NESDI Program Puts Green Technologies Into Action

A Better Oil Trajectory Model & Greener Tank Target for Ranges Among New Products for the Fleet

FOR THE PAST several years, the Navy Environmental Sustainability Development to Integration (NESDI) program has been providing green solutions to the fleet—among them is a better model for predicting oil trajectories and an environmentally friendly range tank target.

The NESDI program evaluates, demonstrates, validates, and integrates innovative technologies, processes, and materials into fleet operations. NESDI projects also fill knowledge gaps that help to minimize operational environmental risks, constraints, and costs.

A vital component of the NESDI program's strategy is putting technology into action—into the hands of Sailors and other fleet personnel charged with the maintenance of weapon system platforms and the sound management of field installation environmental programs. Effective and successful technology integration depends on the ongoing communication and collaboration with end users—the ultimate target of NESDI products and services. These solutions can include technology innovations or replacements, material substitutions, new information or data, or new software or models.

The projects summarized below have all moved technology into action—from initial evaluation to ultimate integration into the hands of the fleet. While not all projects will be subject to each category outlined below, the categories do provide different types of assessment. The projects presented here demonstrate the depth and breadth of NESDI program investments.

The NESDI program evaluates, demonstrates, validates, and integrates innovative technologies, processes, and materials into fleet operations.

Evaluation

Before making a decision to expend limited resources to demonstrate a particular technology, it is often appropriate to evaluate existing and emerging technologies. One type of evaluation process results in what the NESDI program calls an Initiation Decision Report (IDR). IDRs help to identify what might already exist or be on the horizon to address an environmental need. The IDR recommendations focus follow-on demonstrations and promote more efficient solutions to user-defined needs.

Two recent NESDI projects produced IDRs—the Dredge Spoil Management Alternatives IDR and the Waste-to-Clean Energy IDR.

Dredge Spoil Management Alternatives Initiation Decision Report–Study Assesses the Viable Use of Contaminated Dredge Spoils

This IDR evaluates options for beneficial re-use of dredge spoils. Factors considered include Munitions and

Dewatered dredged material.

Explosives of Concern (MEC) detection and removal/exclusion, physical separation of dredged material fractions, contaminant remediation (bioremediation/landfarming), amending/landfarming (topsoil creation), sediment washing, chemical stabilization, cement manufacture, thermal treatment, and base catalyzed decomposition. The IDR presents three promising emerging technologies that would promote the beneficial use of Navy dredged material.

The Problem & the Need

The Navy regularly produces large volumes of dredged material during routine dredging of ports and waterways to maintain navigable depths and during construction and restoration projects. Dredged material is typically disposed in open ocean disposal areas or, in the case of contaminated dredged material, in managed confined disposal areas. However, environmental concerns, regulatory constraints, and limited capacity of existing confined disposal sites are increasingly restricting traditional options.

As a result of chemical and toxicity testing, together with increasingly stringent regulations, a larger amount of dredged material is now being classified as unsuitable to dispose of using traditional options such as open ocean disposal. Disposing larger volumes of dredged material has become particularly problematic due to the presence of chemical contaminants and/or failed toxicity testing and a lack of low-cost disposal options.

Most unsuitable dredged material is currently placed in confined disposal cells in upland (landfills) or aquatic (Confined Aquatic Disposal) locations. These disposal options are very costly, potentially diverting funds from essential mission-related functions and impeding operational readiness. Therefore, alternatives to traditional dredged material disposal methods, such as reuse for a beneficial application, are needed.

The beneficial reuse of dredged material encompasses a broad range of applications including beach nourishment, topsoil creation and possible use as a construction material feedstock. Depending on the chemical and physical nature of the dredged material, certain reuse options may be more feasible than others for the Navy.

Project Approach & Results

The project team identified Navy dredge sites and explored alternative disposal (e.g., landfill cover and other fill applications) and reuse options (cement feedstock, lightweight aggregate production, and topsoil creation) for contaminated dredged sediments. Both maintenance/construction and Installation Restoration (IR) dredging sites were included in the survey. The Navy's Risk Assessment Workgroup (RAW) assembled information about restoration sites, including:

- The associated Engineering Field Division contacts

Recent NESDI Projects: Putting Technology into Action

Evaluation

1. Dredge Spoil Management Alternatives Initiation Decision Report
2. Waste-to-Clean Energy Initiation Decision Report

Demonstration

3. Abiotic Treatment of 1,2,3-Trichloropropane to Protect Drinking Water Resources
4. Predictive Trajectory Model for Oil Spills for Navy Harbors

Validation

5. Alternative Tank Targets

Integration

6. Direct-Push and Point-and-Detect, In situ Sensor for Perchlorate
7. Corn Hybrid Polymer Blast Media for Coatings Removal

- The current phase (study, in progress, closed) of the IR site
- Whether the site is marine or fresh water
- Contaminants of potential concern
- Cost to complete
- Priority status

The project team then contacted site personnel and obtained information regarding the physical properties of the sediment, the amount requiring disposal, and other pertinent site features for inclusion in the report.

As a first alternative, this Navy site-specific information was compared to the requirements for use of dredged material as a cement kiln feedstock to determine whether Navy sites are potential candidates for this reuse application. The research group focused on thermal processing to produce cement and lightweight aggregate specifically, because this reuse option is supported by both the U.S. Environmental Protection Agency (EPA) and industry as an environmentally acceptable and economically beneficial reuse option for dredged material and because previous research has demonstrated that the cement kiln process is economically attractive.

Freshly dredged marine sediment.


Conditioning cell with final product.

During the early stages of the IDR, the project team determined that high salinity characterizes the largest volume of Navy material, particularly material of varying particle sizes (ranging from predominantly silts/clays to mixtures of silts with sand and gravel). It was also determined that many sites produce large volumes only intermittently. Cement feed stocks require a relatively consistent, lower salinity feed to produce cement of known specification. Additionally, it was found that Navy locations that generate dredged material are geographically distant from existing cement kilns and transportation costs would therefore negate the economic benefit of this reuse method. Therefore, it was determined that the cement kiln feedstock option is not presently feasible for the Navy.

After comparing Navy needs and potential dredged material disposal and beneficial reuse methods, the following findings were made, as presented in the IDR:

- The Navy dredges a widely varying amount annually ranging from 100,000 cubic yards (cy) to 7,000,000 cy, according to U.S. Army Corps of Engineers Open Ocean Disposal Database. (Because there is no centralized database to track all Navy dredging, a data gap was identified.)
- IR sites containing sediment are most often small volume sites with contaminant levels ranging from low to moderate.
- Fewer IR sites with large volumes of sediment exist, but these sites could benefit by alternative methods such as reuse since contaminant levels are typically low and the large volumes make it economically attractive.
- Maintenance dredging and large construction projects, such as piers, result in the largest volumes of Navy dredged material.
- All Navy dredged material from navigational channels and ports potentially contains MEC which must be removed (or screened by detectors) and certified MEC-free prior to reuse.
- Physical separation of dredged material is a promising technology because it can produce coarse-grained fractions (sand, gravel, lime) immediately useable for applications in construction and agriculture.


The end result—biologically conditioned dredged material.

- Blending of dredged material with amendments, such as compost, to produce topsoil is a promising low-cost approach for beneficial reuse.

The three most promising options are MEC detection and removal, physical separation, and amending/landfarming (topsoil creation). A landfarming and topsoil creation pilot project using dredged material from Pearl Harbor blended with compost is currently underway at the Navy's former Barbers Point Naval Air Station Biosolids Treatment Facility.

This IDR is now available on the NESDI web site at www.nesdi.navy.mil.

"This is among the best soil available on the island (Oahu)."

—Matt Flach (Joint Base Pearl Harbor-Hickam (after physically handling the treated dredged material)).

Waste-to-Clean Energy Initiation Decision Report—Study Evaluates Viable Options to Landfill Disposal of Solid Waste

This project completed an IDR that evaluates potential Waste-to-Clean-Energy (WtCE) technologies that could help to address the growing compliance problem of landfill space limitations near Navy shore facilities. The IDR evaluates the feasibility of using WtCE conversion technologies as alternatives to landfill disposal and incineration to:

1. Alleviate the closure impacts of solid waste landfills near installations
2. Enhance Navy use of waste as resources and generation of clean renewable energy
3. Prevent overburdening of landfills
4. Avoid ever-increasing landfill disposal costs

The Problem & the Need

Southern California is experiencing a shortage of landfill availability—a problem the rest of the country could face in the near future. Siting new landfills is difficult and greenhouse gas regulations are becoming more stringent. Therefore, naval bases located in southern California must seek alternatives to manage refuse. Commander Navy Region Southwest facility's landfill is projected to reach capacity in 2019.

Project Approach & Results

Personnel from the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC), formerly the Naval Facilities Engineering Service Center, partnered with personnel from the University of California at Los Angeles Engineering Extension to review over 40 technologies and classify them into three general categories utilized by the Navy:

1. Commercially proven technologies
2. Emerging technologies
3. Developmental technologies

Currently, there are over a dozen commercially proven technologies and over 30 emerging and developmental technologies. The team visited facilities in over a dozen countries to collect planning and operations information corresponding to these technologies. Discussions with facility developers/operators and the regulatory agencies provided valuable information regarding WtCE project planning, design, and operations strategies.

The project team also reviewed and analyzed solid waste generation data from a report funded by Commander Naval Installations Command and completed by Battelle in January 2011, together with the waste composition data provided by the State of California. Based on its findings and discussions, the team determined that the available solid waste feedstock tonnage at the majority of the naval facilities is not of sufficient volume for a stand-alone regional or community-based WtCE demonstration project that is economically feasible. Based on current energy and landfill disposal costs, the Navy should continue to support WtCE technologies as a provider of solid wastes to local commercial and/or municipal WtCE facilities.

Evaluation, Demonstration, Validation & Integration—Four Levels of Technology Assessment & Implementation

WHEN THE FLEET needs green technologies to meet changing demands, the NESDI program provides assistance at a number of different levels. The type of project can vary according to the environmental need and maturity of technologies being considered. The four levels described here provide a structure for understanding types of projects although not every technology will require each level of assessment.

Evaluation
Evaluation provides the opportunity to review the current state of existing and emerging technologies. The results of these evaluations can provide direction and focus for any subsequent demonstrations.

Demonstration
Demonstration projects provide a clearer picture of how a technology might (or might not) meet fleet needs. This type of project can highlight benefits and potential issues, and bring costs and requirements into better focus.

Validation
Validation is often combined with demonstration (then referred to as "dem/val"), yet is presented here in its own category. Validation results reveal how a technology meets more encompassing scientific and engineering specifications, addresses critical operational demands, and can be implemented by personnel.

Integration
Integration is the ultimate goal for proven technologies. When a technology is ready to support the mission, it is time to put it into action to help Sailors and other fleet personnel do their jobs.

The key findings and recommendations contained in the IDR are as follows:

1. Thermal Conversion Technologies

   WtCE thermal conversion technologies have been documented and proven for reliable operation. They are commercially available to meet the Navy's combined goals of renewable energy, distributed power generation, improved recycling recovery, maximizing landfill diversion, and reducing greenhouse gas emissions. WtCE thermal conversion technologies are capable of complying with the most stringent of air emissions standards and can beneficially impact climate change.

2. Other Technologies and the "EcoPark Approach"

   Other types of commercially proven, non-combustion conversion technologies are operational around the world. These technologies, such as anaerobic digestion, are utilized to complete the "EcoPark" approach that is discussed in the IDR. (Note: EcoPark is an integrated material recovery and conversion technology facility concept.) Such an integrated approach is expected to maximize the amount of waste diverted from landfills while providing additional energy generation and production of other useful byproducts.

3. Funding, Acquisition, and Benefits

   Naval installations are a small stakeholder in solid waste management. In many cases, the total lifecycle costs of a WtCE facility suggest that the state and/or local governments should be responsible for the costs supporting the development and operation of a WtCE facility, since they are mandated to ensure compliant, cost-effective solid waste disposal within their respective jurisdictions. It should also be noted that conversion technology projects can be privately funded, designed, procured, constructed, and operated as turnkey projects.

4. Supplemental to the Current, On-Going Navy Effort

   The Navy should have an ongoing effort to track and evaluate emerging/developmental technologies in addition to developing an ongoing effort to monitor and evaluate the various projects that are being developed by local governments and private industry. The "lessons learned" from the development and implementation projects of appropriate and financially sustainable WtCE technologies will be invaluable to the Navy.

5. Recommendations Based on a Model Site Case Study

   Naval Base San Diego (NBSD) was used as the model for a case study to formulate the recommendations in this IDR. Currently, NBSD accumulates approximately 100 to 150 tons of waste per day, which is not sufficient for the "economy of scale benefits" from Material Recovery Facilities with WtCE technologies. The Navy should determine the feasibility of being a principal player/investor and also be an advocate of cost effective, "green" options (of which one is WtCE) for solid waste management via Component Regional Environmental Coordinators responsible for interfacing with state and local governments.

6. Other Recommendations

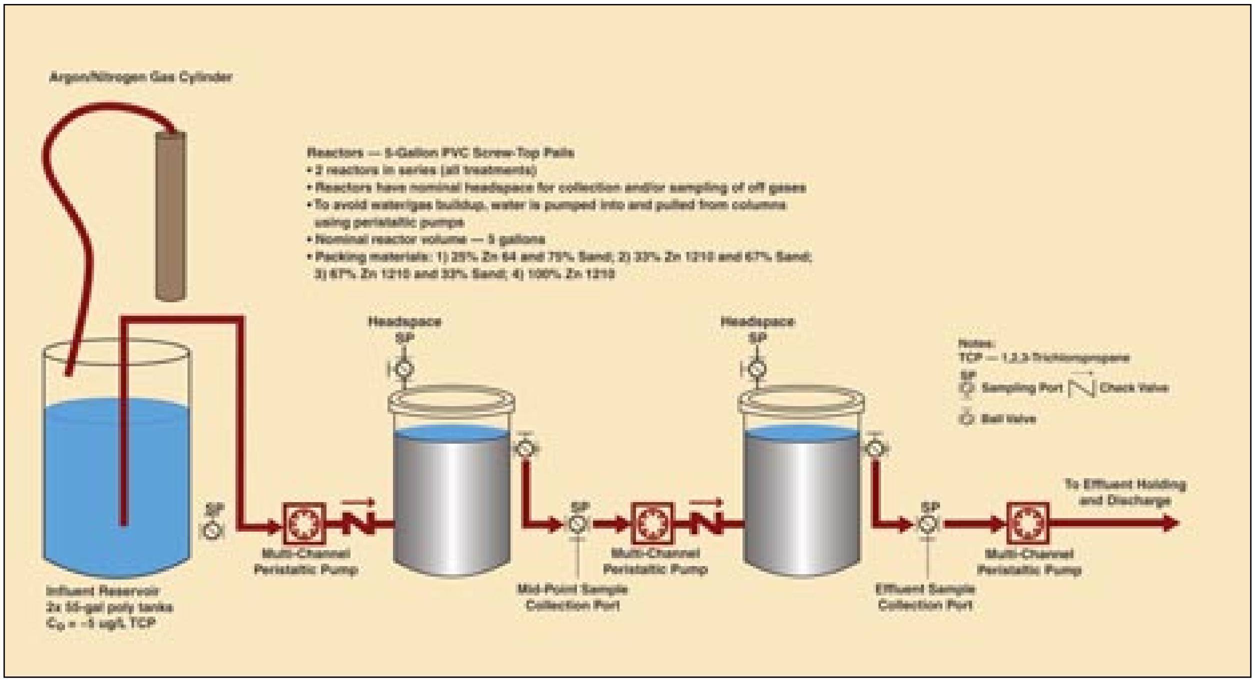
   Recommendations for installation consideration of WtCE technologies referenced in the IDR include the following:

   - Optimize solid wastes recovery and recycling practices
   - Remove objectionable wastes (e.g., food wastes, consumer batteries) that may reduce the energy value of the remaining solid wastes
   - Assess and characterize remaining solid wastes to estimate energy value and requirements for pre-processing technologies (e.g., shredding, grinding)
   - Conduct a feasibility study of suitable and sustainable WtCE alternatives
   - Initiate action supporting the alternatives recommended in the feasibility study

Southern California is experiencing a shortage of landfill availability–a problem the rest of the country could face in the near future.

"I want to thank the NESDI program for educating us via this study. NESDI personnel certainly rose to the occasion. We are looking at a waste management challenge here in San Diego in the coming years and this study provided us with some viable alternatives."

–Leslie McLaughlin (Navy Region Southwest)



Schematic of optimized columns to treat TCP.

Demonstration

Innovative technologies that offer promise might not be sufficiently mature to implement at a full-scale. Depending upon the level of development, a promising solution might require initial laboratory bench-scale testing and/or be appropriate for an in-situ demonstration. This stage offers the opportunity to acquire data on costs and benefits and determine how to move ahead. Two recent projects that have successfully tested and demonstrated a treatment technology and model respectively are Abiotic Treatment of 1,2,3-Trichloropropane to Protect Drinking Water Resources and Predictive Trajectory Model for Oil Spills for Navy Harbors.

Abiotic Treatment of 1,2,3-Trichloropropane (TCP) to Protect Drinking Water Resources–Pendleton Pilot Study Shows Promise for Removing TCP from Groundwater

This NESDI project tested new abiotic treatment methods to remove 1,2,3-TCP from groundwater. It focused on zero valent metals (ZVM) to determine which would be most effective for removing TCP.

The Problem & the Need

The solvent 1,2,3-TCP, which is toxic to humans, is attracting regulatory attention. At Marine Corps Base Camp Pendleton, California, (Camp Pendleton) TCP was detected at levels above California's action level, resulting in two groundwater wells being removed from service. Addressing TCP contamination was a challenge for Camp Pendleton officials because TCP is highly persistent in groundwater, taking a long time to degrade.

Project Approach & Results

This project drew upon results of a Strategic Environmental Research and Development Program research project (ER-1457), which investigated abiotic degradation pathways initiated by various materials, including iron and zinc (Zn).

The specific objectives of this effort included the following:

- Assess the ability of zero-valent zinc (ZVZ) and/or zero-valent iron (ZVI) to effectively degrade TCP in Camp Pendleton groundwater.
- Evaluate potential secondary water quality effects (e.g., changes in pH or dissolved zinc concentration) that could affect future implementation of a ZVZ or ZVI remedy.
- Identify potential factors that may affect performance of ZVZ or ZVI as a remedy for TCP in groundwater.
- Conduct a preliminary evaluation of the full-scale applicability of ZVZ or ZVI for treatment of TCP in groundwater at Camp Pendleton.

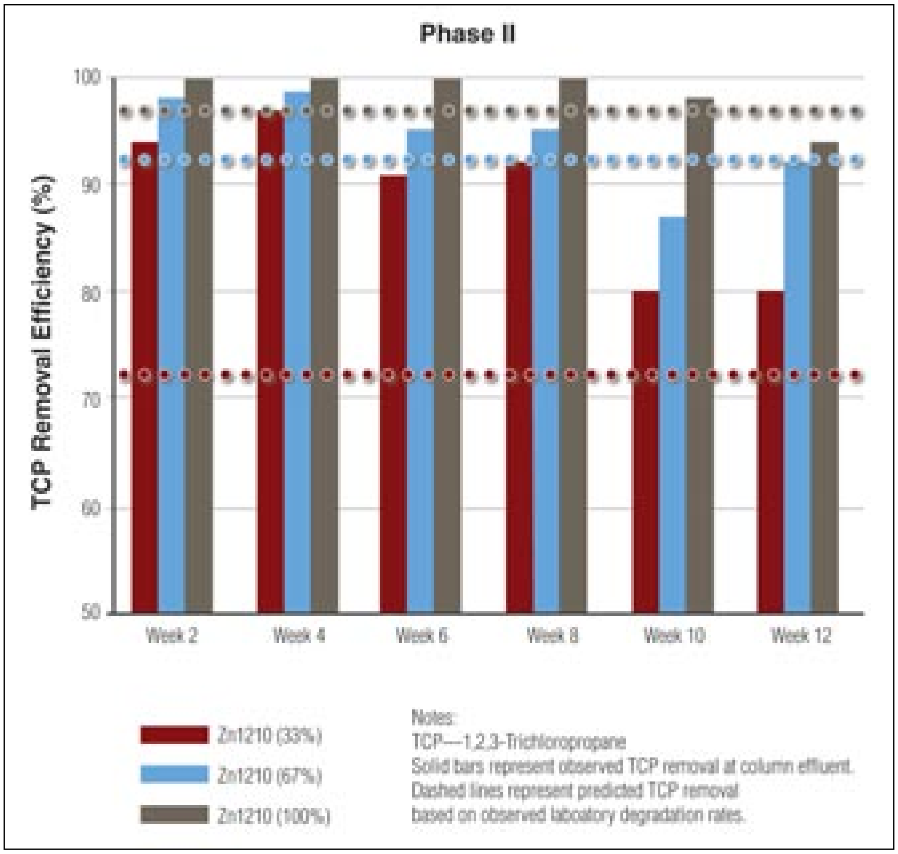
The first stage of this effort was laboratory (bench-scale) testing—conducted to help identify which ZVMs were most suitable for the Camp Pendleton groundwater conditions. This bench-scale testing was also conducted to provide information necessary for subsequent on-site testing to evaluate ZVM performance.

Two phases of on-site column testing were completed to evaluate multiple types of reactive media. Phase I tested:

- A 25% Zn 64 and 75% sand mixture
- A 100% Zn 1210
- A 50% ZVI and 50% sand mixture

Phase II tested:

- A 25% Zn 64 and 75% sand mixture
- A 33% Zn 1210 and 67% sand mixture
- A 67% Zn 1210 and 33% sand mixture
- A 100% Zn 1210



TCP degradation in optimized Phase II columns.

Based on the results of the preliminary laboratory studies and on-site column testing, models were developed to evaluate the costs of applying this technology at scale both in situ (e.g., permeable reactive barrier) and ex situ (e.g., wellhead treatment of TCP at an affected water supply well). This project demonstrated that the chemical and cost effectiveness of using ZVZ, in particular Zn 1210, was particularly promising since it exceeded TCP degradation capabilities.

The project and its results prepare the Navy for increasing regulatory demands regarding TCP and support the remediation of groundwater contaminated by TCP.

Camp Pendleton is now considering a pilot-scale project to treat affected groundwater using a permeable reactive barrier.

"I want to thank the NESDI program for sponsoring this study. We were really scratching our heads trying to figure out how to remediate such a toxic, emergent, recalcitrant compound."

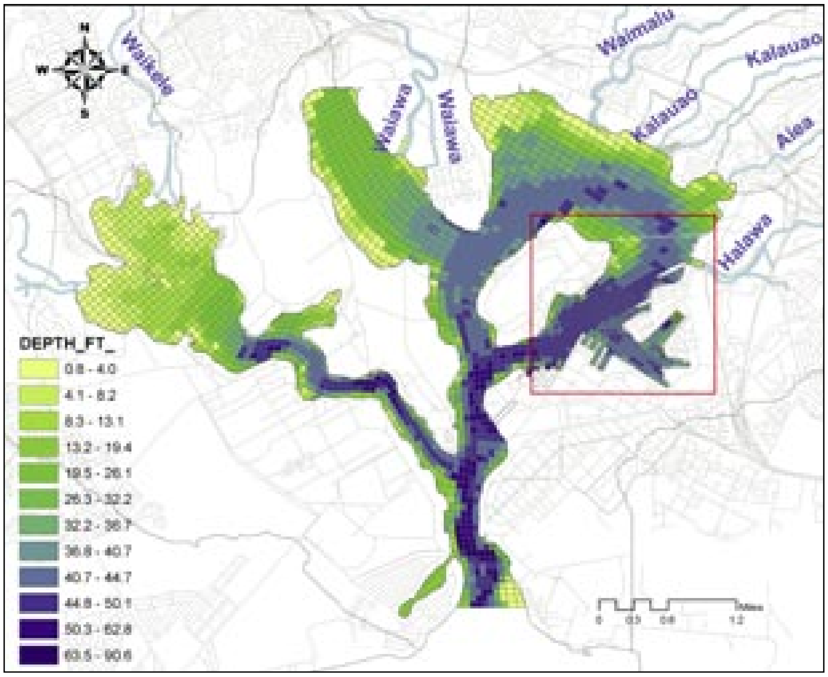
–Theresa Morley
(Naval Facilities Engineering Command Southwest)

Predictive Trajectory Model for Oil Spills for Navy Harbors–New Model Increases Accuracy of Oil Spill Trajectory Predictions

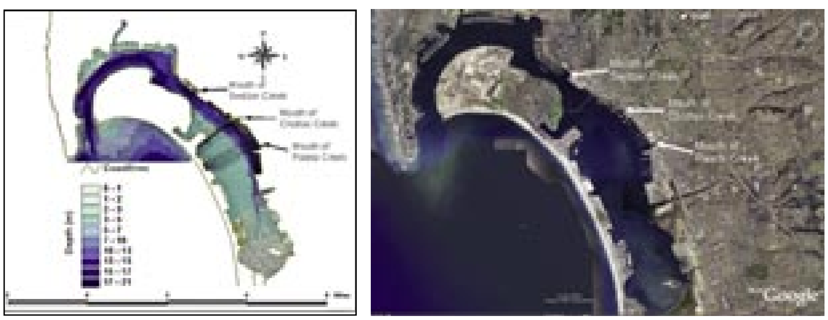
This project improved the predictive accuracy of existing oil spill trajectory models and provided a validated modeling tool to more cost-effectively and efficiently manage oil spill scenarios. This project implements and links two existing models, the National Oceanic and Atmospheric Administration's (NOAA) General NOAA Operational Modeling Environment (GNOME) model and the Navy's Curvilinear Hydrodynamics in 3-dimensions (CH3D), to improve the predictions of oil trajectories following oil spills in Navy harbors. The linked model includes the oil properties and transport prediction from GNOME and the accurate hydrodynamic calculations, including currents and water mass movement in fine resolutions, from CH3D.

The Problem & the Need

Oil spills in harbors may pose great risks in terms of degrading the environment and creating hazards to safe



Model grid for the linked CH3D+GNOME model for Pearl Harbor with bathymetry in color contours.

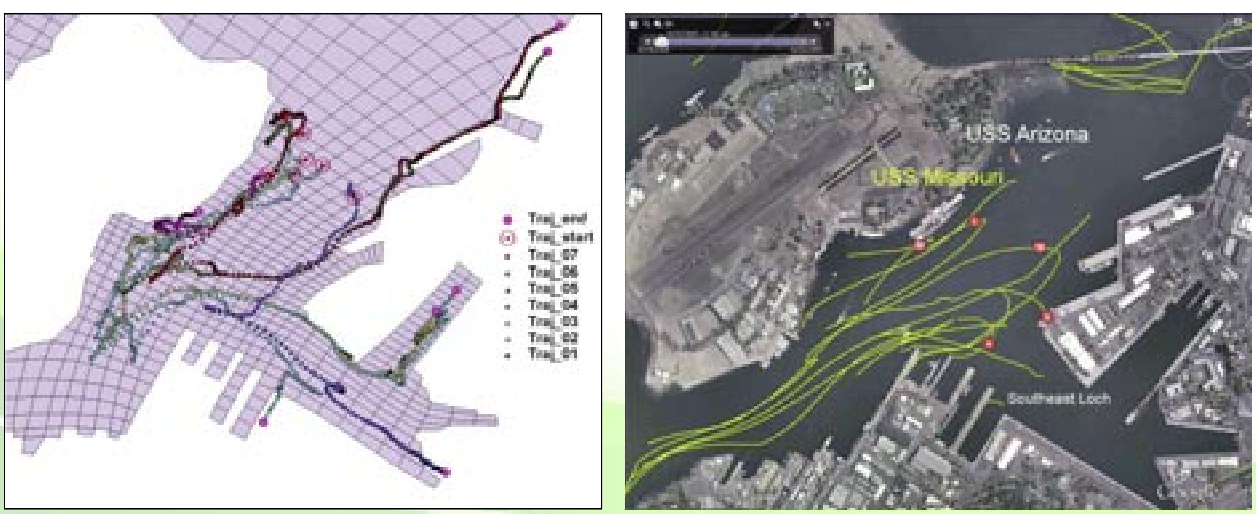


Model grid for the linked CH3D+GNOME model for San Diego Bay with variable grid sizes.

navigation of the waterways. In order to reduce the risk of oil spill occurrence and to effectively design and conduct cleanup and recovery efforts, the Navy needs accurate numerical models to simulate oil spill events, including the transport of oil slick trajectories.

Following an oil spill in an estuary or harbor, the spilled oil immediately undergoes a series of processes controlling its fate and transport. Factors such as wind speed, water currents, and turbulence make it difficult for Navy On-Scene Coordinators (NOSC) and other Navy personnel to predict the oil's trajectory.

Currently, Navy personnel use NOAA's GNOME model for predicting oil spill trajectories. The setup, running, and output of this model is fast, timely, and flexible enough to deal with various time scales. However, oil trajectories predicted by GNOME involve high uncertainty and lack accuracy because it is a transport model and not a hydrodynamic model. GNOME does not compute currents, but relies on data from an external source.



Simulated oil slick trajectories (left) released near the USS Arizona Memorial versus drogue-drifting trajectories.

Project Approach & Results

Project personnel selected two Navy harbors to be used for the demonstration of the merged model—Pearl Harbor, Hawaii and San Diego Bay, California. These harbors were selected based on multiple factors including traffic volume, accumulated knowledge about the site, accessibility of the site, and relevant data about the site.

The linked model for Pearl Harbor uses the same model grid and time step as those for the hydrodynamic model, providing adequate fine resolutions of transport in both space and time. (The study of San Diego Bay is underway.) Therefore, the transport of oil slicks is simulated at greater resolution with improved accuracy, compared to the old oil spill model. For example, oil slicks released by design near the USS Arizona Memorial were projected to oscillate back and forth by the "approximate" tidal currents near the release site. With the linked model, oil slicks are projected to be transported to wider and farther ranges depending on the timing of release and tidal conditions, both of which are adequately simulated by the linked CH3D + GNOME model. The same level of requirements and predictive accuracy are expected when the linked CH3D + GNOME model is applied to other harbors.

The Navy now has a model that simulates oil slick trajectories from an oil spill in Navy harbors with improved prediction accuracy. In particular, NOSCs have access to a better modeling system that can be used for both pre-planning (forecast) and cleanup for oil spill events. Overall, the Navy's oil spill management teams may more effectively and efficiently prepare and deploy spill recovery and cleanup equipment through the use of the predictive model results.

"A key element in effectively managing the response to a large oil spill is to deploy response resources in advance to areas where the oil may have an impact. This new model will provide NOSCs with a more accurate tool to predict the fate and transport of that oil. As a result, responders can prevent the oil from damaging environmentally, culturally, and economically sensitive areas which are vital to the people of Hawaii."

–Cynthia Pang (NAVFAC Hawaii)

Validation

While a demonstrated technology might address a need, in some cases more specific information may be required before a technology can be implemented across the fleet. Does the technology require significant modifications to existing equipment? Does it address critical operational requirements? Will fleet personnel be able to use it? Validating a technology helps to address these and other issues.

The NESDI program's efforts to validate the use of an alternative tank target for Navy ranges provides one example of this approach.

Alternative Tank Targets—New Targets Provide Green Alternatives for Navy Ranges

This project demonstrated and validated an Alternative Live Fire Ground Target (ALFGT) developed by NAVFAC EXWC personnel. The ALFGT contains no hazardous components and is an effective replacement for the diminishing supply of M60 tanks.

The Problem & the Need

The Navy's land-based air-to-ground (ATG) ranges must include hard targets. Managing the targets' lifecycle

The latest prototype of the ALFGT being built.

is a challenge for sustainable range operations. Hard targets, traditionally surplus armored vehicles such as unserviceable tanks and armored personnel carriers, are required on high-explosive ranges because of their durability. However, these targets present environmental and operational challenges because of their environmental impacts, high lifecycle costs, occupational and explosive safety concerns, and their limited availability.

Environmental requirements of traditional hard targets, such as a surplus M60 tank, require significant preparation to remove hazardous, radiological, and special waste materials. In addition to the hazardous wastes generated from target preparation, their use on-range can present a significant environmental liability. Inevitably, some wastes remain in some of the components of a M60 tank because extracting all of the fluids is difficult. The fluids that remain can be released to the environment during its lifetime on-range as a target.

Project Approach & Results

NAVFAC EXWC personnel worked to develop an alternative target initially designed for use at both Naval Air Station (NAS) Fallon and the Pinecastle Range Complex, which have the Navy's largest ATG training operations. General criteria that guided the first prototype included having the alternative target's size as close as possible to the M60 without exceeding the lifting weight limits of available moving equipment. The first prototype, tested in April 2007, was modular in design, so that each component could be moved with lighter equipment.


The latest prototype of the ALFGT placed in the live impact area.


The ALFGT survives close hits from 500-pound bombs.

After the design and testing of the first prototype, however, both NAS Fallon and the Pinecastle Range Complex acquired new tank retrievers. This led to a significant alteration of the design. NAVFAC EXWC personnel developed a second prototype of the ALFGT based on lessons learned from the first prototype. This ALFGT prototype, built onsite at the Pinecastle Range Complex in August 2009, is 8.5-feet wide by 15.3-feet long by five feet tall, including the turret. Its footprint is a little less than three-quarters of the size of a M60 tank, although the ALFGT is much shorter. It is constructed of concrete and steel, is now a single piece, and is much stronger than the first prototype. It has thicker steel with many gussets joining the steel plates. It is also has angled sides to help prevent the penetration of bomb fragments.

The newer design is much simpler and quick to build. Although it took about a week and a half for two workers to build the first ALFGT at the Pinecastle Range Complex, it should only take about a week to build subsequent targets with the proper equipment and experience.

The latest prototype was used from October 2009 to May 2012 and maintained its structural integrity despite sustaining many close hits, proving that it can be a viable target for ATG training. New lessons learned will allow the next generation of alternative tank targets to be even stronger. It should be noted that a direct hit from a bomb, like the one that completely destroyed the alternative tank target, would also completely destroy the commonly-used M60 tank target.

Although the ALFGT was designed for use at heavily used ranges, it may also be used at other ranges as well. In addition, the first (modular) prototype may still be a viable option on island ranges where heavy moving equipment is not available.

These ALFGTs now provide the Navy with the capability to produce a green, affordable, long-lived target in-house for air-to-ground training that eliminates the need for either pre- or post-cleanup costs.

"I believe that this type of environmentally friendly target will be viable if funding can be obtained to construct it. Traditionally, M60 tank targets that contained asbestos in their engine compartments resulted in abatement that cost over $35,000 to remediate."

—Chris Townsend (Pinecastle Range Complex)

Integration

Once technologies are shown to meet a defined environmental need, have been demonstrated and/or validated, and are ready to support the mission, it is time to put them into action. For many of these technologies, it is necessary to receive approval from the appropriate technical authority and reflect the approved use of that technology in guidance and maintenance manuals. From there, the equipment or process needs to be integrated into field and industrial operations so that Sailors and other fleet personnel can use them.

Two NESDI supported projects that have been integrated into fleet operations are reflect this stage of technology maturity are Direct-Push and Point-and-Detect, In situ Sensors for Perchlorate and Corn Hybrid Polymer (CHP) Blast Media for Coatings Removal.

Direct-Push and Point-and-Detect, In situ Sensors for Perchlorate—Perchlorate Sensor Now Part of Fielded Suite of Site Characterization Equipment

This NESDI project validated the use of a direct push and point-and-detect, field deployable sensor system—the Surface Enhanced Raman Spectroscopy (SERS) system—for real time and in-situ use to measure perchlorate, either for rapid screening and monitoring purposes or for contaminant source characterization of perchlorate in groundwater or surface waters.

The Problem & the Need

Perchlorate, used as the oxidizer component and primary ingredient in solid propellant for rockets and missiles, is exceedingly mobile in aqueous systems and can persist for many decades under typical ground and surface water conditions. Perchlorate has been found in groundwater, drinking water, and soils, mainly in the southwestern United States, at levels ranging from eight to 3,700 parts per billion (ppb). As the ground water contamination has become more apparent and new regulatory actions levels are being established, detection and cleanup are rapidly emerging needs.

Edward's Site 285 soil samples as deep as five meters below ground level were collected for later analysis using EPA Standard Method 6860.

Because perchlorate is considered to be an explosive residue, there is a need to screen for perchlorate to assess vulnerabilities related to environmental contamination to sustain range operations both on and off range and determine if environmental conditions impact range operations.

In 1999, there were several known Navy perchlorate sites including Naval Weapons Industrial Reserve Plant McGregor, Outlying Landing Field San Nicolas Island, Allegany Ballistics Laboratory, Naval Surface Warfare Center

Indian Head, and Marine Corps Air Station El Toro. This number may increase as more sites are evaluated.

Some of the issues surrounding perchlorate include:

- Human health. Perchlorate can affect the thyroid gland by blocking iodine uptake resulting in lower thyroid hormone levels. This deficiency results in abnormal metabolism, growth and development.
- Chemical and physical characteristics. Because perchlorate is soluble in groundwater and highly stable, contamination is often found at great distances from the source. Experience has shown that conventional sampling may not accurately represent perchlorate contamination levels.
- Clean-up. Common ground water clean-up techniques, such as filtration, sedimentation, air-stripping, or sorption onto activated carbon, are ineffective for perchlorate removal.

While human health action levels are still being developed, EPA has released a draft human health risk benchmark calculated at 1 ppb—substantially below previous benchmarks. The likelihood of significant monitoring requirements on past and active ranges is growing. Regulators have begun to initiate policies that require intensive sampling efforts as a requirement for site closure. This type of sampling effort will be prohibitively expensive unless more effective site characterization methods are developed.

Project Approach & Results

The validated SERS system includes a portable Raman system (complete with laser, spectrometer, detector, and computer) with a detachable fiber optic probe. A SERS sensor module that houses the cationic-coated SERS substrates was designed and built to mount onto the fiber optic probe. The sensor module was deployed inside a direct push cone penetrometer sampling probe to measure perchlorate in-situ in real time as a function of depth.

Demonstrations were conducted at Edwards Air Force Base Site 285. Located in the northern part of the base, Site 285 is the former site of the National Aeronautics and Space Administration's Jet Propulsion Laboratory solid rocket motor activities. Contamination at the site resulted from the use of ammonium perchlorate, an ingredient in solid rocket fuel. Soil samples were collected from Site 285 to test the sensor's ability to accurately measure levels of perchlorate concentrations in contaminated groundwater. Because perchlorate acts like a solid in soil but dissolves like table salt in groundwater, researchers were able to obtain groundwater samples from the soil at Site 285. Data from the sensor was compared with EPA Standard Method 6860. Using split samples, the correlation coefficient between the standard method and the real time sensor was 0.94.

Given the accuracy of the real-time sensor in comparison to standard methods, it can be used to rapidly delineate the location of perchlorate plumes. Understanding the extent and concentration of underground plumes is important when designing the most cost effective remediation approach and determining the efficacy of the treatment process.

The SERS system has since been installed in all Navy Site Characterization Analysis Penetrometer System (SCAPS) trucks and is now available for use by Navy regional program managers with sites containing potential subsurface perchlorate plumes.

> *"Letting the Navy access Site 285 last September was a no-brainer. This cutting-edge sensor will save the government time and money. Normally, a team has to send samples to a laboratory, where it can take two to six weeks for an analysis. Many times, it means two to six weeks of waiting for the sampling crew because the team relies on the test results to determine where the next samples need to be taken to delineate the plume. With the Navy's sensor, a team will be able to take samples and get on-site analysis in real-time. This expedites the cleanup process and saves time and money."*
>
> –Bruce Oshita (Edwards Air Force Base)

Corn Hybrid Polymer Blast Media for Coatings Removal—New Media Proven Effective on Delicate Substrates

After its successful demonstration and validation steps, Corn Hybrid Polymer (CHP) is now being integrated into fleet use as an alternative stripping method for coating removal and selective stripping of delicate substrates. The project leading up to integration focused on the following objectives:

- Provide an effective, environmentally preferred media to remove coatings from difficult, high-value, Naval

Sea Systems Command and Naval Air Systems Command (NAVAIR) delicate substrates including fiberglass, thin aluminum alloys, carbon fiber, graphite and Kevlar


CHP was used to strip this fiberglass radome mast at the Trident Refit Facility Bangor.

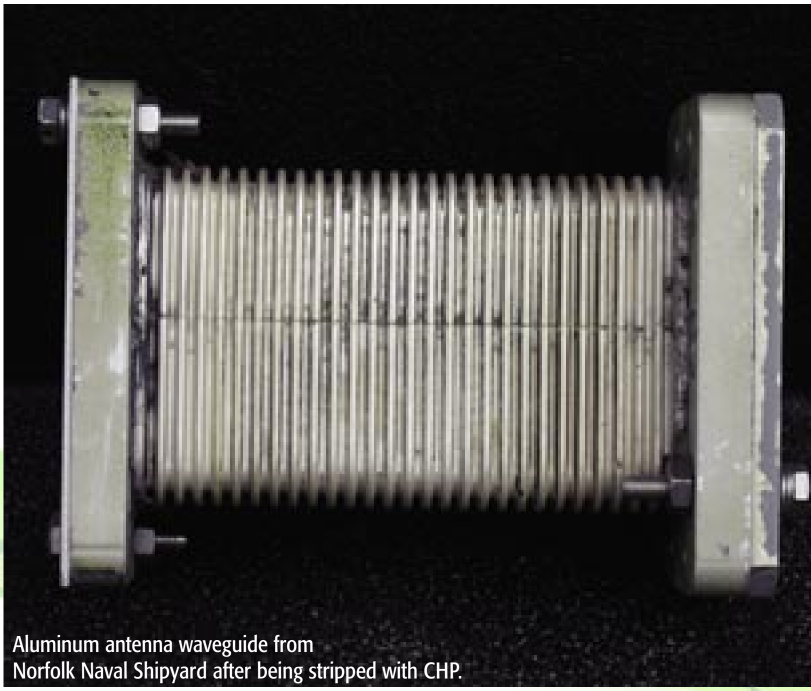
- Introduce the media to facilities where it is not currently in use
- Implement the use of CHP media on a broader and larger scale

The Problem & the Need

Department of Defense (DoD) industrial facilities increasingly need alternative methods for stripping delicate substrates such as composites and thin aluminum alloys. These facilities need new stripping methods to respond to changing environmental and health and safety regulations. Such changes are making manufacturing, repair, and rework practices increasingly difficult, less efficient, and more costly. The practices also can cause damage that requires re-work, increase downtime, and diminish the service life of the military assets. These methods also can release solvent vapors into the atmosphere, generate hazardous waste, and expose workers to potentially unsafe working conditions.

Project Approach & Results

CHP media is a crystallized cornstarch material that is 100 percent organic, non-toxic, and biodegradable. Various Air Force, U.S. Coast Guard, and Navy facilities currently use the CHP blasting technology on more durable substrates. This project identified several facilities to demonstrate the media's use on delicate substrates.


Aluminum antenna waveguide from Norfolk Naval Shipyard after being stripped with CHP.

Successful demonstrations were completed at three Navy shipyards and other facilities between Fiscal Year (FY) 2009 and FY 2011 including:

- Norfolk Naval Shipyard
- Naval Undersea Warfare Center Keyport
- Naval Station Kitsap
- Naval Air Station Whidbey Island
- Puget Sound Naval Shipyard
- Pearl Harbor Naval Shipyard
- Naval Air Warfare Center (NAWC) Lakehurst

Accomplishments to date include the following:

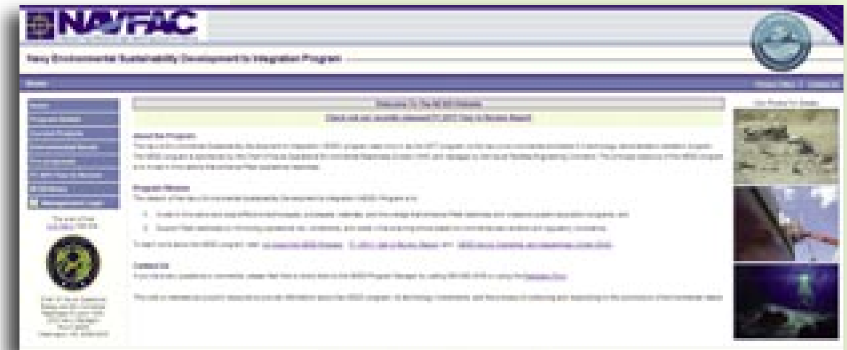
1. NAWC Lakehurst has received formal NAVAIR approval to utilize CHP as a qualified Type VII media in their blasting processes, and added media-specific information into the Support Equipment Cleaning, Preservation, and Corrosion Control (17-1-125) manual.
2. The Puget Sound Naval Shipyard and Intermediate Maintenance Facility is converting one of its blasting booths and a glove box/cabinet blaster to CHP blast media.
3. Portsmouth Naval Shipyard was impressed with the results documented by the Northwest regional and east coast demonstrations, and is preparing a new shipyard blast booth for CHP use.
4. Norfolk Naval Shipyard is considering the conversion of a glove box blaster to CHP for small delicate substrate items (i.e. waveguides).
5. The Corpus Christi Army Depot has approved CHP for use on H-60 helicopter components (rotor blades), including Army, Navy and Marine Corps assets.
6. Florida, Tennessee, North Carolina, Missouri, Mississippi, Kansas, Oklahoma, Utah, Texas and California are among the states that have already approved CHP for bio-based media recycling.

These demonstrations confirmed that CHP media causes no damage to these substrates during coatings removal processes due to the nature of the media and the lower blast pressures used. CHP can be used in standard, light abrasive blast equipment and as a "drop-in" replacement for many plastic media blasting systems. The media can be used repeatedly (typically 12 to 15 times), and can be recycled through an approved Treatment, Storage and Disposal Facility.

Overall, the project has provided Navy and DoD facilities a more effective, environmentally preferred media to remove coatings from difficult, high-value, delicate substrates, including fiberglass, aluminum, carbon fiber, graphite and Kevlar.

For More Information

FOR MORE INFORMATION, visit the program's web site at www.nesdi.navy.mil, then select "Current Projects" then "View" to display a fact sheet that describes the objectives and accomplishments of other successful NESDI projects.



"NAWC Lakehurst was very impressed with the results of both the standard and low temperature powder coated test coupons blasted with CHP at the Norfolk demonstration. The low blast pressures did not affect the surface profiles of the test coupons. NAVAIR has given approval to utilize CHP as a qualified Type VII media in their blasting processes, and are adding media-specific information into the Support Equipment Cleaning, Preservation, and Corrosion Control (17-1-125) manual."

–Dana Kaminsky (NAWC Lakehurst)

CONTACT

Leslie Karr
Naval Facilities Engineering and Expeditionary Warfare Center
805-982-1618
DSN: 551-1618
leslie.karr@navy.mil