locations, reviews, and street maps — became increasingly common and rapidly evolved into the GeoWeb. The GeoWeb is the delivery of spatially referenced information linked to non-spatial data through internet-based technologies to enhance the map-based understanding of our world.

Genesis of EWN ProMap. Since the U.S. Army Corps of Engineers (USACE) is a geographically distributed agency, it has actively embraced the GeoWeb and adopted Rich Internet Application (RIA) technologies to convey the successes of the organization. EWN ProMap, a product of the USACE Engineer Research Development Center, Environmental Laboratory's Geospatial Data and Analysis Facility (GDAF), is RIA built using JavaScript, utilizing Esri's ArcGIS Portal Application. The back-end data are supplied by Esri's ArcGIS server software and ProMap is made available to any user with internet access without individuals needing an ArcGIS license. EWN ProMap involves deployment of background base-map layers hosted by ArcGIS overlaid by a GDAF data layer containing positional and case-study data for specific EWN projects (*http://gis2.sam.usace.army.mil/applications/opj/v013/*).

EWN ProMap Content and Capabilities. EWN ProMap includes more than 175 projects, although this number will increase as new projects are identified or developed. Presently, most of the projects in the database are in the United States with some representation in the rest of the western hemisphere, particularly for reef module breakwaters in the Caribbean and Central America regions. At the time this document was written, only five projects outside of the western hemisphere were included.

EWN ProMap contains a wide array of project types and project information for use as concept starting points for new projects (Figure 2). Projects in ProMap can be displayed, ranging from the global scale to the project scale (Figure 3). Projects can be displayed by the associated infrastructure project type (AIPT) or the intended EWN benefits (EWNB1, EWNB2, EWNB3). The map displayed by ProMap is generated by the user's selection on the left-side tool panel (Figure 4).

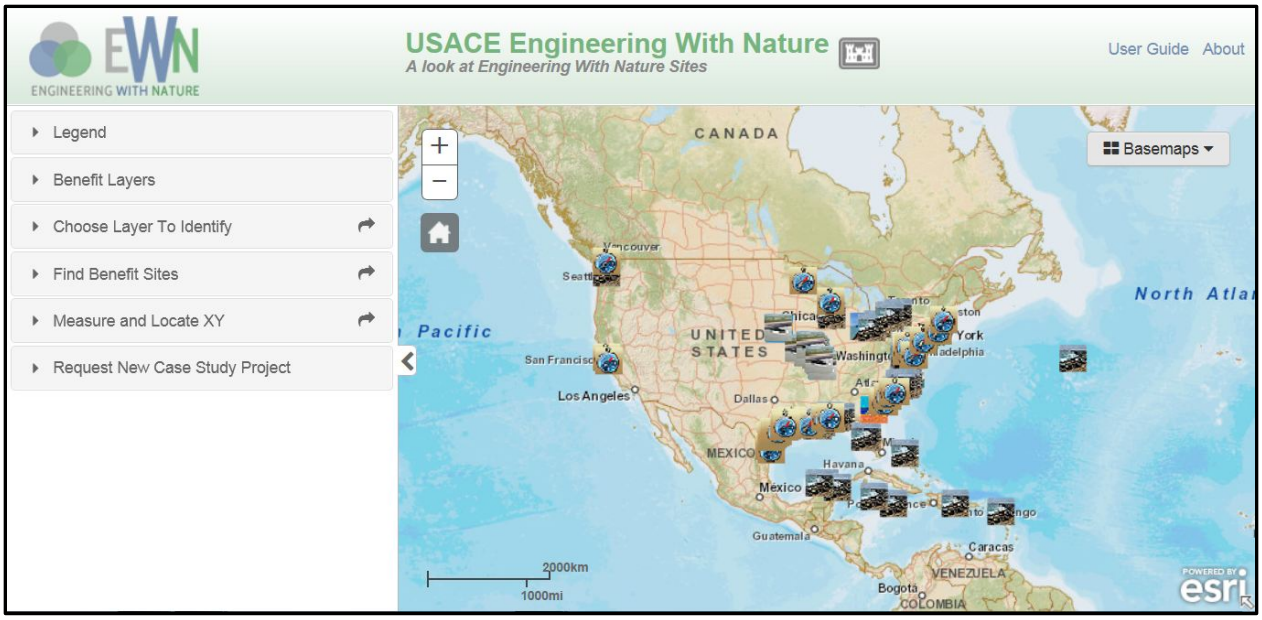

Figure 2. EWN ProMap overview. Icons represent project locations and type. ProMap has a tool panel, a basemap selection tool, a user guide link, and an About page as part of the functionality.

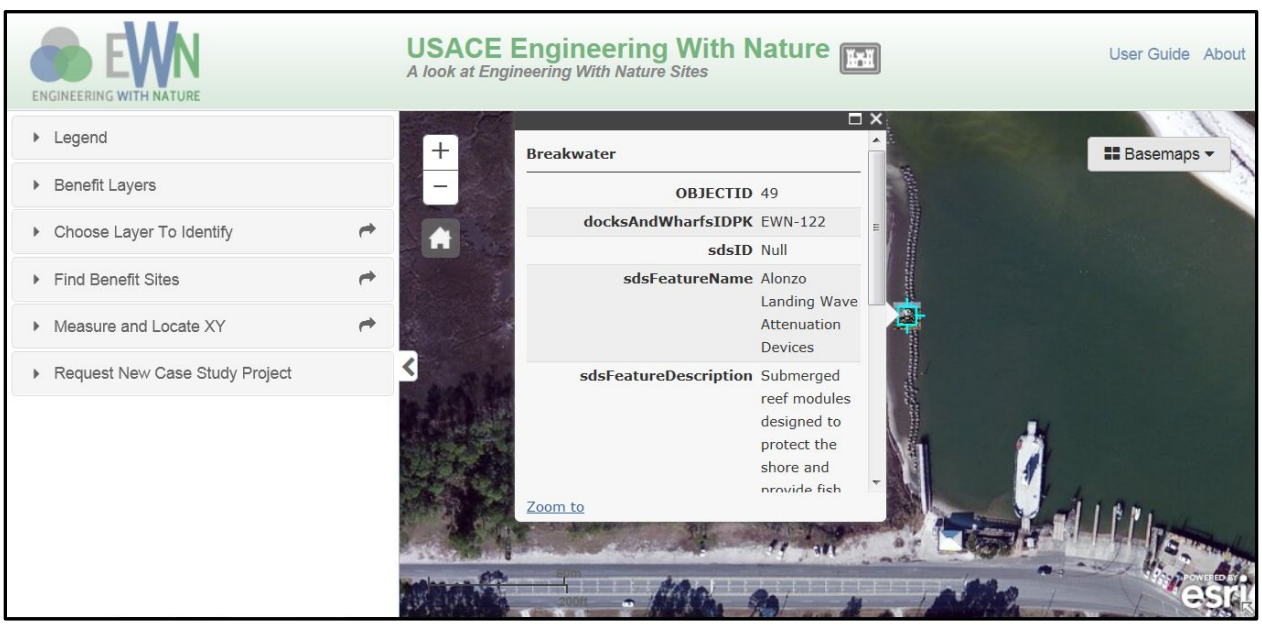

Figure 3. An example of EWN ProMap zoomed to project scale. The project shown is a semi-submerged reef breakwater constructed at Dauphin Island, AL, to provide shore protection and habitat for fish and invertebrates. Each site icon can be clicked to open a pop-up box that provides more detailed site information and relevant web links.

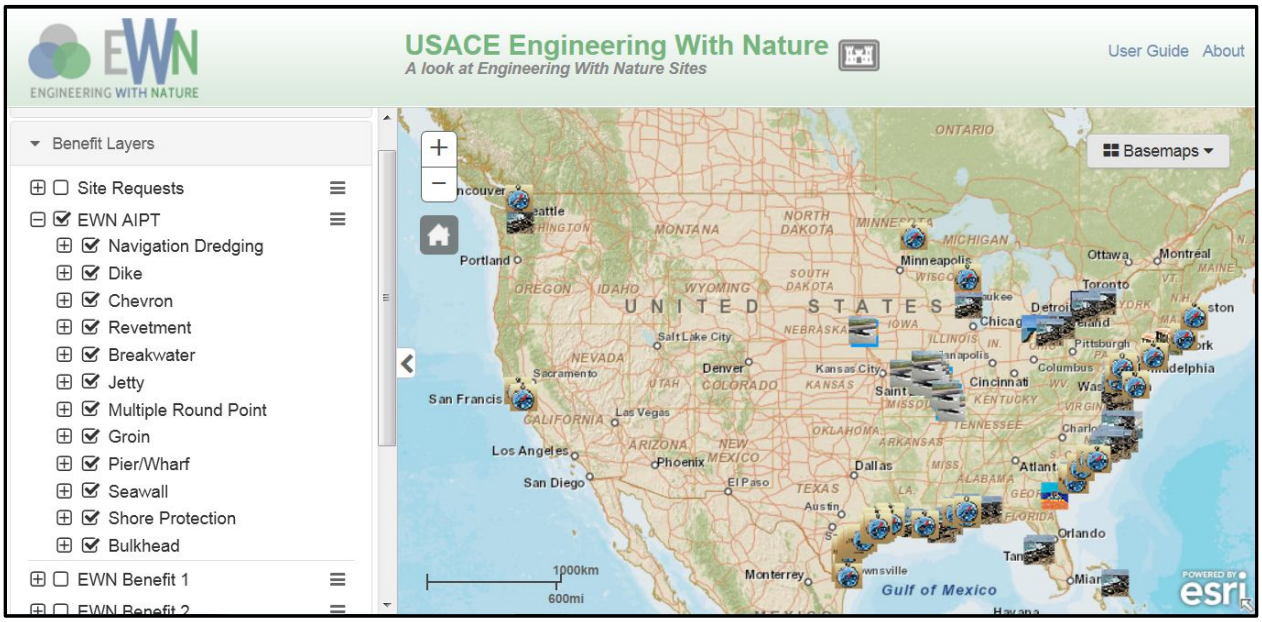

Figure 4. EWN ProMap site selection function displayed. Associated infrastructure project types (AIPT) shown. The tool panel also has a search box that can be used to look for sites by keyword.

The tool panel allows the user to filter the data based on different site types (Table 1) and by a site-name search (Figure. 2). The user is able to view site attribute information by clicking on a site icon in the graphics layer (Figure 3). The site icon pop-up bubble provides the functionality necessary to deliver non-spatial information (e.g., site description, data files, and hyperlinks); the pop-up can also display links to site images. When a site type or particular EWN benefit is selected, the display will populate with all of the possible site candidate types on the map (Figure 5). Thus, if a user is interested in ideas associated with breakwaters or sites that are intended to provide fish habitat, they will be able to quickly narrow their search (Figure 6). The interactive design of the tool panel is the key to the web-viewer's experience.

Table 1. EWN ProMap site classifications used in the tool panel.

Classification Acronym	Description	Information Content
AIPT	Associated Infrastructure Project Type	Defines the type of water resource project from which additional benefits are provided (Beach, Dike, Breakwater, Chevron, Pier, etc.)
EWNB1	Engineering With Nature Benefit 1	Defines the first EWN benefit intended by project designers (Fish Habitat, Bird Habitat, Recreation, Beach Nourishment, etc.)
EWNB2	Engineering With Nature Benefit 2	Defines the second EWN benefit intended by project designers
EWNB3	Engineering With Nature Benefit 3	Defines the third EWN benefit intended by project designers

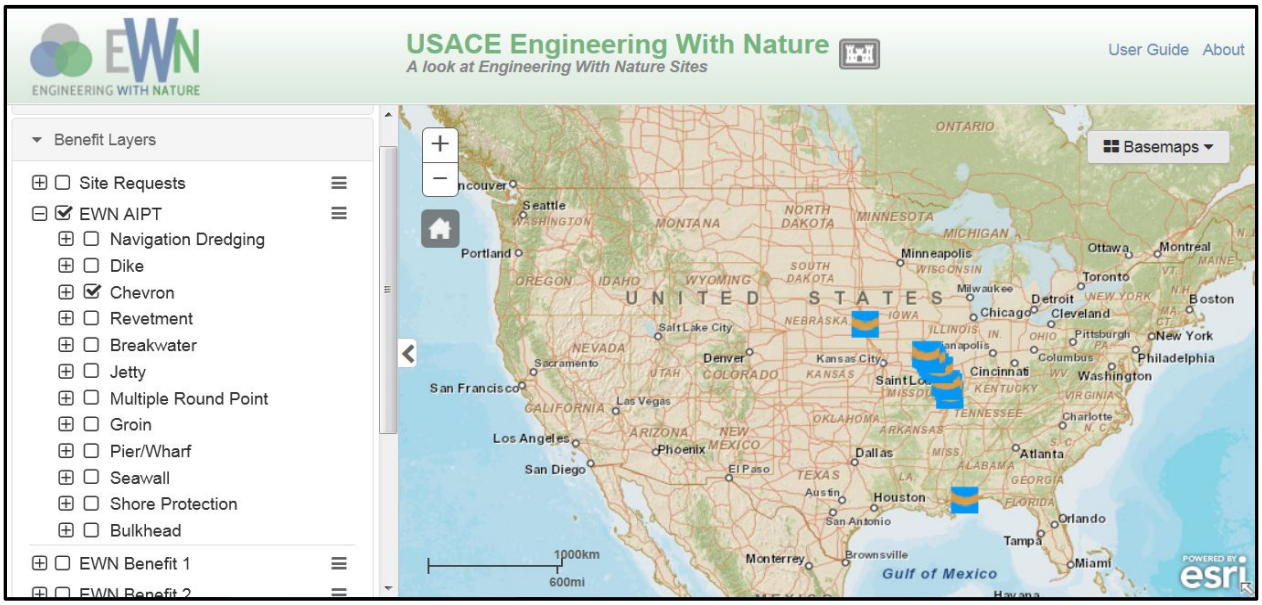

Figure 5. The tool panel used to filter sites by project type. The illustration shows the Chevron infrastructure type as being selected.

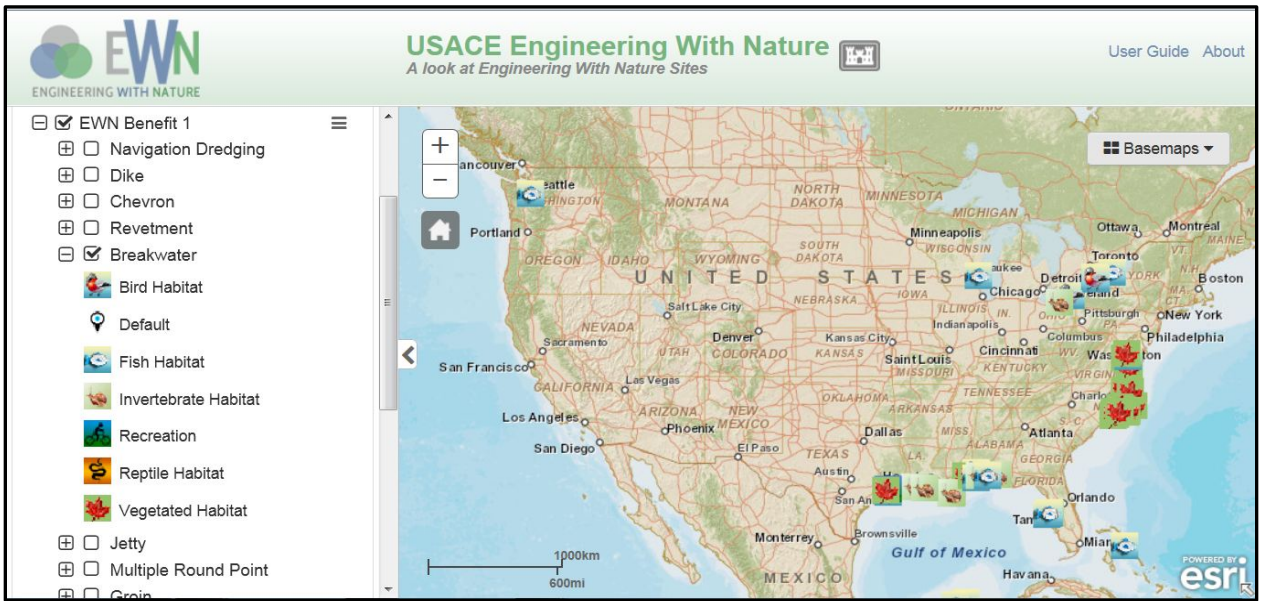

Figure 6. Display of EWN benefits by breakwater site type. Users can select any project type based on their interest.

The site types in the tool panel are the associated infrastructure project type (AIPT) and up to three EWN benefits provided by a project (EWNB1, EWNB2, and EWNB3), as defined by the original goals of the project. This information also often appears in the brief project descriptions (Figure 3). The AIPT defines the goal of the original infrastructure project itself and *not* the EWN benefits (Table 1). For example, when a channel is dredged and the sediment is used to create a wetland, nourish a beach, or to create an underwater topographic feature, the AIPT is Navigation Dredging (a channel, anchorage, turning basin, or other such feature). The secondary benefits — for example, the wetland creation — become EWN benefits, such as EWNB1: vegetated habitat.

There are 13 AIPT selections currently available in EWN ProMap (Table 2), although this list is easily expandable for other types of water resources infrastructure when appropriate examples are identified. Thus, individuals who are planning navigation dredging projects, shore protection projects, breakwaters, or other project types can use these AIPT selections to identify similar projects, which they can consult for ideas and technical resources. Menus also have a "Default" icon that displays when no information is present for a particular data field. Users can also utilize the Basemap drop-down menu in the upper left of the screen to select from among several different map backgrounds.

Table 2. EWN ProMap AIPT and EWN selections available on the tool panel.

Available AIPT Selections	Available EWN Benefit Selections
Breakwater	Aesthetics
Bulkhead	Beach nourishment
Chevron	Bird habitat
Dike	Fish habitat
Groin	Invertebrate habitat
Jetty	Island restoration
Multiple round point	Mammal habitat
Navigation dredging	Recreation
Other in-water construction	Reptile habitat
Pier/wharf	Shore protection
Revetment	Vegetated habitat
Seawall	
Shore protection	

For each project, the three different intended EWN benefits are included in the database. In many cases, when projects were being researched for inclusion in ProMap, the EWN benefits were not explicitly stated in the available project documentation. In these situations, the study team assigned benefits based on reasonable assumptions. For example, reef breakwaters will typically provide habitat for both fish and invertebrates. In the absence of information to the contrary for this example, the team assigned fish habitat for reef breakwaters as EWNB1 and invertebrate habitat as EWNB2. In other cases, such as with the Wilmington offshore fisheries enhancement structure (WOFES), the first EWN benefit clearly was for fish habitat enhancement (Reine et al. 2012). The EWN benefit selections currently included in EWN ProMap are provided in Table 2.

EWN ProMap also has a function that allows users to submit sites that they believe should be included in the database. The user should first navigate to the project and zoom the map in to the location. The process is then initiated by the user clicking on the Request New Case Study portion of the tool panel. This opens a small window where the user selects the AIPT (Figure. 7). Once the AIPT is selected, the user needs to click on the map at the project location. This will automatically provide the geographic coordinates for the database. This will also cause a pop-up window to

appear where the user is prompted to fill in the site name, site owner, EWN benefits, a site description, and any supporting hyperlinks. Once the user has provided all the available information, the Stop Editing button should be clicked, which will save the information and send a notification to the site administrator to review the submission. An EWN ProMap administrator will review the project for approval based upon whether it fits the EWN essential ingredients (see Page 1).

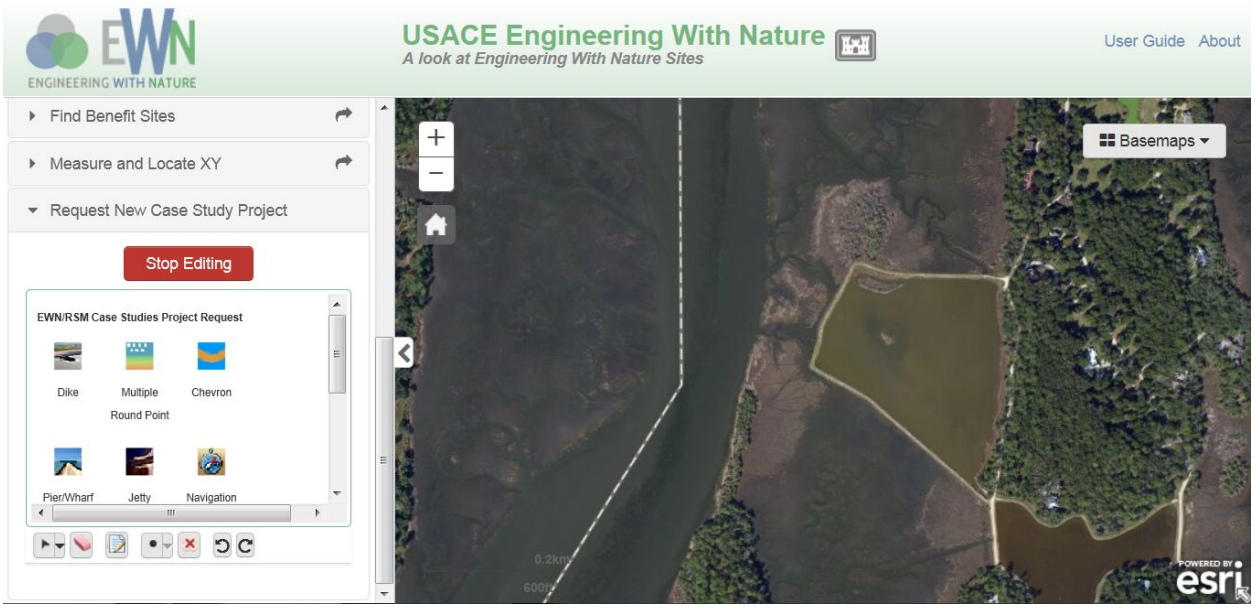

Figure 7. The case study submission portion of the tool panel is shown with ProMap zoomed to project scale.

SUMMARY AND NEXT STEPS: This document summarizes the development of a geography-based mapping resource tool, EWN ProMap, for projects that fit within the Engineering With Nature (EWN) context. Engineering With Nature is the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits associated with water resources projects through collaborative processes. EWN ProMap enables users to search for information when developing EWN ideas during the planning of projects. Esri's ArcGIS™ Application Programming Interface for Flex was selected as the platform on which to build ProMap, due to its pan, zoom, search, and site screening capabilities.

EWN ProMap is an evolving tool. For many projects, the information in the database is only partially complete. In other cases, the database currently only contains a representative number of a particular project class. For example, river training structures that reflect EWN goals, such as chevrons and notched dikes, have been identified for the stretch of the Mississippi River which the St. Louis USACE District manages. However, additional efforts are needed to identify similar structures on the remaining portions of the Mississippi River and also on the Missouri River. Similarly, the EWN ProMap includes a number of reef breakwater projects, but this list is incomplete since additional known reef projects will be incorporated once more information about them is received. The team also expects that as users become aware of EWN ProMap, they will recommend additional projects for the database using the site submission feature.

Future enhancements for EWN ProMap include (1) the ability to export information to other platforms such as Google Earth and (2) integration with other USACE enterprise systems such as CorpsMap (USACE 2013). The Esri Portal software platform that is being used will facilitate these efforts due to its compatibility with these other venues.

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> Fredette, T. J., B. C. Suedel, A. V. Davis, and C. J. Banks. 2015. *Engineering With Nature geographic project mapping tool (EWN ProMap).* EWN Technical Notes Collection. ERDC TN-EWN-15-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center. *http://el.erdc.usace.army.mil/*.

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