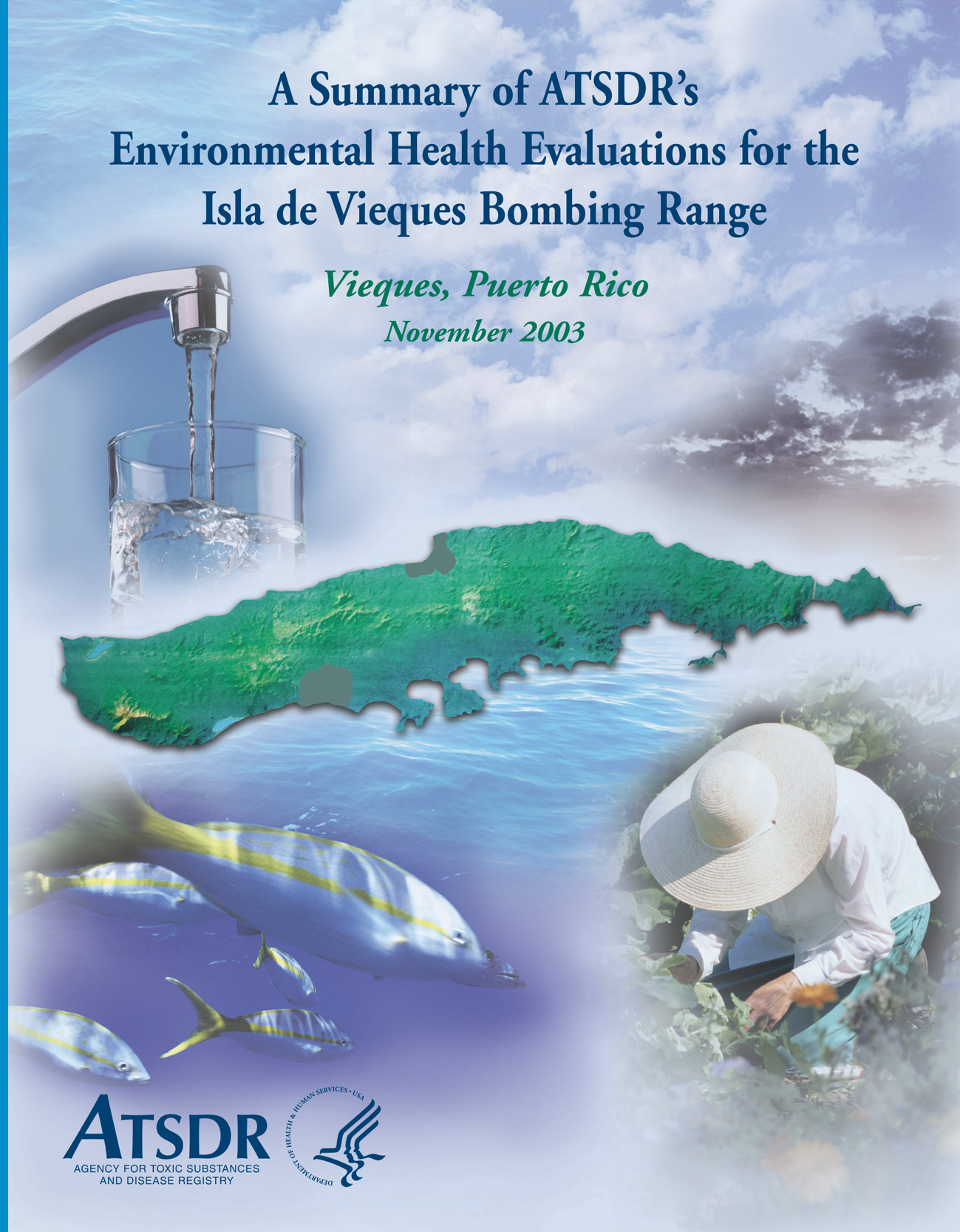
A Summary of ATSDR's Environmental Health Evaluations for the Isla de Vieques Bombing Range

Vieques, Puerto Rico

November 2003



ATSDR

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

DEPARTMENT OF HEALTH & HUMAN SERVICES • USA

Prepared by:

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Agency for Toxic Substances and Disease Registry

The topographic layer of the maps was obtained from "Air Dispersion Modeling and Related Analysis for Inner Range Operations, Vieques, Puerto Rico," February 2000.

Introduction

Isla de Vieques is part of the Commonwealth of Puerto Rico, and is located about 7 miles east-southeast of the main island of Puerto Rico. Until May 2003, the U.S. Navy owned approximately one-half of the island and conducted military training exercises that, until April 1999, included live bombing in an area of about 900 acres known as the Live Impact Area.

In May 1999, a resident of Vieques requested that the Agency for Toxic Substances and Disease Registry (ATSDR) determine whether hazardous substances from the bombing at the Live Impact Area pose a public health threat to people living on Vieques. The petitioner and some other island residents voiced concern that metals and explosive compounds from the bombing could potentially travel from the Live Impact Area to the central portion of the island where the residents live, roughly 8 miles west of the Live Impact Area.

> *A pathway is the route a substance takes from its source to its end point, and is how people can come into contact with (or get exposed to) it.*

ATSDR evaluated the pathways most likely to result in exposure to the residents of Vieques, including drinking groundwater, incidentally ingesting or touching soil, eating fish and shellfish, and breathing air. Each of these evaluations was presented in a separate public health assessment. This document summarizes the major findings of the individual public health assessments, additional community concerns, and ATSDR involvement at Vieques, as well as where you can obtain additional information. Please refer to the original public health assessments for additional details and a complete list of references.

Residents of Vieques have not been exposed to harmful levels of chemicals resulting from Navy training activities at the former Live Impact Area.

Based on a thorough review and evaluation of all relevant information pertaining to the pathways, ATSDR concludes that, overall, residents of Vieques might have been exposed to very low levels of environmental contamination. However, the contaminant levels that people were most likely exposed to are too low to cause harmful health effects. For that reason ATSDR has categorized exposure to environmental contaminants at Vieques as "no apparent public health hazard." This means that people were most likely exposed to environmental contamination through the pathways ATSDR evaluated, but that the exposures are not at levels expected to cause harmful health effects.

Conclusions from ATSDR's Evaluation of Drinking Water Supplies and the Groundwater Pathway

October 16, 2001

The petitioner and other residents of Vieques have voiced concern that contaminated groundwater might move from beneath the Live Impact Area to the populated areas of Vieques. To address this concern, ATSDR studied the hydrogeology of the island and evaluated the levels of chemicals in drinking water and groundwater samples collected from wells and tanks located on Vieques. ATSDR reached the following conclusions:

■ It is safe to drink water from the current public water supply system.

Most of the residents of Vieques currently receive their drinking water supply from the mainland of Puerto Rico through an underwater pipeline. In 1999 and 2000, the U.S. Environmental Protection Agency, Puerto Rico Department of Health, and U.S. Navy tested the drinking water within the public water supply system for volatile organic compounds, inorganic compounds, and explosive compounds. After an evaluation of the results of these tests, ATSDR concluded that the public drinking water supply is not being impacted by Navy activities and is safe to drink.

Bombing of the Live Impact Area has not affected the drinking water supplies of Vieques.

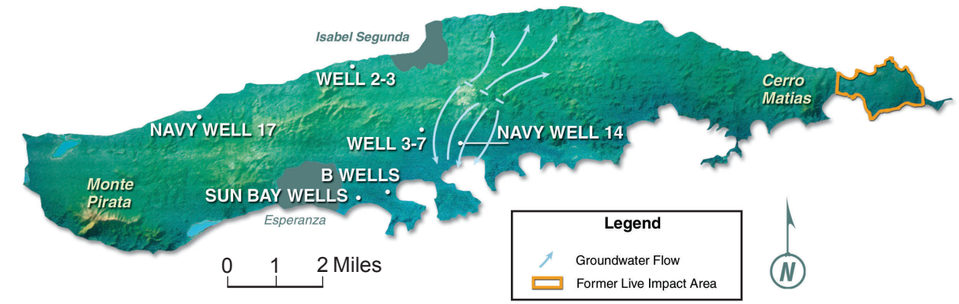
■ It is safe to drink water from most groundwater wells on the island.

In the past, residents were supplied with water from groundwater wells located in the Esperanza and Resolucion valleys. In addition, smaller private wells in the residential areas supplied drinking water in the past and currently provide supplementary drinking water when the public water supply system from the mainland is interrupted.

From 1995 to 2000, the U.S. Environmental Protection Agency, Puerto Rico Department of Health, U.S. Geological Survey, and U.S. Navy sampled groundwater wells on the island for volatile organic compounds, inorganic compounds, pesticides, herbicides, polychlorinated biphenyls, and explosive compounds. Explosive compounds and their residues were not found in any of the wells. ATSDR evaluated whether the other chemicals that were detected were at harmful levels for people drinking water from the wells.

ATSDR concluded that water from all but one of the wells is safe to drink whenever the public water supply is interrupted. However, because of the naturally high sodium content, residents who are on a sodium-restricted diet should consider limiting their intake of water from groundwater wells on the island. One private well (Well 3–7) showed high levels of nitrates/nitrites. The water from Well 3-7 is not safe to drink, especially for children and pregnant women. The Puerto Rico Department of Health issued an advisory, and the department's staff personally informed residents that water from Well 3-7 is not safe. Given the hydrogeology of Vieques, ATSDR does not believe that the contamination is a consequence of bombing range activities; rather, it is probably the result of agricultural activities or septic systems in the area.

Location of Groundwater Wells



■ The geology and topography of the island prevent groundwater from moving from the Live Impact Area to the area where groundwater wells are located.

ATSDR evaluated the hydrogeology of the island to determine whether hazardous substances from the bombing at the Live Impact Area could migrate in groundwater to the area where drinking water wells are located. ATSDR determined that the wells are within isolated aquifers and are not connected to the groundwater on the eastern end of the island. In addition, the island's bedrock and the topography rise westward between the Live Impact Area and where the wells are located. Therefore, groundwater at the Live Impact Area will move slowly downhill toward lagoons and the ocean rather than migrating towards the wells.

■ If good sanitation practices are followed, it is safe to drink water from rainfall collection systems.

No sampling studies have been conducted to characterize the quality of water in rainfall collection systems on Vieques. Therefore, no firm conclusions can be drawn based on site-specific sampling data. However, if good sanitation practices are followed, ATSDR expects that rainfall collection systems on Vieques will provide clean water that does not pose health hazards.

■ It was safe to drink water in the past.

In 1978, the Navy reported very low levels of explosive compounds in drinking water samples from Vieques. The laboratory that analyzed the water samples stated some uncertainty in the results. ATSDR reviewed those data, as well as the sampling and analytical procedures, to evaluate whether those reported detections posed a potential health hazard. To be protective of public health, ATSDR analyzed the results assuming that the explosive compounds were present. ATSDR concluded that the concentrations reported were well below levels harmful to human health and did not pose a health hazard to anyone drinking water from Vieques in the past. Furthermore, more recent analyses of drinking water samples using updated sampling and analysis methodologies did not detect any explosive-related contamination.

Conclusions from ATSDR's Evaluation of the Soil Pathway

February 7, 2003

Community members have expressed concern that contaminants generated by bombing and other Navy training activities might have traveled from the Live Impact Area and been deposited on the soils of the residential areas of Vieques. To address this concern, ATSDR evaluated roughly 600 soil samples collected by the U.S. Geologic Survey, the Puerto Rico Department of Natural Resources, the U.S. Navy, and Servicios Científicos y Téchnicos, Inc. These samples were analyzed for metals, other inorganic compounds, and explosive compounds. ATSDR reached the following conclusions:

- **Residents of Vieques are not being exposed to harmful levels of chemicals in the soil.**

ATSDR compared the levels of chemicals found in the soils on Vieques to levels that are considered to be safe by public health professionals. ATSDR also conducted detailed analyses to determine the amount of chemicals people are expected to be exposed to over their lifetime. The analyses showed that incidental ingestion of soil or contact with soil would not result in harmful health effects for either adults or children living on Vieques.

The levels of chemicals found in Vieques soils are not of public health concern.

- **The protestors who lived on the Live Impact Area for a year were not exposed to harmful levels of chemicals in the soil.**

From April 1999 to May 2000, adults and children lived in camps on the Live Impact Area to protest the U.S. Navy's presence on Vieques. The Navy and Servicios Científicos y Téchnicos, Inc., collected soil samples from the areas where the protestors lived. ATSDR analyzed the data and determined that all of the chemicals were found at levels too low to cause harmful health effects for anyone incidentally ingesting or touching the soil.

- **Some of the metals detected in Vieques soil are moderately elevated in comparison to soil elsewhere.**

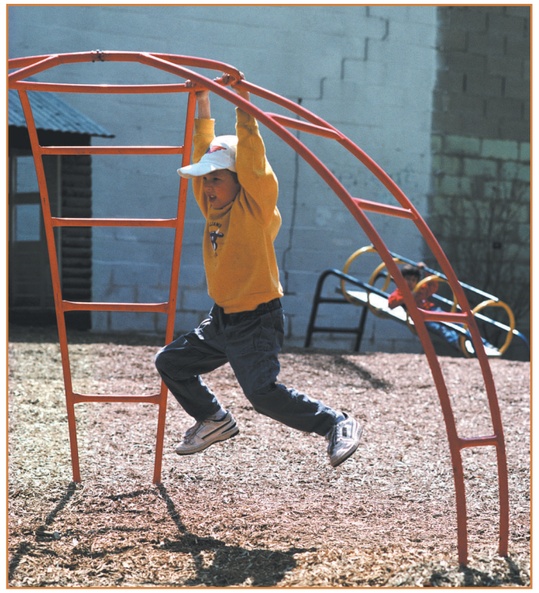
ATSDR compared the quality of the soil on Vieques with sediment on the mainland of Puerto Rico and with soil of the United States. ATSDR found that the maximum level of some of the metals detected in Vieques soil is moderately elevated in comparison to Puerto Rico and the United States. ATSDR also analyzed the chemical characteristics of soil on Vieques to determine whether metals in the soil are found at unnaturally high levels. To do this, ATSDR grouped soil samples throughout the island according to their underlying rock (the geologic units), and compared the general chemical characteristics of those soils. ATSDR found that the soils of Vieques are strongly influenced by the type of rock from which they were formed (in other words, soils developed on different underlying rock have different levels of metals). The levels of metals detected on Vieques are consistent with what is normally found in soils underlain by the type of rock found on Vieques (e.g., volcanic rocks) and are not at levels of health concern.

- **The concentrations of metals in the soils of the Live Impact Area appear to be moderately elevated but are not at harmful levels.**

According to ATSDR's analysis, the soils of the Live Impact Area appear to have been influenced by Navy training activities and contain elevated levels of metals. However, ATSDR determined that the concentrations of the metals in the soil are not at harmful levels.

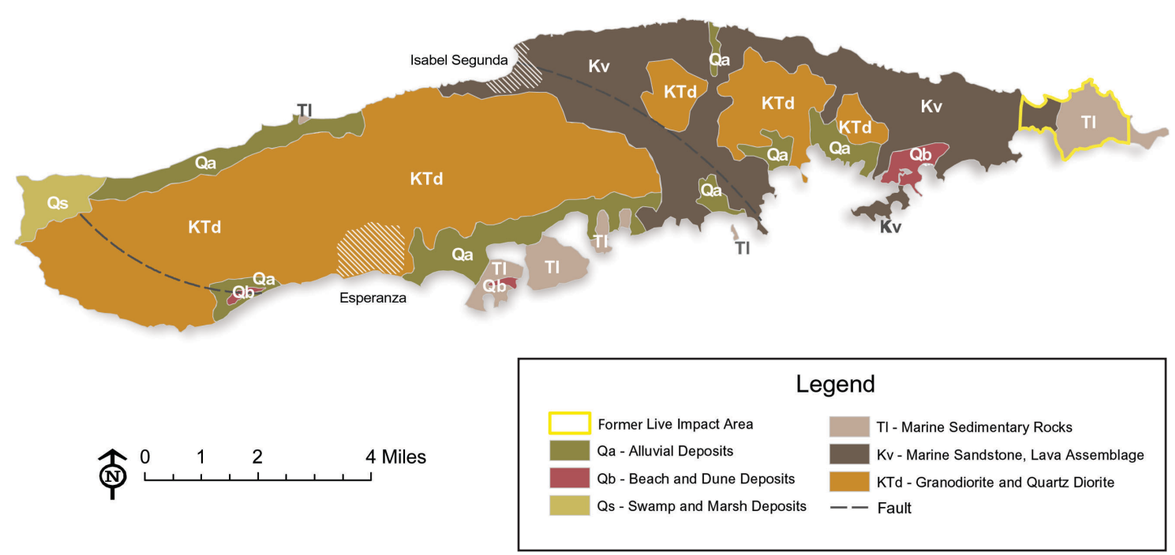
- **According to ATSDR's spatial analysis, it does not appear that metals are moving from the Live Impact Area to the residential areas.**

ATSDR examined the soil data for spatial trends that would show movement of metals from the Live Impact Area to the residential areas of Vieques (i.e., a pattern of high to medium to low concentrations from east to west). To do this, ATSDR plotted on maps the locations of metal concentrations detected on Vieques. None of the spatial maps showed a pattern beginning with high concentrations in the Live Impact Area and decreasing concentrations tapering off to the



western parts of the island. Thus, the soil data collected from across the island did not indicate that contaminants from the Live Impact Area were transported in the air and deposited in residential areas in substantial quantities.

Geologic Units on Vieques



Conclusions from ATSDR's Evaluation of

Eating Fish and Shellfish

June 27, 2003

Previous studies reported elevated levels of metals in fish and shellfish that are eaten by the residents of Vieques. To address this concern, ATSDR worked with the U.S. Environmental Protection Agency's Environmental Response Team to collect and analyze fish and shellfish from the coastal waters and near-shore land on Vieques to determine whether fish and shellfish muscle tissues contain levels of metals and explosive compounds that would be harmful to human health.

From July 16th to 20th, 2001, fish and shellfish were collected from six locations on Vieques. ATSDR decided to collect grouper, snapper, parrotfish, grunt, goatfish, blue land crab, spiny lobster, and queen conch because they were identified by several sources as types of seafood that are commonly caught and eaten. These fish and shellfish were collected from reefs and near-shore areas at the following six locations: (1) north of the Live Impact Area, (2) south of the Live Impact Area, near a sunken Navy vessel, (3) south of Esperanza, (4) north of Isabel Segunda, (5) a fish market in Isabel Segunda, and (6) west of the Laguna Kiani Conservation Zone on the west end of Vieques. Fillet and muscle tissues were analyzed for metals and explosive compounds. All sampling and analysis procedures were conducted in accordance with established U.S. Environmental Protection Agency protocols.

Although several metals were detected in some of the fish and shellfish, the levels were too low to be of health concern for people eating the seafood.

During the sampling event, the divers noted that all sample locations supported diverse, healthy populations of marine organisms and that all reefs were in good condition. They also noted that, with very few exceptions, the organisms collected appeared to be healthy.

ATSDR reached the following conclusions:

- **Explosive compounds were not detected in any of the edible fish and shellfish from Vieques.**
- **Metals were detected in the fish and shellfish from Vieques; however, the levels were too low to cause harmful health effects for people eating the seafood.**
- **It is safe to eat fish and shellfish from Vieques every day.**

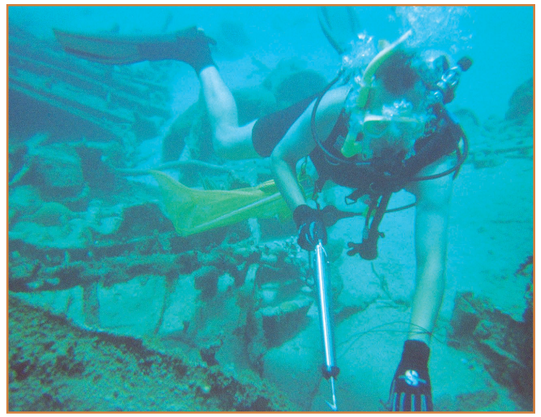
According to a local consumption study, almost half of the residents of Vieques eat seafood one or two times a week. However, some people responded that they eat seafood five or more times a week. To be protective of all residents, ATSDR estimated exposure by determining the amount of metals people would most likely be exposed to over their lifetime if they ate fish or shellfish every day for 70 years. ATSDR then compared these levels to those that are considered to be safe by public health professionals. ATSDR found that it is safe to eat a variety of fish and shellfish from Vieques on a daily basis.

- **It is safe to eat fish and shellfish from any location.**

It is safe to eat fish and shellfish from all of the areas that ATSDR sampled. Some metals were detected in higher concentrations at specific locations. However, none of the detected concentrations were high enough that ATSDR would expect to see harmful health effects, even if people ate fish or shellfish solely from a single location (e.g., only from the fish market or only from areas around the Live Impact Area).

- **It is safe to eat snapper every day.**

According to a local consumption study and information provided by Vieques residents and fishermen, snapper is the most desirable and commonly consumed species of fish. Therefore, ATSDR evaluated the specific scenario of people eating snapper every day. ATSDR concluded that the levels of chemicals present in snapper are too low to be of health concern, even if people ate snapper every day for 70 years.



- **It is safe to eat lobster.**

Although arsenic levels in the lobsters were higher than levels reported during a 1978 National Marine Fisheries Service survey, the levels of arsenic in lobster were not higher than the U.S. Food and Drug Administration's level of concern for average lobster consumption. ATSDR does not expect harmful health effects to occur in people eating lobster less than three times a week.

Conclusions from ATSDR's Evaluation of the Air Pathway

August 26, 2003

Several Vieques residents asked ATSDR if the air on the island is safe to breathe. The residents were most concerned about contaminants released to the air during the Navy's military training exercises, both the Navy's past "live bombing" exercises, as well as their more recent "practice bombing" exercises. The residents also had questions about whether dusts from the bombing range blow into their neighborhoods.

Levels of air pollution on Vieques are not a public health hazard, nor did they pose a health hazard during the time when the Navy conducted military training exercises.

For the last 3 years, the Puerto Rico Environmental Quality Board has been measuring air pollution in two Vieques neighborhoods. This picture shows a sampling device in Esperanza.

ATSDR reached the following conclusions:

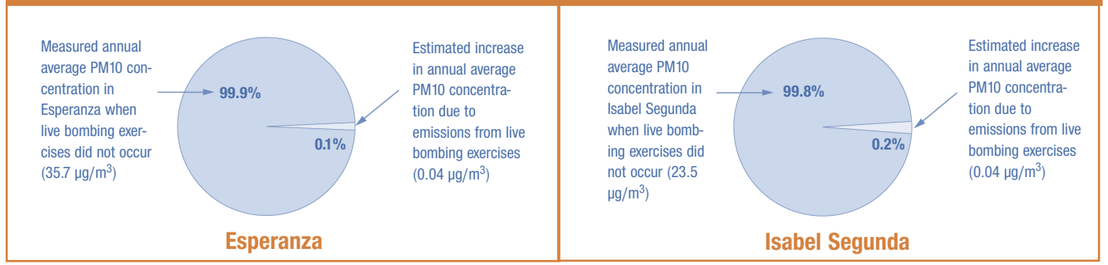
■ Wind-blown dust from the bombing range does not pose a health hazard to residents.

The air quality impacts of wind-blown dust are typically evaluated by measuring the levels of particulate matter in the air. The term "particulate matter" refers to solid particles and liquid droplets in the air that we breathe. For the last 3 years, the Puerto Rico Environmental Quality Board has been measuring levels of particulate matter at two locations in the residential areas of Vieques. To date, nearly 450 air samples have been collected, and the amounts of particulate matter in every measurement have been well below levels of health concern.

■ The Navy's "practice bombing" exercises did not pose a health hazard to residents.

From May 2000 through May 2003, the Navy's military training exercises were conducted with "practice bombs." The Puerto Rico Environmental Quality Board has collected more than 50 particulate matter samples on days when practice bombs were dropped on the bombing range. In every sample, the levels of particulate matter were much lower than levels of health concern. In fact, there is no clear relationship between the number of practice bombs that were dropped and the levels of air pollution measured in the residential part of the island. Based on these observations, and on estimated air concentrations of other contaminants, ATSDR found that, on days when practice bombing occurred, levels of air pollution did not present a health hazard to the island's residents.

Effect of Live Bombing Exercises on Annual Average PM10 Concentrations on Vieques



"PM" is short for particulate matter. "PM10" refers to airborne particles and water droplets that are smaller than 10 microns in diameter. Particles of this size are not visible to the eye, and their diameter is much smaller than human hair. Environmental agencies monitor airborne levels of PM10 because particles of this size are capable of reaching deep portions of the human lung.

■ Based on the results of ATSDR's modeling analysis, the Navy's "live bombing" exercises did not pose a health hazard to residents.

Three air sampling studies were conducted during the time when the Navy used live bombs on Vieques. The Puerto Rico Environmental Quality Board conducted two of these studies, and the Navy conducted the other. None of the measurements in these studies found air pollution to be at levels of health concern. However, because original documentation of these studies has not been located, ATSDR could not rest its health conclusions on these studies alone.

ATSDR estimated air quality impacts from live bombs using a modeling analysis. This analysis considered nearly 100 different contaminants that are known to be released to the air when ordnance explodes. The modeling analysis found that chemicals released to the air in smoke by the bombs dispersed to extremely low levels as the smoke traveled from the bombing range toward where people live. For most contaminants, the predicted air quality impacts where residents live were so low that even highly sensitive air sampling devices would likely not be able to measure them. In the case of particulate matter, for example, emissions from live bombing exercises were predicted to account for less than 1 percent of the concentration of particulate matter currently measured in the residential areas of Vieques. This comparison suggests that emissions from the bombing range have extremely small impacts on the air quality in the residential areas of Vieques. Based on this modeling analysis, ATSDR concluded that emissions from live bombing exercises did not cause air pollution to reach levels known to be associated with health effects.

"Live Bombs" and "Practice Bombs": What Is the Difference?

The Navy has used various types of ordnance during its military training exercises at Vieques. Prior to April 1999, "live bombs" were used in many of the exercises. Live bombs contain explosives and release large amounts of energy upon impact. The Navy was not allowed to use live bombs at Vieques after April 19, 1999, when two bombs dropped during a military training exercise accidentally killed a civilian guard. From May 2000 to May 2003, the Navy only used "practice bombs" during its military training exercises. A practice bomb does not have an explosive charge. Instead, it is filled with inert materials, like sand or concrete. A practice bomb might still contain a very small amount of explosives to create a signal where the bomb lands, but the amount of explosives is much smaller than the amount contained in a live bomb. Live bombs release more contaminants to the air than do practice bombs.

Additional Community Concerns Evaluated by ATSDR

Hair Analysis Panel Discussion

December 2001

Some Vieques community members had their hair analyzed for metal contamination. Upon receiving the results, they expressed concern that they were being exposed to unhealthy levels of metals. The medical literature, however, recommends that physicians not rely solely on hair analysis to diagnose or treat metal toxicity.

In June 2001, ATSDR convened an expert panel to discuss the state of the science for relating the results of hair analysis to environmental exposures. The panel consisted of individuals who represented state and federal government agencies, academia, and private practice and whose expertise, interests, and experience covered a wide range of related technical disciplines.

ATSDR believes many scientific issues need to be resolved before hair analysis can become a useful tool to understand environmental exposures. Although hair analysis may answer some questions about environmental exposure to a few substances, hair analysis often raises more questions than it answers.

The panelists agreed that "for most substances, insufficient data currently exist that would allow the prediction of a health effect from the concentration of the substance in hair. The presence of a substance in hair may indicate exposure (both internal and external), but does not necessarily indicate the source of exposure."

Vieques Heart Study Expert Panel Review

August 17, 2001

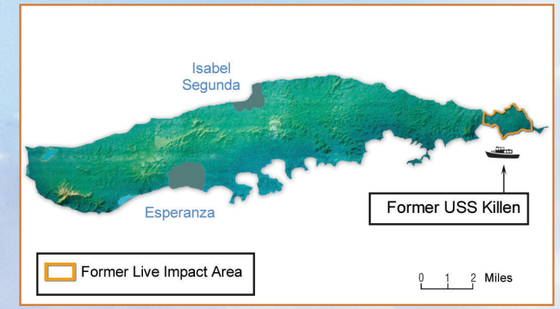
In January 2001, the government of Puerto Rico notified federal authorities about the results of a pilot study indicating that some Vieques residents had possible abnormalities in their heart valves and might be experiencing thickening of their pericardium (the lining surrounding the heart). To follow-up on this pilot study, the Ponce School of Medicine launched a more definitive study of possible heart abnormalities among Vieques residents, specifically fishermen.

ATSDR and the Ponce School of Medicine jointly selected a panel of independent experts to review and interpret the Ponce School of Medicine's findings and to independently re-read the study's echocardiograms. Eight accomplished physician-scientists from research institutes and universities were chosen as reviewers. Four were from the United States, two were from Mexico, and two were from Spain. Half the panel members were experts in cardiology and echocardiography; the others were epidemiologists. Because of its reputation and extensive experience, the echocardiography laboratory at the Mayo Clinic in Rochester, Minnesota, was chosen to review the study's echocardiograms.

In July 2001, the panel met in San Juan, Puerto Rico. The panel found that the well-executed Ponce School of Medicine study showed no indication of abnormal heart function attributable to pericardial thickening.

The Former USS Killen

See the Fish and Shellfish Evaluation, June 27, 2003



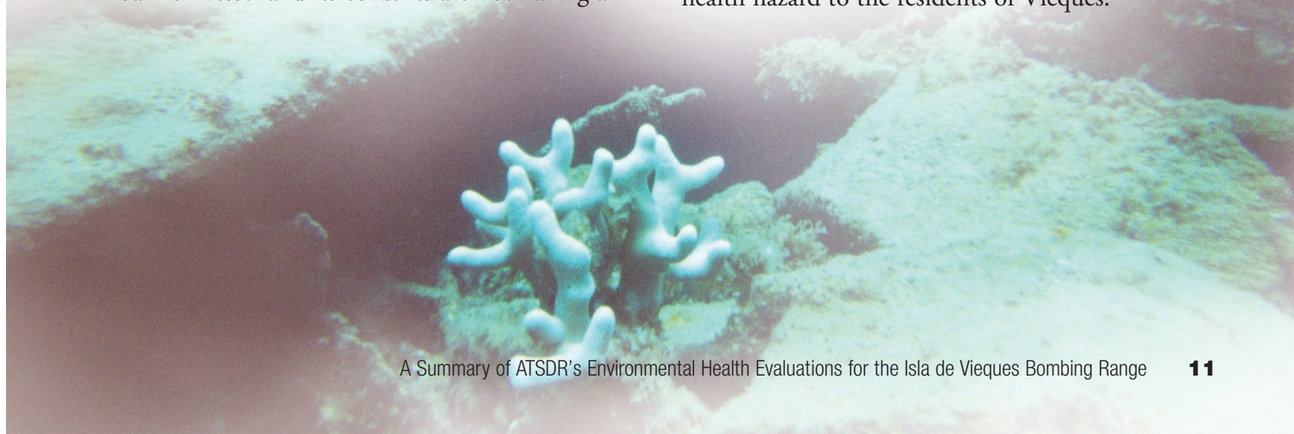
In November 1999, lawyers for the Puerto Rican government contracted the University of Georgia to examine the health of the Vieques coral reefs. During their investigation, the university's researchers reported seeing "two sunken vessels" south of the Live Impact Area that contained hundreds of 55-gallon drums. The community expressed concern that the presence of the ships and drums may contaminate the environment.

The wreckage is actually the scuttled remains of the former USS Killen, a World War II destroyer that had been used as a target vessel. It has been hypothesized that the 55-gallon drums were filled with air and placed on board to enhance buoyancy to keep the vessel afloat as long as possible. In addition, some of the 55-gallon drums may have been filled with sand or seawater and used as ballast to add stabilization.

ATSDR sampled and analyzed fish and shellfish at the site of the sunken Navy vessel in July 2001. The sunken vessel was home to a diverse population of apparently healthy fish and small head corals, and was surrounded by a large halo and a healthy turtle grass bed. In addition, ATSDR found that the fish and shellfish collected from the area did not contain levels of metals or explosive compounds that would adversely affect the health of someone eating fish and shellfish from this area.

In 2001, the Navy conducted a site investigation at the former USS Killen and concluded that the sunken vessel and its contents are not having a negative effect on the coral reef ecosystem; rather, they are acting as a productive artificial reef habitat. There is a large body of information that supports the Navy's conclusion. Ships and other manmade objects are frequently sought by natural resource agencies and private environmental organizations worldwide, to be used as artificial reef. Such structures form desirable habitat for marine life and are common sites of recreational fishing and diving activities throughout the world.

Community members were also concerned that the former USS Killen could be radioactive from its involvement as a target ship during Operation HARDTACK, which consisted of underwater nuclear tests in the Pacific in 1958. During the tests, the former USS Killen was under constant water wash before and after the blasts to remove as much of the radioactivity as possible. A few days after each test, crews went on board, surveyed the ship, and manually decontaminated those areas needing additional treatment. Radiation measurements collected in 1975 and 2002 showed that the radiation levels associated with the former USS Killen are indistinguishable from radiation associated with background and do not pose any public health hazard to the residents of Vieques.

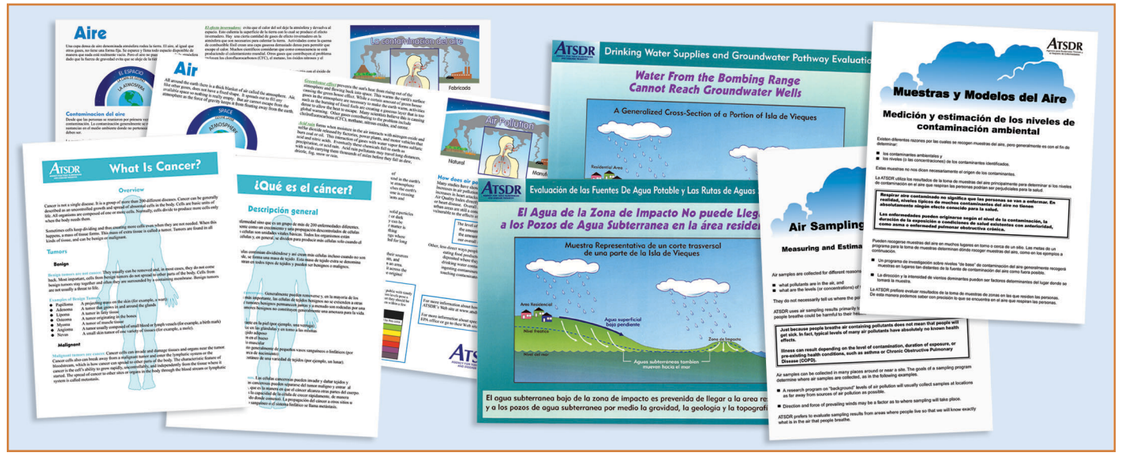


ATSDR Involvement at Vieques

Since being petitioned in 1999, ATSDR has worked extensively to characterize the extent of environmental contamination and potential health effects and to respond to community needs. Teams of ATSDR scientists and community involvement specialists have visited Vieques more than 10 times. During these visits, ATSDR toured the areas owned by the Navy, identified health concerns, collected relevant data and site information, collected fish and shellfish for analysis, and presented findings of ATSDR evaluations. ATSDR also visited the main island of Puerto Rico to communicate and coordinate with the commonwealth's government officials, to visit university libraries and gather research reports, to meet with staff of the Ponce School of Medicine and other university researchers, and to meet with Navy personnel and gather information from them.

Defining community concerns is an essential step in the public health assessment process. To define specific environmental health issues of concern, ATSDR met several times with individuals and families on Vieques. ATSDR has also met with elected officials, physicians, nurses, school educators, fishermen, leaders of women's groups, pharmacists, and businessmen. Among other discussion topics, ATSDR inquired how the agency can most effectively provide public health information to the community. ATSDR plans to continue such community involvement activities at Vieques.

In addition, ATSDR has worked with physicians, nurses, and school officials to provide educational materials and to support the overall public health of Vieques residents. To date, the agency has hosted four physician workshops and three nurse training workshops covering the various aspects of environmental health, including procedures for taking an exposure history. The agency has also facilitated community education sessions on cancer. ATSDR intends to provide additional education sessions that will address topics such as air quality and asthma, nutrition and wellness, and environmental health. ATSDR will continue to provide detailed fact sheets in English and Spanish on issues relating to health concerns and topics of awareness, prevention, or promotion in support of this ongoing health education effort.



Where Can I Get More Information?

When contacting ATSDR, please indicate that you are interested in Vieques, Puerto Rico, and whether you are requesting additional information or are requesting that specific documents be mailed to you. Residents can find more information on ATSDR's activities at Vieques the following three ways:

1. ***Visit one of the records repositories.*** English and Spanish copies of the public health assessments and accompanying Fact Sheets are available from records repositories located at the Biblioteca Publica (Calle Carlos Lebrum, Vieques), the Vieques Conservation and Historical Trust (Flamboyan Street, Vieques), and the University of Puerto Rico's School of Public Health (San Juan, Puerto Rico).

2. ***Visit the ATSDR Web site* at *www.atsdr.cdc.gov*** or e-mail ATSDR at *atsdr@cdc.gov*.

3. ***Contact ATSDR directly.*** Residents can contact representatives from ATSDR directly by dialing the agency's toll-free number, 1-888-42-ATSDR (1-888-422-8737), or writing to:

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