



Background

The former Atlantic Fleet Weapons Training Area in Vieques, Puerto Rico, served as the Navy's premier training range for ensuring combat readiness of US Atlantic Fleet Forces and for North Atlantic Treaty Organization (NATO) operations. From the mid-1940s until 2003, more than 300,000 munitions were fired during military training operations. Because the Commonwealth of Puerto Rico considered Vieques the highest priority facility for cleanup, in 2005 large portions of Vieques and the surrounding waters were placed on the National Priorities List (NPL).

Today, the former installation has been transferred to federal and local agencies, mostly for conservation as part of the Vieques National Wildlife Refuge. The refuge houses a variety of natural resources, including sensitive habitats such as mangroves, subtropical dry forests, lagoons, and coral reefs, and endangered species such as sea turtles, manatees, and brown pelicans. Portions of the former installation are open to the general public for recreation and for access to culturally significant areas.



Figure 1. The former Vieques Naval Installation is 23,000 acres, with another 12,000 acres of surrounding waters.

Position Description

The Vieques Environmental Restoration Program faces challenges such as unexploded ordnance (and associated contaminants) across thousands of acres of land and sea floor, abundant ecologically and culturally sensitive resources, and the often-disparate objectives of numerous stakeholders, including the local community, education and scientific organizations, and various advocacy groups. To meet these challenges, the Vieques Environmental Restoration Program Team comprises representatives from Naval Facilities Engineering Command (NAVFAC) Atlantic, the Environmental Protection Agency (EPA), Puerto Rico Environmental Quality Board (PREQB) and Department of Natural and Environmental Resources (PRDNER), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Department of Interior (DOI), and United States Fish and Wildlife Service (USFWS). The 2007 Federal Facilities Agreement (FFA) establishes the framework for the stakeholder agencies to collaboratively implement the Environmental Restoration Program under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to achieve the following objectives:

- Implement prompt actions to protect human health, safety, and the environment



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Vieques Naval Installation, Vieques, Puerto Rico | *Environmental Restoration – Team*

- Manage and prioritize investigations and remedial actions, based on risk to human health and the environment, anticipated land use, and available funding
- Develop safe, cost-effective, and innovative cleanup approaches and technologies
- Execute a novel community involvement program to promote public safety and stakeholder participation in the cleanup process
- Maximize partnerships with federal, Commonwealth, and local authorities to accelerate achieving land use goals through interim actions and final decisions



Figure 2. Due to unique regulatory, environmental, and natural and cultural resource conditions associated with Vieques, NAVFAC Atlantic teams with over a dozen Federal and Commonwealth agencies throughout the East Coast and Puerto Rico. To promote effective communications, the Vieques Environmental Restoration Team meets frequently among themselves and with the many other stakeholders, including the local community, academia, and scientific organizations.

Summary of Accomplishments

Accelerated Cleanup, Innovative Strategies, Risk Reduction, and Green Remediation: The environmental restoration on Vieques is the highest priority and the costliest project in the Navy's Munitions Response Program. With input from the local community, the Governor of Puerto Rico, PREQB, PRDNER, and the USFWS, the Navy identified priority areas on both the land and offshore for accelerated cleanup to fast-track public access or other planned use. In addition to measures to accelerate land use, the Navy, in partnership with the other stakeholder agencies, has implemented innovative strategies that have reduced explosive hazards as well as the environmental footprint and cost of cleanup. Between October 2015 and September 2017, the accomplishments described below were achieved that demonstrate the safety-focused, cost-effective, and innovative approaches characteristic of the Vieques Environmental Restoration Program. These accomplishments are distinct from past successes submitted previously:

- *Underwater Nearshore Munitions Removal* – With nearly 20 miles of beaches associated with the former Navy training area, the potential presence of munitions just offshore poses a significant concern to commercial fishermen, beachgoers, swimmers, divers, and boaters. To date, hundreds of munitions have been observed on the seafloor in the nearshore environment using remotely operated vehicles (ROVs) and unmanned aerial vehicles

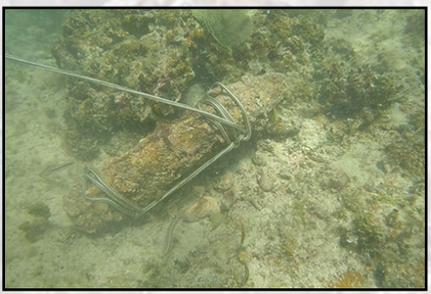


Figure 3. World War II-era rocket being removed to accelerate public access to popular recreational area.

(UAVs), and many more munitions are likely present. A non-time-critical removal action (NTCRA) is being implemented to accelerate risk reduction by removing underwater munitions that may be readily encountered. The NTCRA utilizes a removal prioritization process that includes criteria such as likely public exposure, munitions types, densities, condition, and potential mobility. This multi-year NTCRA began in 2017 with the removal of five World War II-era rockets just offshore of a small island adjacent to a popular public beach. Removal of the munitions facilitates near-term opening of the island and its surrounding waters to the general public. The NTCRA will accelerate beneficial reuse of beaches and their nearshore waters by more than a decade.

- *Accelerating Risk Reduction in the Most Dangerous Area* – The former bombing range contains a 75-acre area where tens of thousands of submunitions from cluster bombs were dropped over decades of military training. Many types of submunitions are laying on the ground surface, hidden by vegetation. This situation poses a very high risk to anyone who may enter the area, including local residents, tourists, Wildlife Refuge managers, and cleanup workers. In 2017, an innovative time-critical removal action (TCRA) was implemented to safely and effectively clear the submunitions from the ground surface. The innovative approach includes using remotely-operated equipment to remove large bombs (using a magnetic attachment) and to cut and rake the vegetation into piles (using mower and rake attachments). This



Figure 4. Remotely-operated equipment cutting and raking vegetation into piles.



Figure 5. UAV monitoring controlled burning of cut vegetation that allows workers safe access to remove submunitions.

allows munitions-clearance workers to safely access the area to burn the vegetation piles and remove the submunitions made readily visible on the ground surface. Air monitoring is performed during the controlled burns to ensure there are no effects on air quality in the community and a UAV is used to determine when it is safe for workers to return to the area following the controlled burns. Without using these innovative technologies, the “Submunitions Area” would have remained indefinitely a significant source of explosive risk.

- *Eco-friendly Remedial Action* – Cayo La Chiva is a 12-acre island utilized by the Navy during military training activities in the 1950s. As part of the CERCLA process, the Navy, working closely with the Cayo La Chiva land manager (PRDNER), developed a munitions remedial action that allows the island to be safely used for eco-tourism with minimal land disturbance. The plan, approved by all stakeholder agencies, involves removing munitions along a planned nature trail and associated recreational areas, while preserving over 90 percent of the island’s vegetation. This approach not only saves the tropical forest, but averts potentially devastating impact on the surrounding waters from erosion.

- *Low-impact road maintenance* – The restoration area is accessed by more than 30 miles of unpaved roads, which are subjected to the harsh tropical climate inherent to Vieques. Maintaining these roads is a persistent undertaking. In a cooperative effort between the land manager (USFWS) and the Navy, over 10,000 cubic yards of gravel were excavated from beneath a defunct Navy runway for road maintenance. Use of this material not only obviated the need to quarry and import material from off-island, but preserved an estimated \$500,000 that was then applied directly to munitions cleanup.



Figure 6. Preserving virgin material by repurposing runway base course for road maintenance.

- *Fast-tracking Beneficial Land Reuse* – Based on data collected during the Remedial Investigation and with concurrence among the stakeholder agencies, the Navy redefined site boundaries to potentially accelerate by more than a decade the return of nearly 5,000 acres of relatively unimpacted land to beneficial reuse. Additionally, explosive hazards were significantly reduced, as over 200 acres were cleared of munitions, resulting in over 8,200 munitions removed and more than 1.5 million pounds of scrap metal shipped to a recycling facility. Proceeds from the recycling were used to partially offset the cost of the cleanup, and over \$4M in cost savings was realized due to implementing efficiency measures such as using a local workforce; using a real-time, web-based tool to plan and track cleanup; and using remotely-operated equipment.

Groundbreaking Technologies: Identifying and implementing groundbreaking technologies to reduce both risk and cost is fundamental to the Vieques program. Key technologies have been identified that will save tens of millions in cleanup costs, including:

- *Advanced Geophysical Classification to Expedite Remedial Investigation* –As part of a 2,000-acre Remedial Investigation, the nature and extent of subsurface munitions and associated contamination must be delineated. In order to streamline logistics and reduce cost, in 2017 the Navy developed an innovative approach that includes the use of an advanced geophysical technology, Time-domain Electromagnetic Multi-sensor Towed Array Detection System (TEMTADS). The TEMTADS is used to distinguish subsurface munitions from scrap metal, not only to help make site-wide estimates of the types and quantities of subsurface munitions, but also to cost-effectively select areas for subsurface sample collection.



Figure 7. Advanced Geophysical Classification used to rapidly identify sampling locations, expedite Remedial Investigation, and lower costs.

Implementation of this approach is accelerating the subsurface characterization and accumulated savings are estimated to be \$100K.

- *Groundbreaking Technology to Measure Trace Munitions Contaminants Underwater* – Hundreds of munitions have been observed on the sea floor around Vieques, and tens of thousands more are believed to be buried in the shallow sand offshore. Regulatory agencies and the general public have significant concerns about the potential human health and ecological risks posed by munitions constituents that may leak from these underwater munitions. In 2016, the Vieques team supported a research project funded by the Department of Defense

Environmental Security Technology Certification Program (ESTCP) to study munitions constituent concentrations underwater. The study utilized Polar Organic Chemical Integrative Samplers (POCIS), which are designed to detect munitions constituents in seawater down to ultra-trace levels. An integrated team of munitions and science divers



Figure 8. POCIS and grab water sample collection adjacent to an underwater munition.



Figure 9. Divers collecting sediment pore water samples adjacent to an underwater munition.

deployed and retrieved the POCIS samplers and collected grab surface water, sediment, and sediment pore water samples. With thousands of underwater munitions present around Vieques and elsewhere around the United States, the potential cost implications associated with investigation and remediation of underwater munitions are significant. The information gathered from this study supports a growing databank of similar studies that demonstrate munitions constituents in the marine environment associated with underwater munitions sites are not a significant concern, which may save millions in investigation and cleanup costs.

- *Tracking Underwater Munitions Mobility* – Understanding the movement of munitions in the underwater environment and their interaction with beaches is of critical importance because beaches are the most sought-after destinations by the public. Throughout 2016 and 2017, the mobility of 61 munitions surrogates, deployed just offshore of 9 beaches, was monitored under the effect of beach changes and variable sea conditions. The data gathered during this study will be used to make long-term predictions of beach changes and burial and mobility of munitions in a wide range of conditions, which will allow the Navy to make the most suitable remedial action determinations and optimize long-term monitoring at Vieques and other restoration sites across the country. The Vieques team is sharing these field results with researchers for the Department of Defense (DOD) Strategic Environmental Research and Development Program (SERDP) to assist their efforts to create a computer model for munitions burial and mobility in the underwater environment. A successful model will support underwater munitions cleanup efforts across DOD.



Figure 10. Diver measuring the movement and burial of a munitions surrogate.

- Underwater Munitions Assessment of 12,000 acres* – In 2016 and 2017, a wide area assessment (WAA) was conducted as a preliminary assessment of the densities and extent of underwater munitions across the site. This assessment utilized a towed magnetometer array to determine the presence and

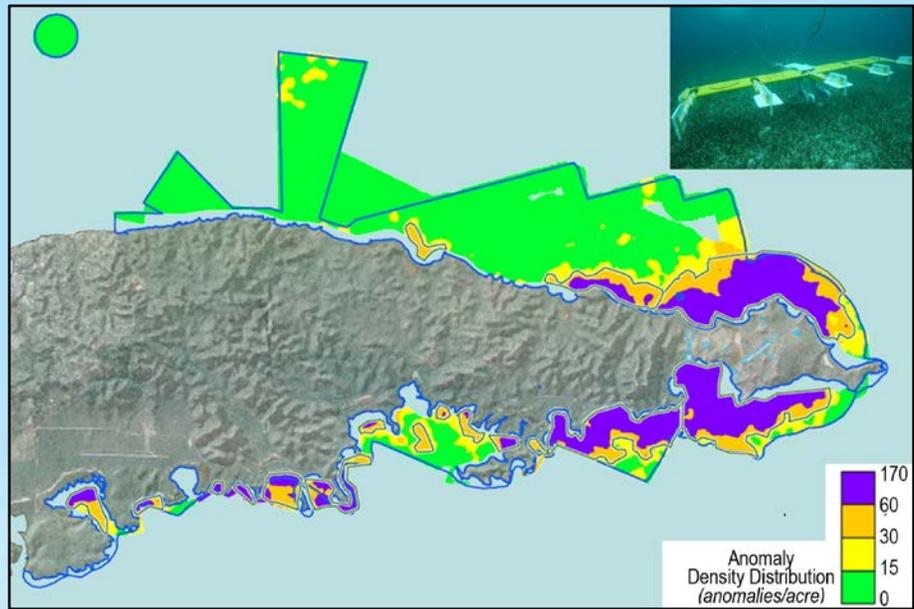


Figure 11. Distribution and density of potential munitions on and beneath the seafloor identified by the towed magnetometer array.

- distribution of potential munitions on and beneath the seafloor. In addition, video cameras were mounted on the towed “wing” to visually characterize bottom types and ecological regimes. The ecological information from the video cameras allowed a programmatic biological assessment (BA) to be prepared for consultation with the National Marine Fisheries Service. The programmatic approach to the entire underwater site will save significant time and tens of thousands of dollars versus the cost of biological assessments prepared for multiple, localized areas. Most importantly, the information gathered from the WAA is key to effectively strategize focused, follow-up investigations, help make remedial decisions, implement remedial actions, and perform long-term monitoring associated with underwater munitions.
- Remotely-operated Munitions Removal Equipment* - In 2016, the Navy utilized a remotely-operated excavator to expedite munitions cleanup along a scenic peninsula targeted for future recreational use. As part of a NTCRA, munitions removal was performed along planned trails and beaches, including using the remotely-operated excavator to remove munitions at beaches from depths not achievable using traditional methods. The innovative approach resulted in the land potentially being made available to the Refuge 8 to 10 years ahead of the original plan. Incorporation of this technology into the Navy’s restoration program is anticipated to save over \$10M in munitions clearance costs.

Partnerships with Government, Academic, Scientific, and Community Stakeholders: Due to the large volume of restoration work executed (approximately \$20M/year) and the unique and complex site conditions (widespread munitions, environmental contamination, cultural artifacts, endangered species, and sensitive habitats on land and in the surrounding waters, multiple land owners, and various land uses), there are more than 20 stakeholder groups that participate in the cleanup process on Vieques. To ensure effective planning and accelerate cleanup decision making, regular meetings are held by the Vieques Environmental Restoration Program Team and technical support staff. These meetings often involve joint scoping sessions to reach consensus on work plans and resolve technical issues for a wide range of topics in environmental restoration, compliance, munitions cleanup, community involvement, and risk

assessment. The meetings are typically supplemented with site visits and joint participation at the community Restoration Advisory Board (RAB) meetings. This approach results in enhanced relationships and accelerated progress toward achieving the goals of all stakeholders.

Significant partnership activities and accomplishments in 2016 and 2017 include:

- *Commitment to Worker and Community Safety* – The most important aspect of the Vieques Environmental Restoration Program is the safety of the Vieques community and the cleanup workers (many of which are local residents). As part of the commitment to worker safety, the Navy conducted weeklong annual safety training in 2016 and 2017 to ensure workers have the most up-to-date training on proper procedures and tools. Additionally, the Navy supported the local school during its 2016 Public Servant Day by hosting a munitions safety awareness event, including interactive safety demonstrations for children. In 2017, the Navy implemented use of color-coded UXO safety markers around the island that are highly-visible, straightforward tools to warn the public of potential dangers.
- *Commitment to Disseminating Information to the Community* – In 2017, bilingual Cleanup Fact Sheets were added to the Navy’s state-of-the-art community outreach program. Each Cleanup Fact Sheet focuses on a specific topic identified by the community as an area of interest or concern, including air quality associated with the open detonations to destroy munitions, and controlled burning of vegetation in the Submunitions Area to allow cleanup workers to see and remove the previously hidden submunitions from the ground surface. These Fact Sheets were mailed to community members, distributed at RAB and public meetings, posted to the Vieques Environmental Restoration website and Facebook page to ensure the broadest distribution possible.
- *Site Visits for the Public* – In 2017, the Navy provided escort and logistical support to the regulatory agencies and members of an organization, “Friends of Cayo La Chiva,” established to provide formal input on a beneficial reuse plan for a 12-acre island adjacent to Vieques used by the Navy for amphibious landings. The site visit provided the organization the ability to gather site-specific information and ask questions in order to formulate and submit a conceptual design for public use of the island.

- *Partnership for Mission Success* –The Navy and USFWS have formed a mutualistic relationship that promotes accelerated cleanup, resource conservation, and land reuse beneficial to both wildlife and Refuge visitors. In 2016, this close relationship was highlighted when the Secretary of the Interior made a personal visit to tour the Refuge and discuss the Navy’s cleanup program. Additionally, the Navy helped USFWS meet its ongoing mission by providing UXO escort to Refuge biologists to various beaches on the former bombing ranges so they could monitor nesting behavior and success of endangered sea turtles.



Figure 12: Innovative, state-of-the-art tools are used to promote safety, foster partnership, and disseminate information to the local community, including interactive community meetings, site visits, informational brochures, and safety awareness training.