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# FINAL MASTER STANDARD OPERATING PROCEDURES, PROTTOCOLS, AND PLANS
# ENVIRONMENTAL RESTORATION PROGRAM VIEQUES ISLAND PUERTO RICO

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Final

# Master Standard Operating Procedures, Protocols, and Plans

## Environmental Restoration Program
## Vieques, Puerto Rico

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# Contents

**Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program**

Summary of the ERA Process ..... 1

Approach and Methodology ..... 4

References ..... 21

**Baseline Human Health Risk Assessment Protocol for Vieques Environmental Restoration Program**

Risk Results Format and Interim Deliverables ..... 1

Risk Assessment Process ..... 5

Toxicity Assessment ..... 45

References ..... 50

**Soil Sample Depth Selection Protocol**

Surface Soil ..... 1

Subsurface Soil ..... 1

**Master Waste Management Plan**

Introduction ..... 1-1

Handling ..... 2-1

Management ..... 3-1

Characterization and Profiles ..... 4-1

Shipping and Disposal ..... 5-1

**Standard Operating Procedures**

A-1 Soil Boring Drilling and Abandonment
A-2 Soil Sampling
A-3 Homogenization of Soil and Sediment Samples
A-4 Soil Sampling for VOCs Using the EnCore® Sampler
A-5 Slide Hammer Soil Sampling
A-6 Soil Sampling for VOCs Using the Terra Core® Sampler

B-1 Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling

C-1 Calibration and Measurement with Field Instruments
C-2 Electromagnetic Induction
C-3 Magnetometry

D-1 Monitoring Well Installation
D-2 Monitoring Well Development
D-3 Monitoring Well and Borehole Abandonment
D-4 Temporary Injection Points

E-1 Decontamination of Personnel and Equipment
E-2 Decontamination of Drilling Rigs and Equipment

G-1 Surface Water Sampling
G-2 Sediment Sampling

H-1 Preparing Field Log Books
H-2 Water-Level Measurements
H-3 Aquifer Slug Testing
H-4 Chain-of-Custody
H-5 Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods
H-6 Equipment Blank Preparation
H-7 Surveying Specifications

I-1 Vegetation Clearance SOP for Environmental Investigations

**Non-CERCLA-related Contaminant Considerations (Pesticides/Dioxins/PAHs)**

**Response To Comments**

# Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program

This protocol describes the approach and methods that will be used to conduct ecological risk assessments (ERAs) for upland and near-shore Navy sites at Vieques Island, Puerto Rico. This protocol does not apply to off-shore habitats. This final protocol document reflects the results of conference calls held on 18 March 2009 and 30 April 2009 to discuss regulator comments on the original ERA protocol for Vieques, as documented in the *Summary of Proposed ERA Protocol Modifications*, *Ecological Risk Assessment Protocol Development*, *Vieques, Puerto Rico* (7 May 2009). It also reflects the results of conference calls held on 10, 15, and 17 December 2009 to discuss regulator comments on the first revision of the ERA protocol (July 2009), as well as regulator comments on the second revision of the ERA protocol (February 2010). Final responses to all of these regulator comments are documented in the response documents that accompany this final protocol revision. Additional updates to the various components of this protocol may also occur in the future as additional data become available.

Any site-specific deviations from this protocol will be documented in site-specific ERA interim deliverables to be completed prior to the conduct of the site-specific ERA. It is important to note that once the regulatory comments on the site-specific ERA interim deliverable are resolved to the satisfaction of the stakeholder agencies, the site-specific ERA interim deliverable will not be formally resubmitted. Rather, the resolution of the comments will be documented in meeting/ conference call minutes, or the "red-lined" interim deliverable and the relevant information will be carried forward into the ERA. This is because the interim deliverable is intended to facilitate the stakeholder agencies' agreement on the input parameters and procedures of the site-specific ERA and is not produced as a final, stand-alone document.

## 1.1 Summary of the ERA Process

ERAs to be performed at Vieques Island, Puerto Rico, will be conducted in accordance with the *Navy Policy for Conducting Ecological Risk Assessments* (CNO, 1999) and the Navy guidance for implementing this ERA policy (NAVFAC, 2003). The Navy ERA policy and guidance, which describe a process consisting of eight steps organized into three tiers, are conceptually similar to the eight-step ERA process outlined in U.S. Environmental Protection Agency (USEPA) ERA guidance for the Superfund program (USEPA, 1997a; Figure 1). For both sets of guidance, Steps 1 and 2 involve conducting a Screening ERA (SERA) using very conservative assumptions. The Baseline ERA (BERA) represents Steps 3 through 7. The BERA uses more realistic assumptions and site-specific data to refine the risk estimates from the SERA for components that fail the initial screen. Step 8 addresses risk management issues. The major differences between the Navy ERA policy/guidance and the USEPA ERA guidance are:

1) The Navy policy/guidance provides clearly defined criteria for exiting the ERA process at specific points (see Figure 2)

2) The Navy policy/guidance divides Step 3 (the first step of the BERA) into two distinct sub-steps (Steps 3A and 3B), with a potential exit point after Step 3A

3) The Navy policy/ guidance incorporates risk management considerations throughout all tiers of the ERA process

The ERA process to be used at Vieques Island is summarized in Table 1.

ERAs are conducted using a tiered, step-wise approach and are punctuated with Scientific Management Decision Points (SMDPs). SMDPs represent points in the ERA process where agreement on conclusions, actions, or methodologies is needed so that the ERA process can continue (or terminate) in a technically defensible manner. The results of the ERA at a particular SMDP are used to determine how the ERA process should proceed, for example, to the next step in the process or directly to a later step. The process continues until a final decision has been reached (i.e., remedial action or controls if unacceptable risks are identified, or no further action if risks are acceptable). The process can also be iterative if data needs are identified at any step; the needed data are collected and the process starts again at the point appropriate to the type of data collected.

The screening (preliminary) problem formulation is the first step of an ERA and establishes the goals, scope, and focus of the SERA. As part of problem formulation, the environmental setting of the site is characterized in terms of the habitats and biota known or likely to be present. The types and concentrations of chemicals that are present in ecologically relevant media (such as surface water, surface sediment, and surface soil) are also described. A preliminary conceptual model is developed that describes potential source areas, potential transport pathways (the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media), potential exposure pathways (an exposure pathway links a potential source of contamination with one or more receptors through exposure via one or more media and exposure routes), potential exposure routes (e.g., ingestion), and potential receptors. Assessment endpoints, measurement endpoints, and risk hypotheses are then selected to evaluate those receptors for which complete and potentially significant exposure pathways are likely to exist[1]. The fate, transport, and toxicological properties of the chemicals present at the site, particularly the potential for bioaccumulation, are also considered during the problem formulation process.

Step 1 of the ERA process is intended to answer two main questions:

1) Do complete exposure pathways exist?

2) Are sufficient data available to conduct the SERA?

If no complete exposure pathways exist, the ERA process terminates at Step 1 with a conclusion of negligible (acceptable) risk because exposure, and thus potential risk, can only occur if complete exposure pathways exist. If one or more complete exposure pathways are known to exist, or are likely to exist, the ERA process continues to Step 2 but only evaluates those pathways that have been determined to be "critical" (ecologically important), that is, represent

[1] An assessment endpoint is an explicit expression of the environmental component or value that is to be protected. A measurement endpoint is a measurable ecological characteristic that is related to the component or value chosen as the assessment endpoint. Risk hypotheses are testable hypotheses about the relationship among the assessment endpoints and their predicted responses when exposed to contaminants or other stressors.

exposures to sensitive receptors that are associated with the predominant fate and transport mechanisms at the site (USEPA, 1997a). An evaluation of the available data is then conducted to determine if they are adequate to support the SERA. If not, additional data are collected before the ERA process continues. The second step of the ERA process involves conducting a screening exposure assessment, a screening effects assessment, and a screening risk calculation (risk characterization) based upon very conservative assumptions.

The results of the SERA are used to evaluate the potential for unacceptable ecological risks based upon very conservative assumptions. If the results of the SERA suggest that further ecological risk evaluation is warranted, the ERA process proceeds to the BERA (Steps 3 through 7), which is a more detailed phase of the ERA process, for the pathways, chemicals, receptors, and areas identified in the SERA. As indicated above, the first step of the BERA (Step 3) is divided into two distinct sub-steps (3A and 3B) in Navy ERA guidance.

Step 3 of the USEPA ERA guidance consists of the following activities (USEPA, 1997a):

1) Refinement of the Chemicals of Potential Concern (COPCs) from the SERA.

2) Further characterizing the potential ecological effects of contaminants.

3) Refining information on contaminant fate and transport, complete exposure pathways, and receptors potentially at risk.

4) Selecting assessment endpoints.

5) Refining the conceptual model and risk hypotheses from the SERA.

Step 3A of the Navy policy/guidance (refinement of conservative exposure assumptions) corresponds to the first activity listed above for the USEPA ERA guidance. In Step 3A, a refined evaluation of exposure estimates is conducted using more realistic assumptions and additional methodologies relative to those used in the SERA, which is intended to be a very conservative assessment. Examples of more realistic exposure assumptions include using central tendency (e.g., mean) estimates (rather than maximums) for media concentrations, bioaccumulation factors, and exposure parameters. Examples of additional methodologies include consideration of background and upgradient concentrations, bioavailability, and detection frequency (CNO, 1999; NAVFAC, 2003).

If risk estimates (and their associated uncertainty) are acceptable following Step 3A, the site will meet the conditions of the exit criterion specified in the Navy guidance. If the Step 3A evaluation does not support a determination of acceptable risk within acceptable uncertainty, the site continues to Step 3B.

Step 3B of the Navy policy/guidance (problem formulation) corresponds conceptually to the last four activities of Step 3 listed above for the USEPA ERA guidance. In Step 3B, the preliminary conceptual model from the SERA is refined based upon the results of the Step 3A evaluation to develop a revised list of key receptors, critical exposure pathways, key COPCs, assessment endpoints, measurement endpoints, and risk hypotheses. Based upon the refined conceptual model, the lines of evidence to be used in characterizing risk are determined. Agreement on the refined conceptual model, COPCs, exposure pathways, endpoints, and risk hypotheses constitutes the SMDP at the end of Step 3 in both Navy and USEPA ERA guidance.

Following the completion of Step 3, a decision point is reached with two potential outcomes. If the refined risk estimates are acceptable for each selected assessment endpoint, the investigation proceeds to risk characterization (Step 7) to document this conclusion and the ERA process terminates. If the uncertainties associated with the refined risk estimates are unacceptable and/or the risk estimates indicate that unacceptable risks may exist, site-specific studies might be required and the ERA process continues (Steps 4 through 6). Step 4 is a work planning step where additional site-specific studies are scoped and designed. Step 5 consists of the verification of the field sampling design developed in Step 4 while Step 6 constitutes the site investigation and data analysis phase of the process. The scope (e.g., spatial extent of sampling) and components (e.g., collection of biological data, such as tissue samples, toxicity testing, etc.) of any site-specific studies are determined by the conclusions of Step 3 and the pathways/ endpoints associated with the potential unacceptable risks.

Step 7 consists of the documentation and synthesis of the information and data identified in Steps 1 through 3 (no additional study) or Steps 1 through 6 (additional study). In this step, risk is evaluated and characterized using both quantitative and qualitative methods. Conclusions are made as to whether there is a reasonable potential for unacceptable ecological risk and, if there is a potential for unacceptable ecological risk, the magnitude of that risk. The results of the completed BERA (Step 7) are used to make necessary risk management decisions (Step 8) related to current or future risks. Possible decisions include:

- Adequate information exists to conclude that no unacceptable ecological risks exist. The assessment should stop at Step 7.
- Adequate information exists to conclude that unacceptable ecological risks exist for which remedial actions or controls are warranted. Whether remedial actions or controls are taken, and the specific actions or controls taken, will depend upon a number of risk management factors such as the results of human health risk assessments (if applicable) and the potential impact of the remedial action or control itself on the habitats and biota present. This analysis would occur as part of Step 8.
- Adequate information does not exist to estimate risk or the risk estimate is believed to be too conservative or uncertain to recommend remediation. The assessment should be refined.

## 1.2 Approach and Methodology

This section describes the specific technical approaches, methodologies, and models that will be used for the exposure assessment, effects assessment, and risk characterization portions of an ERA, as well as tables of specific model input parameter values and toxicity values.

### 1.2.1 Exposure Assessment

The principal activity associated with the exposure assessment is the estimation of chemical concentrations in applicable media, termed exposure point concentrations (EPCs), to which the receptors may be exposed. This is accomplished through the selection of appropriate sets of the available analytical data using a set of criteria (e.g., validation status, sampling date). Once the analytical data sets are selected, EPCs are calculated as a particular point on the distribution of concentrations. At the screening level (Step 2), the EPC is the maximum detected concentration. At the baseline level (Step 3), EPCs are central tendency estimates (e.g., arithmetic mean). EPCs

are then used in bioaccumulation and food web models to estimate exposures to upper trophic level receptors.

For conservatism, the maximum (SERA) and mean (BERA) reporting limits for chemicals analyzed for but not detected will also be compared to medium-specific ecological screening values (ESVs) and (where applicable) used for food web exposure modeling. This will be done to determine if reporting limits are less than chemical concentrations at which potential adverse effects to ecological receptors may occur.

#### 1.2.1.1 Selection Criteria for Analytical Data

Available analytical data will be selected for use in the ERA based upon a set of selection criteria that include:

- To be used for quantitative risk assessment, data must have been validated by a qualified data validator using acceptable data validation methods. However, unvalidated data may be used, in a qualitative manner, if validated data are not available. Rejected (R) values will not be used in the ERA. Unqualified data and data qualified as J (estimated), L (biased low), or K (biased high) will be treated as detected. Data qualified as U (undetected) or B (blank contamination) will be treated as non-detected.
- For samples with duplicate analyses, the higher of the two concentrations will be used, for conservatism, when both values are detects or when both values are non-detects. In cases where one result is a detect and the other a non-detect, the detected value will be used in the assessment.
- For non-detected results, the sample quantitation (reporting) limit (SQL) will be used to represent the concentration. When calculating statistics (e.g., arithmetic mean), one-half of the SQL will be used for non-detected results.
- For surface soil, samples collected from depths of 0 to 12 inches will be preferentially used since this depth range represents the most relevant potential exposures for most of the ecological receptors evaluated in terrestrial habitats. In appropriate habitats, soil data from 0 to 24 inches will be specifically sampled to represent exposure to land crabs and will thus be used in the ERA. Other depth interval samples that begin at 0 inches (e.g., 0 to 6 inches, 0 to 18 inches) will be used if they are considered to be a reasonable representation of the surface soil exposure pathway at a sampling location and no other surface soil data are available.
- Soil data collected below permanent barriers (e.g., building foundations, asphalt roads or parking lots) will not be used in the ERA unless the conceptual model specifies that there is a potentially complete ecological exposure pathway (considering factors like future land use). Decisions on what data to include in a site-specific ERA (and why) will be documented in the site-specific ERA interim deliverable.
- For sediment, samples from depths of 0 to 6 inches will be used preferentially since this depth range represents the most relevant exposures for sediment-dwelling species. Other depth interval samples that begin at 0 inches (e.g., 0 to 12 inches) will be used if they are considered to be a reasonable representation of the sediment exposure pathway at a sampling location and no other sediment data are available.

#### 1.2.1.2 Upper Trophic Level Receptors

Because of the complexity of natural systems, it is generally not practical to directly assess the potential impacts to all ecological receptors present at a site. Therefore, specific receptor species (e.g., green heron) are selected as surrogates to evaluate potential risks to larger components of the ecological community (guilds; such as piscivorous birds) used to represent the assessment endpoints (e.g., survival and reproduction of piscivorous birds). Selection criteria typically include those species that:

- Are known to occur, or are likely to occur, at the site.
- Have a particular ecological, economic, or aesthetic value.
- Are representative of taxonomic groups, life history traits, and/or trophic levels in the habitats present for which complete exposure pathways are likely to exist.
- Can, because of toxicological sensitivity or potential exposure magnitude, be expected to represent potentially sensitive populations.

The following upper trophic level species have been selected as representative receptors for exposure modeling in terrestrial habitats based upon the criteria listed above and their known presence/abundance at Vieques:

- Norway rat (*Rattus norvegicus*) - terrestrial mammalian omnivore (modeled as a herbivore in the SERA portion of the ERA).
- Indian mongoose (*Herpestes auropunctatus*) - terrestrial mammalian omnivore (modeled as an invertivore in the SERA portion of the ERA).
- Pearly-eyed thrasher (*Margarops fuscatus*) - terrestrial avian omnivore (modeled as an invertivore in the SERA portion of the ERA).
- Red-tailed hawk (*Buteo jamaicensis*) - terrestrial avian carnivore.

The following upper trophic level species have been selected as representative receptors for exposure modeling in wetland/aquatic habitats based upon the criteria listed above and their known presence/abundance at Vieques:

- Green heron (*Butorides virescens*) - aquatic avian piscivore/invertivore (modeled as a piscivore in the SERA portion of the ERA).
- Spotted sandpiper (*Actitis macularius*) – aquatic avian invertivore.

Upper trophic level receptor species quantitatively evaluated in the ERA are limited to birds and mammals, the taxonomic groups with the most available information regarding exposure and toxicological effects.

Individual bat species, or other appropriate receptors, may be considered on a site-specific basis during the development of the site-specific conceptual model in the ERA interim deliverable based upon site-specific habitat conditions. Receptor-specific parameter values (e.g., body weight) will be provided as part of the site-specific ERA interim deliverable for any additional species that are used at a specific site. Also, available information on any rare, threatened, and/or endangered wildlife species that may use a particular site, including guidance about the

habitat types used by each species, will be provided in the site-specific ERA interim deliverable. If such species are known or likely to be present on a site, they will be included as target receptors or appropriate surrogate species will be used to represent them.

#### 1.2.1.3 Exposure Point Concentrations

EPCs are calculated as a particular point on the distribution of concentrations. At the screening level (SERA; Step 2), the EPC will be the maximum detected concentration. At the baseline level (BERA; Step 3), the EPC will be a central tendency estimate (arithmetic mean and the 95 percent upper confidence limit [UCL] of the arithmetic mean), which provides a more representative estimate of potential exposures and risks to receptor populations (the focus of the selected assessment endpoints). Medium-specific EPCs are then used in bioaccumulation and food web models to estimate exposures to upper trophic level receptors. Dietary items for which tissue concentrations may be modeled include terrestrial plants, soil invertebrates (earthworms), small mammals, aquatic plants, benthic invertebrates, and fish. The models and parameter values that will be used for calculating these tissue calculations are outlined in the following subsections.

Not all chemicals will be evaluated for food web exposures. Only those chemicals with the potential to bioaccumulate to a significant extent, as defined in Table 4-2 of USEPA (2000), will be evaluated. Important bioaccumulating organic chemicals are generally those with a log $K_{ow}$ value of > 3.5 to 4.0 (USEPA, 1999; 2000). Table 2 provides a list of these bioaccumulative chemicals and also identifies those that are typically sampled for in environmental media at Vieques. Chemicals not considered "standard" facility analytes are not included in the subsequent bioaccumulation factor (BAF) and toxicity reference value (TRV) tables. Should a chemical (e.g., dioxins and furans) not typically sampled for at the facility be sampled for at a specific site, the applicable BAF and TRV values will be derived and included in the site-specific ERA interim deliverable. In addition, any explosive compounds detected in the media at a particular site will be added to the list of chemicals evaluated for food web exposures and will also be specified in the site-specific ERA interim deliverable. However, in instances where appropriate TRVs, BAFs, and other necessary modeling parameters are not available in the literature, the food web evaluation may not be feasible for all explosive constituents. In these cases, other relevant toxicity information and associated uncertainties will be described. Lastly, chemicals not on the list of important bioaccumulative chemicals for which bird and/or mammal Eco-SSLs have been developed will also be evaluated for terrestrial food web exposures; these chemicals are also listed on Table 2 (see Section 1.2.3). While the standard approach will be to evaluate only the chemicals included in the above discussion for food web exposures, under unique, site-specific circumstances, other selected non-bioaccumulative chemicals may be included in food web modeling. Under these circumstances, the relevant information will be included in the site-specific ERA interim deliverable.

##### SERA Approach

For the screening exposure estimates, the uptake of chemicals from the abiotic media into food items will be based upon conservative (e.g., 90$^{th}$ percentile) bioconcentration factors (BCFs) or BAFs from the literature, where available. The 90$^{th}$ percentile is generally recommended to provide for a conservative screening assessment (Sample et al., 1998a; 1998b; Bechtel Jacobs, 1998b). If 90$^{th}$ percentile values are not available in the cited reference, the maximum value will be used if available. If only central tendency (e.g., median) values are reported, they will be considered for both the SERA and BERA. Where an individual study (as opposed to a

compilation of multiple studies) is cited, the best available value was sometimes a single value or the derivation was not specified. Default (assumed) factors of 1.0 will only be used when data are not readily available for a chemical in the literature. If measured tissue concentrations are available, they will be used in place of modeled values.

### BERA Approach

BCFs and BAFs used for baseline exposure estimates will be based upon, or modeled from, central tendency estimates (e.g., median or mean). Baseline values will consider both the distribution of the data (e.g., normal or log normal) and the recommendations in the cited reference. Geometric means are preferred for log normal distributions and arithmetic means for normal distributions. In some cases, neither distribution is applicable or the distribution is biased by an outlying value. In these cases, point estimates like the median will then be considered. Where an individual study (as opposed to a compilation of multiple studies) is cited, the best available value was sometimes a single value or the derivation was not specified. Default (assumed) factors of 1.0 will only be used when data are not readily available for a chemical in the literature. If measured tissue concentrations are available, they will be used in place of modeled values.

The compilation of BAF values in this protocol (described below) resulted in data gaps for some chemicals. Additional efforts will be made (e.g., additional literature searches), on a site-specific basis, to develop BAF values for chemicals, or specific chemical forms (e.g., methyl mercury), lacking such values that will likely be "risk drivers" at the site. Where warranted, the collection of site-specific data (e.g., tissue residue samples) may be proposed to directly address these data gaps for key chemicals of potential concern (COPCs). If the chemical is not a key COPC, the limitations of the available bioaccumulation data will be addressed as an uncertainty in the ERA.

In the baseline assessment, using central tendency estimates (rather than high-end values or maximums) for exposure parameters such as BAFs provides a more representative estimate of potential exposures and risks to receptor populations (the focus of the selected assessment endpoints) of upper trophic level receptors. Since these upper trophic level species are highly mobile, they would be expected to effectively average their exposure over time as they forage within the area defining their home range. Average prey concentrations are most appropriately estimated using central tendency estimates of media concentrations and accumulation factors. For example, the wildlife dietary exposure models contained in the *Wildlife Exposure Factors Handbook* (USEPA, 1993a) specify the calculation of an average daily dose. Increasing the representativeness of the exposure estimates relative to population-level effects is consistent with the intent of the BERA. In cases where adequate spatial sampling coverage exists, mean concentrations are also appropriate for evaluating potential risks to populations of lower trophic level receptors because the members of the population are expected to be found throughout a site (where suitable habitat is present), rather than concentrated in one particular area. While effects on individual organisms might be important for some receptors, such as rare and endangered species, population- and community-level effects are typically more relevant to ecosystems.

### Terrestrial Plants

Tissue concentrations in the above-ground vegetative portion of terrestrial plants will be estimated by multiplying the maximum (SERA) or mean (BERA) surface soil concentration for each chemical by chemical-specific soil-to-plant BAFs obtained from the literature. These BAFs,

for both the SERA and BERA, are listed in Table 3. For the SERA, the point estimate BAFs in Table 3 (screening set) will be the preferred values. For the BERA, the algorithms listed in Table 4, where available for a chemical, will be the preferred method for deriving BAFs (provided that there are no site-specific factors that preclude their use, such as surface soil concentrations outside the range of concentrations used to develop the regression equation, which would be documented in the site-specific interim deliverable), followed by the point-estimate BAFs in Table 3 (baseline set).

The BAF values selected were based upon root uptake from soil and upon the ratio between dry-weight soil and dry-weight plant tissue. Literature values based upon the ratio between dry-weight soil and wet-weight plant tissue were converted to a dry-weight basis by dividing the wet-weight BAF by an estimated solids content for terrestrial plants (15 percent [0.15]; Sample et al., 1997).

For inorganic chemicals lacking literature-based, chemical-specific BAFs or applicable algorithms, a soil-to-plant BAF of 1.0 was used. For non-ionic organic chemicals (with a log $K_{ow}$ of between 3 and 8) without literature-based BAFs, soil-to-plant BAFs were estimated using the rinsed foliage algorithm provided in Figure 5B of USEPA (2007j):

$$\log BAF = (-0.4057)(\log K_{ow}) + 1.781$$

where: BAF = Soil-to-plant BAF (unitless; dry-weight basis)
$K_{ow}$ = Octanol-water partitioning coefficient (unitless)

The log $K_{ow}$ values used in this equation are listed in Table 2.

### Soil Invertebrates (Earthworms)

Tissue concentrations in soil invertebrates (earthworms) will be estimated by multiplying the maximum (SERA) or mean (BERA) surface soil concentration for each chemical by chemical-specific soil-to-invertebrate BCFs or BAFs obtained from the literature. These BCF/BAF values, for both the SERA and BERA, are listed in Table 5. For the SERA, the point estimate BAFs in Table 5 (screening set) will be the preferred values. For the BERA, the algorithms listed in Table 4, where available for a chemical, will be the preferred method for deriving BAFs (provided that there are no site-specific factors that preclude their use, such as surface soil concentrations outside the range of concentrations used to develop the regression equation, which would be documented in the site-specific interim deliverable), followed by the point-estimate BAFs in Table 5 (baseline set). For PAHs, the SERA values in Table 5 were calculated using generic models from USEPA (2007j) and PAH-specific log $K_{ow}$ values. These models tend to greatly overestimate bioaccumulation in earthworms because they do not consider metabolism and depuration. For this reason, the BERA values were based upon compound-specific measured median values from the literature (Beyer and Strafford, 1993).

BCFs are calculated by dividing the concentration of a chemical in tissue by the concentration of that same chemical in the surrounding environmental medium (in this case, soil) without accounting for uptake via the diet. BAFs consider both direct exposure to soil and exposure via the diet. Since earthworms consume soil, BAFs are more appropriate values and were used where available. BAFs based upon depurated analyses (soil was purged from the gut of the earthworm prior to analysis) were given preference over undepurated analyses when selecting BAF values because direct ingestion of soil is accounted for separately in the food web model.

The BCF/BAF values selected were based upon the ratio between dry-weight soil and dry-weight earthworm tissue. Literature values based upon the ratio between dry-weight soil and wet-weight earthworm tissue were converted to a dry-weight basis by dividing the wet-weight BCF/BAF by the estimated solids content for earthworms (16 percent [0.16]; USEPA, 1993a). For chemicals without available measured BAFs/BCFs, an earthworm BAF was estimated using available regression equations from the literature, was estimated using data for similar chemicals, or a BAF of 1.0 was assumed.

### Small Mammals

Whole-body tissue concentrations in small mammals (omnivores, herbivores, and insectivores) will be estimated using one of two methodologies. For chemicals with literature-based soil-to-small mammal BAFs, the small mammal tissue concentration will be calculated by multiplying the maximum (SERA) or mean (BERA) surface soil concentration for each chemical by a chemical-specific soil-to-small mammal BAF obtained from the literature. These BAF values, for both the SERA and BERA, are listed in Table 6. For the SERA, the point estimate BAFs in Table 6a (screening set for omnivores) will be the preferred values. For the BERA, the algorithms listed in Table 4 (for omnivores), where available for a chemical, will be the preferred method for deriving BAFs (provided that there are no site-specific factors that preclude their use, such as surface soil concentrations outside the range of concentrations used to develop the regression equation, which would be documented in the site-specific interim deliverable), followed by the point-estimate BAFs in Table 6a (baseline set for omnivores).

The BAF values selected were based upon the ratio between dry-weight soil and whole-body dry-weight tissue. Literature values based upon the ratio between dry-weight soil and wet-weight tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for small mammals (32 percent [0.32]; USEPA, 1993a).

For chemicals without soil-to-small mammal BAF values or algorithms[2], an alternate approach will be used to estimate whole-body tissue concentrations. Because most chemical exposure for these small mammal species is via the diet, it will be assumed that the concentration of each chemical in the small mammal's tissues is equal to the chemical concentration in its diet multiplied by a diet to whole-body BAF (wet-weight basis) derived from the literature. For chemicals lacking diet to whole-body BAF values (not to be confused with the soil-to-small mammal BAFs listed in Table 6), a diet to whole-body BAF of one will be assumed. The use of a diet to whole-body BAF of one is likely to result in a conservative estimate of chemical concentrations for chemicals that are not known to biomagnify in terrestrial food webs (such as PAHs), and a reasonable estimate of chemical concentrations for chemicals that are known to bioaccumulate or biomagnify, based upon reported literature values. For example, a maximum diet to whole-body BAF (wet-weight) value of 1.0 was reported by Simmons and McKee (1992) for PCBs based upon laboratory studies with white-footed mice. Menzie et al. (1992) reported diet to whole-body BAF values (wet-weight) for DDT of 0.3 for voles and 0.2 for short-tailed shrews. Reported diet to whole-body BAF (wet-weight) values for dioxin were only slightly above one (1.4) for the deer mouse (USEPA, 1990). Resulting tissue concentrations (wet-weight) will be converted to a dry-weight basis using an estimated solids content of 32 percent (see above).

[2] Eco-SSL equations for antimony, barium, and beryllium were not used because they were based upon diet-to-biota factors for cattle. Instead, small mammal tissue concentrations for these three metals were derived as described later in this paragraph.

### Aquatic Plants

Tissue concentrations in the above-ground vegetative portion of rooted aquatic plants will be estimated using the same methodologies as described above for terrestrial plants except that sediment (not soil) concentrations will be used in the calculation.

### Benthic Invertebrates

Tissue concentrations in benthic invertebrates will be estimated by multiplying the maximum (SERA) or mean (BERA) sediment concentration for each chemical by chemical-specific sediment-to-invertebrate BAF or biota-sediment accumulation factor (BSAF) values obtained from the literature. BSAF (wet weight) values will be converted to BAF values (dry weight) for use in the food web models using the default percent lipid and percent solid values listed in Table 7, and the measured site-specific TOC (or a default of 1 percent if no site-specific TOC data are available). These values, for both the SERA and BERA, are listed in Table 7. Alternately, BAFs may be calculated on a site-specific basis using the algorithms listed in Table 4. For the SERA, the point estimate BAFs in Table 7 (screening set) will be the preferred values. For the BERA, the algorithms listed in Table 4, where available for a chemical, will be the preferred method for deriving BAFs (provided that there are no site-specific factors that preclude their use, such as sediment concentrations outside the range of concentrations used to develop the regression equation, which would be documented in the site-specific interim deliverable), followed by the point-estimate BAFs in Table 7 (baseline set).

The BAF values selected were based upon the ratio between dry-weight sediment and dry-weight invertebrate tissue. BAFs based upon depurated analyses (sediment was purged from the gut of the organism prior to analysis) were given preference over undepurated analyses when selecting BAF values because direct ingestion of sediment is accounted for separately in the food web model. However, in some cases, the depurated data set was limited or highly variable, and the pooled or undepurated data were then considered (see Table 7).

Literature values based upon the ratio between dry-weight sediment and wet-weight invertebrate tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for benthic invertebrates (21 percent [0.21]; USEPA, 1993a). For chemicals without available measured BAFs, a BAF was estimated using available regression equations from the literature, was estimated using data for similar chemicals, or a BAF of 1.0 was assumed.

### Fish

Tissue concentrations in whole-body fish will be estimated using sediment-to-fish BAFs or BSAFs from the literature for applicable fish species. BSAF (wet weight) values will be converted to BAF values (dry weight) for use in the food web models using the default percent lipid and percent solid values listed in Table 8, and the measured site-specific TOC (or a default of 1 percent if no site-specific TOC data are available). Alternately, tissue concentrations may be calculated from surface water on a site-specific basis. If this is done, the calculation of site-specific water-to-fish BAFs will consider the methods provided in USEPA (2003c; 2008c), as appropriate, and will be conducted as part of the site-specific ERA interim deliverable. Where applicable, consumption of trophic level 3 fish will be assumed. The collection of site-specific fish tissue samples may also be considered as part of the normal application of the 8-step ERA process, as warranted.

Tissue concentrations in whole-body fish will be estimated by multiplying the maximum (SERA) or mean (BERA) sediment concentration for each chemical by the chemical-specific sediment-to-fish BAFs or BSAFs obtained from the literature. These values, for both the SERA and BERA, are listed in Table 8.

The BAF values were based upon the ratio between dry-weight sediment and dry-weight fish tissue. Literature values based upon the ratio between dry-weight sediment and wet-weight fish tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for fish (25 percent [0.25]; USEPA, 1993a). For chemicals without literature-based sediment-to-fish BAFs, a BAF was estimated using data for similar chemicals or a BAF of 1.0 was assumed.

#### 1.2.1.4 Dietary Intakes

Upper trophic level receptor exposures (via the food web) to chemicals present in surface soil, surface water, and/or surface sediment will be determined by estimating the chemical concentrations in each relevant dietary component for each receptor, as described in the previous section. Incidental ingestion of soil or sediment will be included when calculating the total exposure. Direct ingestion of drinking water will only be considered for sites with a regular source of water and where the salinity is typically below 15 ppt, the approximate toxic threshold for wildlife receptors (Humphreys, 1988).

Dietary intakes for each receptor species will be calculated using the following formula (modified from USEPA [1993a]):

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

where:

| | | |
|---|---|---|
| $DI_x$ | = | Dietary intake for chemical x (mg chemical/kg body weight/day) |
| FIR | = | Food ingestion rate (kg/day, dry-weight) |
| $FC_{xi}$ | = | Concentration of chemical x in food item i (mg/kg, dry-weight) |
| $PDF_i$ | = | Proportion of diet composed of food item i (dry-weight basis) |
| $SC_x$ | = | Concentration of chemical x in soil/sediment (mg/kg, dry-weight) |
| PDS | = | Proportion of diet composed of soil/sediment (dry-weight basis) |
| WIR | = | Water ingestion rate (L/day) |
| $WC_x$ | = | Concentration of chemical x in water (mg/L) |
| BW | = | Body weight (kg, wet-weight) |

Note that soil/sediment ingestion is modeled as a dietary component (rather than using a separate soil/sediment ingestion rate). Parameter values for the selected receptors (see Section 1.2.1.2) are listed in Tables 9 (screening) and 10 (baseline). When measured food and water ingestion rates were not available for a receptor from the literature, the rates were estimated using allometric equations from Nagy (2001) and USEPA (1993a) for food and water ingestion, respectively.

##### SERA Approach

The selected exposure parameter values were selected to provide for a conservative evaluation at the screening level (Step 2). Examples of these conservative assumptions include:

- All of the dietary items consumed by the receptor are obtained from the site or area (i.e., an Area Use Factor [AUF] of one is assumed) at the point of maximum concentration.
- Chemicals are 100 percent bioavailable.
- Maximum food and water ingestion rates are used (calculated maximum ingestion rates using allometric equations were based upon the maximum adult body weight).
- Minimum adult body weights are used. The selection focused on the most geographically appropriate values available from standard literature sources (e.g., USEPA, 1993a).
- Exclusive diets (composed of one primary prey item) are used.

#### BERA Approach

For the BERA, central tendency estimates (e.g., mean, median, or midpoint) for adult body weight and ingestion rates are used, as are more realistic dietary compositions. Central tendency estimates for these exposure parameters are more relevant for a BERA because they better represent the characteristics of a greater proportion of the individuals in the population. Populations or communities (rather than individual organisms) will be emphasized when developing the assessment endpoints for each site-specific ERA.

An AUF of 1.0 will be retained in this refinement step as the default approach; any proposed use of an AUF <1 will be proposed as part of the site-specific ERA interim deliverable.

### 1.2.2 Effects Assessment

The effects assessment defines the methods and data used to define an adverse ecological effect. This is typically done (at Steps 2 and 3A) by establishing chemical exposure levels (ESVs and TRVs) that represent conservative thresholds for adverse ecological effects.

#### 1.2.2.1 Uncertainty Factors

The ESVs and TRVs to be used in the ERA will be based upon chronic no-effect levels. When chronic No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Level (NOAEL) values are not available, estimates will be derived or extrapolated from subchronic NOEC/NOAEL values, chronic or subchronic Lowest Observed Effect Concentration (LOEC)/ Lowest Observed Adverse Effect Level (LOAEL) values, or acute values (e.g., $LC_{50}$ or $LD_{50}$) using the uncertainty factors provided in Table 11.

For the application of the uncertainty factors in Table 11, exposure duration is defined as follows (USEPA, 1999; Sample et al., 1996):

- Fish, mammals, and birds:
  - Chronic - > 90 days or during a critical life stage
  - Subchronic - 14 to 90 days
  - Acute - < 14 days
- Plants and invertebrates:
  - Chronic - > 7 days
  - Subchronic - 3 to 6 days
  - Acute - < 3 days

Because assessment endpoints will be based upon population- or community-level effects, no intraspecies uncertainty factors will be applied. Taxonomic class-type uncertainty factors will also not be applied because the ESVs and TRVs selected were typically derived based upon data from a broad range of taxonomic groups.

#### 1.2.2.2 Medium-Specific ESVs

Chemical-specific ESVs for the list of chemicals typically analyzed for in samples of environmental media at Vieques were developed for surface soil, surface water (freshwater and marine), and sediment (freshwater and marine). The sources of the medium-specific ESVs are presented in the following subsections in general order of preference (first choice to last choice). Values from a source lower in the hierarchy were used in place of a value from a source higher in the hierarchy under some circumstances. General reasons for this include:

- If the value was updated and the updated value is reflected in a source lower in the hierarchy, the updated value from the source lower in the hierarchy was used.
- Acute or subchronic values from a source higher in the hierarchy were not used if a suitable chronic value was available from a source lower in the hierarchy.
- Suitable no effect values, or their equivalent, from a source lower in the hierarchy were used in place of a lowest effect value from a source higher in the hierarchy.
- A value based on a chemical class (as opposed to a specific chemical) from a source higher in the hierarchy was not used if a suitable chemical-specific value was available from a source lower in the hierarchy.
- Because ESVs were intended to screen for effects to lower trophic level receptors (effects to upper trophic level receptors were screening using ingestion-based TRVs), wildlife-based ESVs (e.g., Final Residue Values) were not used unless no other suitable value was available.

Other, medium-specific reasons for deviating from the protocol are discussed in the following subsections. ESVs were based upon chronic data or extrapolated from subchronic or acute data using the uncertainty factors (Table 11) discussed in the preceding subsection.

The choice between applying soil or sediment ESVs for seasonally dry, emergent jurisdictional wetlands (e.g., wet meadows), ephemeral streams, and lagoons, as well as tidally influenced shorelines and wetlands, will be determined on a site-specific basis as part of the site-specific ERA interim deliverable.

##### Surface Water

For surface water, the selected ESVs for chemicals known to bioaccumulate in aquatic food webs were based upon final or secondary chronic values (or their equivalent), when such values were available, rather than the final residue value as per USEPA (1996a) and Suter and Tsao (1996). The use of final or secondary chronic values is intended to protect ecological receptors from direct exposures to chemicals in surface water, rather than from exposure via food webs. Potential risks to upper trophic level receptors from food web exposures (tissue residues) will be evaluated separately using the ingestion-based TRVs outlined in Section 1.2.2.3.

In general, fresh water values will not be extrapolated to marine habitats and vice versa. However, such extrapolations may be considered on a site-specific basis and, if done, will be documented in the site-specific ERA interim deliverable.

Freshwater ESV sources were as follows:

- Puerto Rico water quality standards (PREQB, 2003) for aquatic life (human health-based values are not considered).
- National Ambient Water Quality Criteria (NAWQC) (USEPA, 2009b; USEPA, 2006a).
- EcoTox thresholds (USEPA, 1996a). EcoTox thresholds based upon 1994 ORNL values were not used if a 1996 ORNL value was available for a chemical.
- Oak Ridge National Laboratory (ORNL) surface water screening benchmarks (Suter and Tsao, 1996).
- National Oceanic and Atmospheric Administration (NOAA) SQuiRTs (Buchman, 2008) for other values not included in the above-listed sources (New Zealand-based values from this source were not used).
- Other relevant studies or sources from the literature for multiple chemical groups (e.g., Environment Canada compendium values [MacDonald et al., 1999]) and for explosives (e.g., Talmage et al., 1999; LANL, 2008).
- USEPA's ECOTOX database (http://cfpub.epa.gov/ecotox) will be considered on a site-specific basis for particular detected constituents that do not have applicable values from any of the above-listed sources.

Marine/estuarine ESV sources were as follows:

- Puerto Rico water quality standards (PREQB, 2003) for aquatic life (human health-based values are not considered).
- NAWQC (USEPA, 2009b; USEPA, 2006a).
- EcoTox thresholds (USEPA, 1996a).
- NOAA SQuiRTs (Buchman, 2008) for other values not included in the above-listed sources (New Zealand-based values from this source were not used).
- Other relevant studies or sources from the literature for multiple chemical groups (e.g., Environment Canada compendium values [MacDonald et al., 1999]) and for explosives (e.g., Nipper et al., 2001; 2002).
- USEPA's ECOTOX database (http://cfpub.epa.gov/ecotox) will be considered on a site-specific basis for particular detected constituents that do not have applicable values from any of the above-listed sources.

Freshwater ESVs for several divalent metals require site-specific adjustment based upon water hardness. If available, measured hardness values from individual water bodies will be used for this adjustment. If not, hardness will be calculated based upon existing surface water analytical samples using the following formula (Franson, 1992):

$$Hardness = 2.497\ (Ca) + 4.118\ (Mg)$$

where: Ca = Mean total calcium surface water concentration (mg/L)
Mg = Mean total magnesium surface water concentration (mg/L)

The selected ESVs for surface water are shown in Tables 12 (freshwater) and 13 (marine). Hardness-adjusted surface water ESVs are shown at a hardness of 100 mg/L and pH-adjusted surface water ESVs are shown at a pH of 7.8. Site-specific hardness and pH will be used, as appropriate to each evaluation, to derive site-specific ESVs for these chemicals.

### Sediment

For sediment, available ESVs were generally based upon two approaches. The first approach relied on studies that correlate chemical concentrations in sediment with some measure of benthic community impairment. This approach is known as the Screening Level Concentration (SLC) approach. Examples are ER-L and LEL values. Since these ESVs do not consider site-specific bioavailability and correlate effects to each individual chemical without accounting for the possible effects that might be produced by other chemicals present in the sediment samples used to develop the value, their use tends to result in conservative risk estimates. The second approach, equilibrium partitioning (EqP), is appropriate for developing sediment ESVs for non-ionic (non-polar) organic chemicals (USEPA, 1993b; 1996a). The use of this method with polar organic compounds is not proposed since it tends to result in a value that is overly conservative (Jones et al., 1997). Use of this approach is also not appropriate for sediments with less than 0.2 percent total organic carbon (TOC). Examples of ESVs developed for non-polar organic chemicals using EqP include ORNL sediment benchmarks and most of the USEPA EcoTox thresholds for organic chemicals. In general, SLC-based sediment ESVs will be used to conduct the sediment screening. EqP-based values will be used to estimate chemical bioavailability and will also be used to address chemicals without SLC-based ESVs in Step 3A.

Equilibrium partitioning values are calculated using the following formula (USEPA, 1996a; 1999):

$$Value = (f_{oc})\ (K_{oc})\ (FCV)$$

where: Value = Equilibrium partitioning-based value (µg/kg)
$f_{oc}$ = Total organic carbon content (percent, as a fraction)
$K_{oc}$ = Normalized adsorption coefficient (L/kg)
FCV = Chronic AWQC or its equivalent (µg/L)

If available, measured total organic carbon (TOC or $f_{oc}$) values from individual water bodies will be used in the ERA. If site-specific values are not available, a default value of one percent will be used (USEPA, 1996a). $K_{oc}$ values were estimated from octanol-water partitioning coefficient ($K_{ow}$) values using the formula from USEPA (1996a):

$$Log_{10}K_{oc} = 0.00028 + 0.983\ (Log_{10}K_{ow})$$

In general, fresh water values will not be extrapolated to marine habitats and vice versa. However, such extrapolations may be considered on a site-specific basis and, if done, will be documented in the site-specific ERA interim deliverable.

Freshwater sediment ESV sources were as follows:

- Freshwater sediment consensus values (MacDonald et al., 2000a).
- EcoTox thresholds (USEPA, 1996a).
- Numerical sediment quality assessment guidelines for Florida inland waters (MacDonald et al., 2003).
- Ontario sediment quality criteria (Persaud et al., 1993).
- Canadian sediment quality guidelines for the protection of aquatic life (CCME, 2002).
- Sediment Effect Concentrations (SECs) (Ingersoll et al., 1996).
- NOAA SQuiRTs (Buchman, 2008) for other values not included in the above-listed sources.
- ORNL sediment screening benchmarks (Jones et al., 1997) and other EqP-based sediment benchmarks for organic chemicals (e.g., DiToro and McGrath, 2000; USEPA, 2008b).
- Other relevant studies or sources from the literature for multiple chemical groups (e.g., Environment Canada compendium values [MacDonald et al., 1999]) and for explosives (e.g., Talmage et al., 1999; LANL, 2008).

Marine/estuarine sediment ESV sources were as follows:

- Effects range–low (ER-L) values (Long et al., 1995). Older ER-L values (Long and Morgan, 1990) were considered on a chemical-by-chemical basis in relation to other available values.
- EcoTox thresholds (USEPA, 1996a).
- Numerical sediment quality assessment guidelines for Florida coastal waters (MacDonald et al., 1994).
- Canadian sediment quality guidelines for the protection of aquatic life (CCME, 2002).
- NOAA SQuiRTs (Buchman, 2008) for other values not included in the above-listed sources. Some apparent effects thresholds (AETs) from this source were not used (e.g., Washington State values) as reported; values from the original reference were used in their place.
- Equilibrium partitioning sediment benchmarks for organic chemicals (e.g., DiToro and McGrath, 2000; USEPA, 2008b).
- Other relevant studies or sources from the literature for multiple chemical groups (e.g., Environment Canada compendium values [MacDonald et al., 1999]) and for explosives (e.g., Nipper et al., 2001; 2002).

The selected SLC-based ESVs for sediment are shown in Tables 14 (freshwater) and 15 (marine) and EqP-based ESVs from the literature are shown in Tables 16 (freshwater) and 17 (marine). The derivation (calculation) of EqP-based sediment values for chemicals not listed in Tables 16 and 17 will be conducted, where available data allow, on a site-specific basis as part of the site-specific ERA interim deliverable. TOC-adjusted sediment ESVs are shown at a TOC of one percent. Site-specific TOC values will be used, as appropriate to each evaluation, to derive site-specific ESVs for these chemicals.

#### Surface Soil

Surface soil ESV sources were as follows:

- Lowest-available of the Ecological Soil Screening Levels (Eco-SSLs) for plants and soil invertebrates (USEPA, multiple dates). Bird and mammal Eco-SSLs will be used in a pre-screening step prior to food web modeling (food web modeling will be conducted in parallel with media screening) as described in Section 1.2.2.3.
- Toxicological benchmarks for effects to terrestrial plants (Efroymson et al., 1997a) and toxicological benchmarks for effects to soil and litter invertebrates (Efroymson et al., 1997b). In some cases, reported values were modified to conform to the uncertainty factors listed in Table 11.
- Canadian soil quality guidelines for the protection of environmental and human health (CCME, 2007). Soil quality guideline (SQG) values were used where reported. Interim Remediation Criteria (IRC) for residential/parkland were also considered on a case-by-case basis.
- Intervention values and target values - soil quality standards (MHSPE, 2000; 2001).
- U.S. Fish and Wildlife soil screening values (Beyer, 1990). B values ("moderate soil contamination") from this reference were selected since they generally conform to IRC values from CCME (2007) and represented a reasonable compromise between background (A values) and remediation criteria (C values).
- Other relevant studies or sources from the literature (e.g., Talmage et al. [1999] and LANL [2008] for explosive compounds).

The selected ESVs for surface soil are shown in Table 18.

### 1.2.2.3 Ingestion TRVs

TRVs were derived for both mammalian and avian upper trophic level receptors, the only two taxonomic groups for which sufficient toxicological information was generally available for the range of bioaccumulative chemicals evaluated. Toxicological information from the literature for wildlife species most closely related to the receptor species were used, where available, but were supplemented by laboratory studies of non-wildlife species (e.g., laboratory mice) where necessary. The ingestion TRVs are expressed as milligrams of the chemical per kilogram body weight of the receptor per day (mg/kg-BW/day).

Survival, growth, and reproduction were emphasized as toxicological endpoints because they are the most relevant, ecologically, to maintaining viable populations and because they are generally the most studied toxicological endpoints for ecological receptors. Endpoints based upon reproduction were generally preferred to those based upon growth which were preferred to those based upon survival. If several chronic toxicological studies were available from the literature, the most appropriate study was selected for each receptor species based upon study design, study methodology, study duration, study endpoint, and test species.

Ingestion TRVs were derived for both chronic NOAEL and chronic LOAEL endpoints. The applicable uncertainty factors from Table 11 were applied to derive these TRVs where it was applicable (uncertainty factors were not generally applied to TRVs obtained from Eco-SSL

documents because these TRVs often encompassed multiple studies). Maximum Acceptable Toxicant Concentrations (MATCs), defined as the geometric mean of the NOAEL and LOAEL, were also calculated. For terrestrial habitats, bird and mammal Eco-SSLs will be considered as part of a "pre-screen" (see Section 1.2.3). These Eco-SSLs are listed in Table 19. Ingestion TRVs for mammals and birds are summarized in Tables 20 and 21, respectively.

### 1.2.3 Risk Characterization

The risk characterization portion of the ERA uses the information generated during the three previous parts of the ERA (problem formulation, exposure assessment, and effects assessment) to estimate potential risks to ecological receptors at the level of conservatism applied (screening or baseline). Also included is an evaluation of the uncertainties associated with the models, assumptions, and methods used in the ERA, and their potential effects on the conclusions of the assessment.

#### SERA Approach

The main objective of risk characterization at the screening level (termed risk calculation) is to derive a list of COPCs. As part of this risk calculation, the maximum exposure concentrations (abiotic media) or maximum exposure doses (upper trophic level receptors) are compared with the corresponding ESVs or TRVs to derive risk estimates using the hazard quotient (HQ) method. HQs are calculated by dividing the chemical concentration in the medium being evaluated by the corresponding medium-specific ESV or by dividing the exposure dose by the corresponding ingestion-based TRV. HQs equaling or exceeding one indicate the potential for unacceptable risk since the chemical concentration or dose (exposure) equals or exceeds the ESV or TRV (effect); these chemicals are identified as COPCs at Step 2. However, ESVs/TRVs and exposure estimates are derived using intentionally conservative assumptions at the screening level such that HQs greater than or equal to one do not necessarily indicate that unacceptable risks are present. Rather, it identifies chemical-pathway-receptor combinations requiring further evaluation using more realistic exposure scenarios and assumptions. Following the same reasoning, HQs less than one indicate that unacceptable risks are unlikely, enabling a conclusion of negligible (acceptable) risk to be reached with high confidence.

In addition to chemicals that exceed medium-specific ESVs based upon maximum detected concentrations, or that exceed TRVs based upon maximum ingestion doses, the following will also apply to COPC selection at Step 2:

- Non-detected chemicals will be retained as COPCs if the maximum detection limit exceeds the ESV for that medium or if the ingestion dose calculated using the maximum detection limit exceeds the TRV.
- All detected chemicals lacking a TRV and/or ESV will be retained as COPCs.
- The essential nutrients calcium, magnesium, potassium, and sodium will be excluded as potential COPCs since they are essential macronutrients that are needed in relatively high concentrations for normal metabolism, growth, and reproduction.
- In terrestrial habitats, food web COPCs will be selected by first comparing maximum soil concentrations with the lower of the available bird and mammal Eco-SSLs (Table 19). Chemicals that exceed the Eco-SSLs based upon the maximum soil concentration will be retained for site-specific food web modeling. Those that do not will not be evaluated further

for terrestrial food web exposures. The final food web COPCs will be selected based upon a comparison of maximum exposure doses from site-specific food web modeling with the NOAEL-based ingestion TRV. Those chemicals with an exposure dose exceeding the NOAEL-based ingestion TRV will be identified as COPCs.

### BERA Approach

COPCs from the SERA are reevaluated in the first step of the BERA (Step 3A). As discussed previously, this reevaluation involves using more realistic assumptions about exposures and a comparison of these revised exposure estimates (based upon central tendency estimates of media concentrations, BAFs, and exposure parameters) with ESVs and TRVs.

In addition to chemicals that exceed medium-specific ESVs based upon mean detected concentrations, or that exceed TRVs based upon mean ingestion doses, the following will also apply to COPC selection at Step 3A:

- All detected chemicals lacking a TRV and/or ESV will be retained as COPCs for risk evaluation.
- Ingestion-based (food web) COPCs will be based upon a comparison of mean and 95% UCL exposure doses with ingestion TRVs based upon the NOAEL, MATC, and LOAEL. An exceedance of the MATC will generally be considered an unacceptable effect at Step 3A although chemicals that exceed the MATC, but not the LOAEL, will be discussed for possible risk management considerations.

For Step 3A, the following additional factors will also be considered, as appropriate:

- **Frequency of Detection.** Chemicals that are detected in less than five percent of the samples in a medium will generally be eliminated as COPCs in that medium if at least 20 samples are available (USEPA, 1989). It is unlikely that infrequently detected chemicals represent an unacceptable risk to receptors at the population level, due to limited spatial exposure. However, a qualitative evaluation will be conducted to insure that "hot spot" areas are not eliminated from consideration based upon this screening criterion before a chemical is eliminated from further consideration.
- **Bioavailability.** If data are available, site-specific measures of bioavailability will also be considered in Step 3. These include, for sediment, acid volatile sulfides/simultaneously extracted metals (AVS/SEM), TOC, grain size, and pH; for soil, TOC, grain size, cation exchange capacity (CEC), and pH; and for surface water, hardness, pH, dissolved metal concentrations, and dissolved organic carbon (DOC). Differences in chemical speciation (e.g., inorganic versus methyl mercury, trivalent versus hexavalent chromium, total versus free cyanide) will also be considered.
- **Vieques-Wide Background Concentrations.** Vieques-specific background concentrations from the East Vieques and West Vieques background studies (CH2M HILL, 2007; 2002) will also be considered in the reevaluation for surface soil. The initial background evaluation will be a direct comparison of site surface soil concentrations to the upper tolerance limits (UTLs) developed for inorganics in the background study, or that have been developed for pesticides as part of various site-specific evaluations (CH2M HILL, 2009a; 2009b) using available facility-wide surface soil data (Table 22), in a manner analogous to the comparison to ESVs. Background considerations for dioxins/furans and PAHs will be addressed on a

site-specific basis, as appropriate. More robust statistical methods may be proposed on a site-specific basis, as needed. Note that background may be included along with ESV comparisons in SI-types of ecological screening, like was done for the East Vieques PA/SI Report (CH2M HILL, June 2008).

- **Site-Specific Background Concentrations**. Surface water and sediment concentrations from locations that are hydrologically upgradient of a specific site, or not otherwise potentially influenced by site-specific or other point releases, may also be considered as part of the BERA evaluation, where available. This evaluation will involve, depending upon the available sample size, either a qualitative comparison of concentrations (i.e., calculation of ratios based upon mean and maximum concentrations from the respective data sets) or a quantitative statistical comparison of site-specific concentration distributions with site-specific background concentration distributions.

### 1.2.4 Uncertainties

Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. In addition, the use of various models (e.g., uptake and food web exposures) carries with it some associated uncertainty as to how well the model reflects actual conditions. Since conservative assumptions will generally be used in the exposure and effects assessments, these uncertainties are more likely to result in an overestimation rather than an underestimation of the likelihood and magnitude of risks to ecological receptors. Sources of uncertainty, and their potential effects on the conclusions of the risk assessment, will be addressed in each site-specific ERA document.

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FIGURE 1 USEPA EIGHT-STEP ECOLOGICAL RISK ASSESSMENT PROCESS FOR SUPERFUND

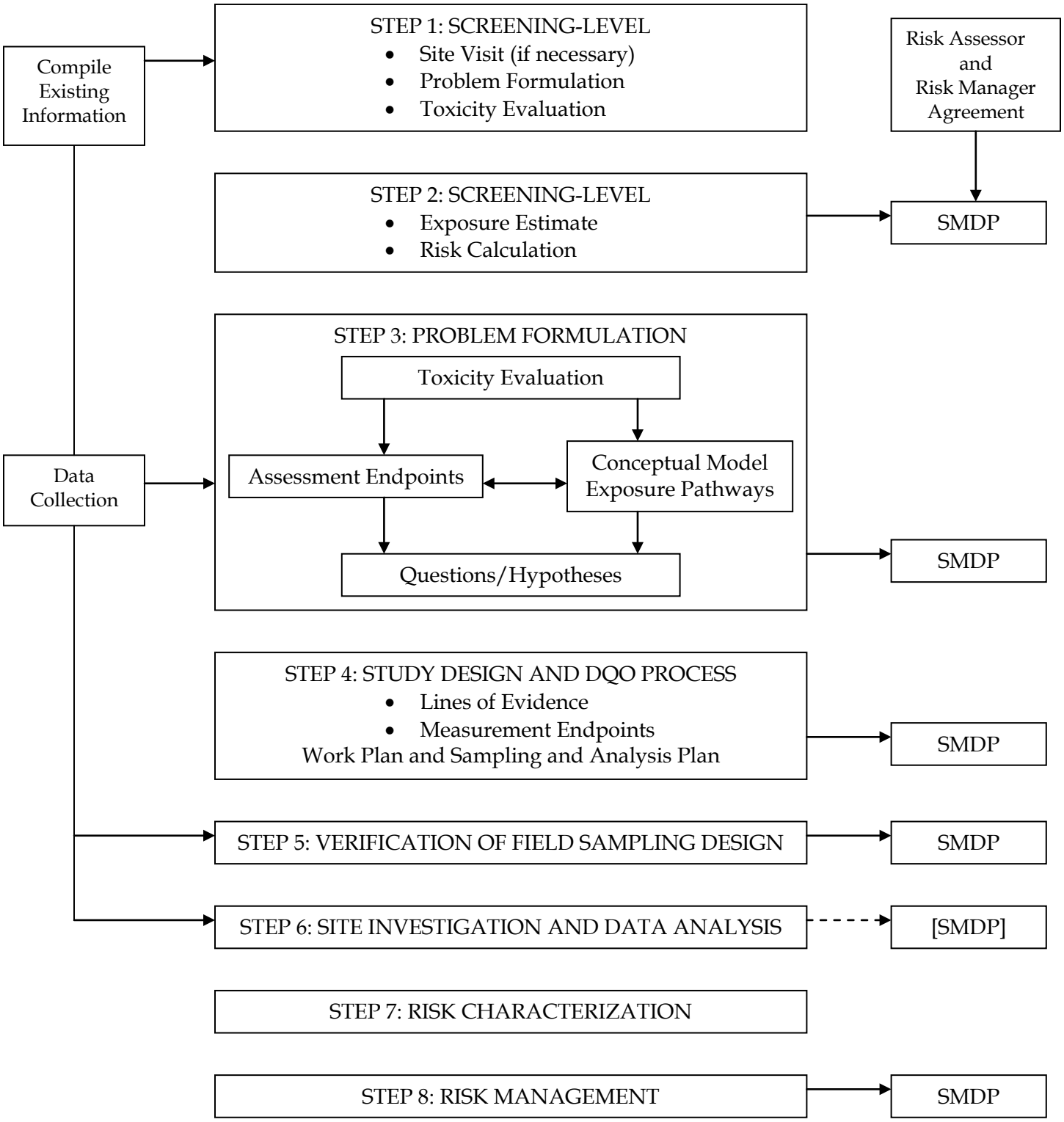
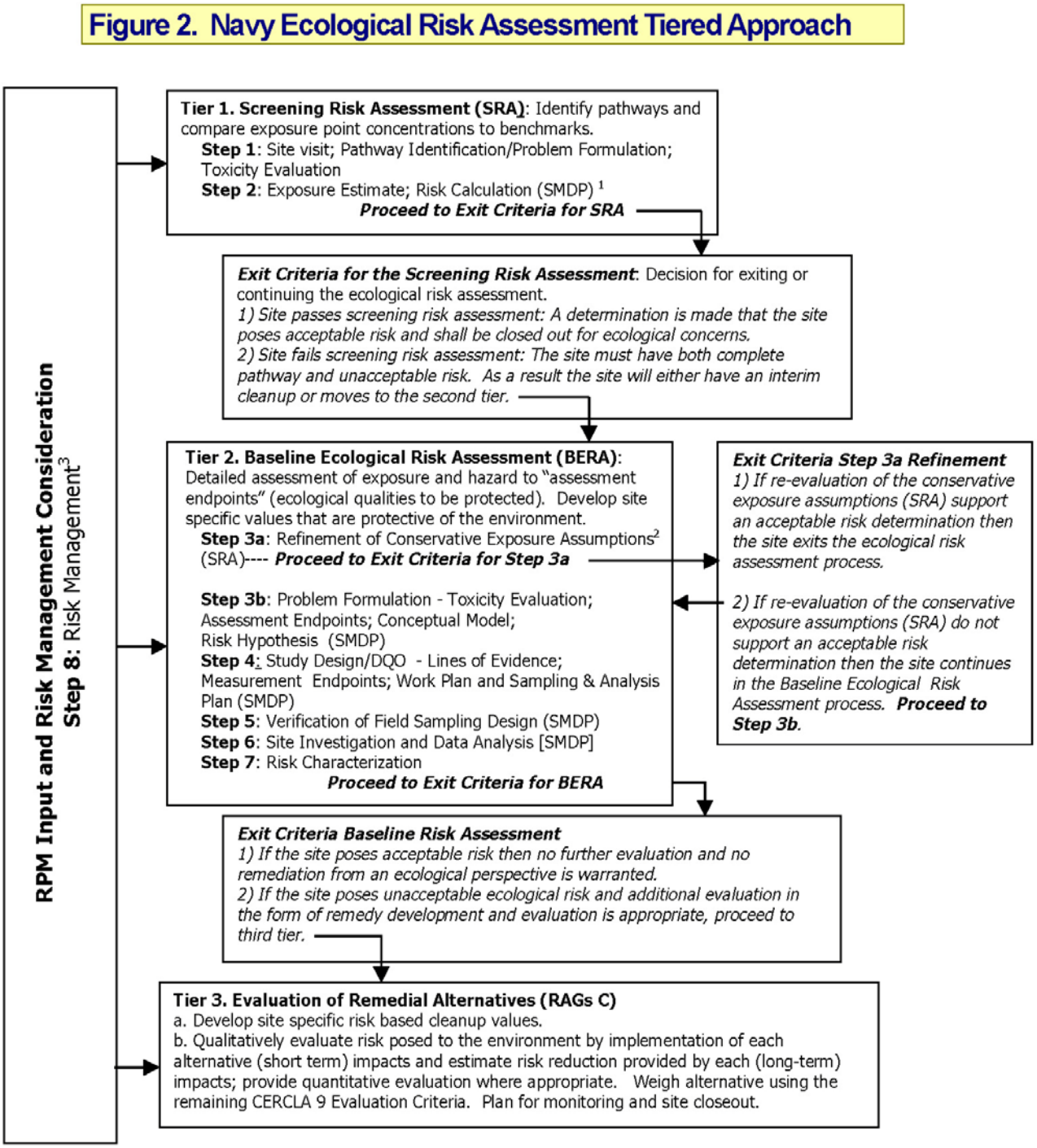


FIGURE 2 NAVY ECOLOGICAL RISK ASSESSMENT TIERED APPROACH




Notes: 1) See EPA's 8 Step ERA Process for requirements for each Scientific Management Decision Point (SMDP).
2) Refinement includes but is not limited to background, bioavailability, detection frequency, etc.
3) Risk Management is incorporated throughout the tiered approach.

Table 1
Summary of the Ecological Risk Assessment Process
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Step | Description | Decision Required |
|---|---|---|
| 1 | Screening Problem Formulation | Complete exposure pathways exist? Sufficient data available to conduct screen? |
| 2 | Screening Ecological Effects Evaluation, Exposure Estimate, and Risk Calculation | Have all assessment endpoints been met (risks acceptable) within acceptable uncertainty? Continue on to Baseline ERA? |
| 3A | Refinement of Conservative Exposure Assumptions | Have all assessment endpoints been met (risks acceptable) within acceptable uncertainty? |
| 3B | Baseline Problem Formulation | Agreement on problem formulation and need for additional studies |
| 4 | Study Design and Data Quality Objectives | Agreement on study design, data quality objectives, and data analysis methods |
| 5 | Field Verification of Sampling Design | Approval of site-specific work plan and sampling and analysis plan |
| 6 | Site Investigation and Data Analysis | None |
| 7 | Risk Characterization | Have all assessment endpoints been met (risks acceptable) within acceptable uncertainty? |
| 8 | Risk Management | Agreement on remedial actions (in FS/ROD) |

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Table 2
Bioaccumulative Chemicals List and Log $K_{ow}$ Values
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | CAS Number | "Standard" Facility Analyte? | Log $K_{ow}$ Range | Selected log $K_{ow}$ | Reference |
|---|---|---|---|---|---|
| Metals | | | | | |
| Antimony[1] | 7440-36-0 | Yes | -- - -- | -- | -- |
| Arsenic | 7440-38-2 | Yes | -- - -- | -- | -- |
| Barium[1] | 7440-39-3 | Yes | -- - -- | -- | -- |
| Beryllium[1] | 7440-41-7 | Yes | -- - -- | -- | -- |
| Cadmium | 7440-43-9 | Yes | -- - -- | -- | -- |
| Chromium[2] | 7440-47-3 | Yes | -- - -- | -- | -- |
| Cobalt[1] | 7440-48-4 | Yes | -- - -- | -- | -- |
| Copper | 7440-50-8 | Yes | -- - -- | -- | -- |
| Lead | 7439-92-1 | Yes | -- - -- | -- | -- |
| Manganese[1] | 7439-96-5 | Yes | -- - -- | -- | -- |
| Mercury[3] | 7439-97-6 | Yes | -- - -- | -- | -- |
| Nickel | 7440-02-0 | Yes | -- - -- | -- | -- |
| Selenium | 7782-49-2 | Yes | -- - -- | -- | -- |
| Silver | 7440-22-4 | Yes | -- - -- | -- | -- |
| Tributyltin | 56-35-9 | No | -- - -- | -- | -- |
| Vanadium[1] | 7440-62-2 | Yes | -- - -- | -- | -- |
| Zinc | 7440-66-6 | Yes | -- - -- | -- | -- |
| Polychlorinated Biphenyls[4] | | | | | |
| Aroclor-1016 | 12674-11-2 | Yes | Not reported | 5.60 | Sample et al. 1996 |
| Aroclor-1221 | 11104-28-2 | Yes | Not reported | 4.70 | Jones et al. 1997 |
| Aroclor-1232 | 11141-16-5 | Yes | Not reported | 5.10 | Jones et al. 1997 |
| Aroclor-1242 | 53469-21-9 | Yes | Not reported | 5.60 | Jones et al. 1997 |
| Aroclor-1248 | 12672-29-6 | Yes | Not reported | 6.20 | Jones et al. 1997 |
| Aroclor-1254 | 11097-69-1 | Yes | Not reported | 6.50 | Jones et al. 1997 |
| Aroclor-1260 | 11096-82-5 | Yes | Not reported | 6.80 | Jones et al. 1997 |
| Aroclor-1268 | 11100-14-4 | No | -- - -- | -- | -- |

Table 2
Bioaccumulative Chemicals List and Log $K_{ow}$ Values
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | CAS Number | "Standard" Facility Analyte? | Log $K_{ow}$ Range | Selected log $K_{ow}$ | Reference |
|---|---|---|---|---|---|
| Pesticides | | | | | |
| 4,4'-DDD | 72-54-8 | Yes | 5.90 - 6.65 | 6.10 | USEPA 1995a |
| 4,4'-DDE | 72-55-9 | Yes | 5.63 - 6.96 | 6.76 | USEPA 1995a |
| 4,4'-DDT | 50-29-3 | Yes | 5.56 - 7.01 | 6.53 | USEPA 1995a |
| Aldrin | 309-00-2 | Yes | 5.11 - 7.50 | 6.50 | USEPA 1995a |
| alpha-BHC | 319-84-6 | Yes | 3.75 - 3.81 | 3.80 | USEPA 1995a |
| alpha-Chlordane[5] | 5103-71-9 | Yes | 5.80 - 6.41 | 6.32 | USEPA 1995a |
| beta-BHC | 319-85-7 | Yes | 3.75 - 3.84 | 3.81 | USEPA 1995a |
| Chlorpyrifos | 2921-88-2 | No | -- - -- | -- | -- |
| delta-BHC | 319-86-8 | Yes | Not reported | 4.10 | USEPA 1996b |
| Diazinon | 333-41-5 | No | -- - -- | -- | -- |
| Dicofol | 115-32-2 | No | -- - -- | -- | -- |
| Dieldrin | 60-57-1 | Yes | 3.63 - 6.20 | 5.37 | USEPA 1995a |
| Disulfoton | 298-04-4 | No | -- - -- | -- | -- |
| Endosulfan I | 959-98-8 | Yes | 3.55 - 3.85 | 3.83 | USEPA 1995a |
| Endosulfan II | 33213-65-9 | Yes | 3.62 - 4.52 | 4.52 | USEPA 1995a |
| Endrin | 72-20-8 | Yes | 2.92 - 5.20 | 5.06 | USEPA 1995a |
| Ethion | 563-12-2 | No | -- - -- | -- | -- |
| Ethalfluralin | 55283-68-6 | No | -- - -- | -- | -- |
| gamma-BHC (Lindane) | 58-89-9 | Yes | 3.61 - 3.90 | 3.73 | USEPA 1995a |
| gamma-Chlordane[5] | 5103-74-2 | Yes | 5.80 - 6.41 | 6.32 | USEPA 1995a |
| Heptachlor | 76-44-8 | Yes | 4.93 - 6.26 | 6.26 | USEPA 1995a |
| Heptachlor epoxide | 1024-57-3 | Yes | 3.50 - 5.40 | 5.00 | USEPA 1995a |
| Methoxychlor | 72-43-5 | Yes | 4.20 - 5.60 | 5.08 | USEPA 1995a |
| Mirex | 2385-85-5 | No | -- - -- | -- | -- |
| Nitrofen | 1836-75-5 | No | -- - -- | -- | -- |
| Oxyfluorfen | 42874-03-3 | No | -- - -- | -- | -- |
| Pentachloronitrobenzene | 82-68-8 | No | -- - -- | -- | -- |
| Permethrin | 52645-53-1 | No | -- - -- | -- | -- |
| S-Fenvalerate | 66230-04-4 | No | -- - -- | -- | -- |

Table 2
Bioaccumulative Chemicals List and Log $K_{ow}$ Values
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | CAS Number | "Standard" Facility Analyte? | Log $K_{ow}$ Range | Selected log $K_{ow}$ | Reference |
|---|---|---|---|---|---|
| Terbufos | 13071-79-9 | No | -- - -- | -- | -- |
| Toxaphene | 8001-35-2 | Yes | 4.33 - 5.56 | 5.50 | USEPA 1995a |
| Trifluralin | 1582-09-8 | No | -- - -- | -- | -- |
| Volatile and Semivolatile Organic Compounds | | | | | |
| 1,1,1,2-Tetrachloroethane[6] | 630-20-6 | No | -- - -- | -- | -- |
| 1,1,2,2-Tetrachloroethane[6] | 79-34-5 | Yes | 2.31 - 2.64 | 2.39 | USEPA 1995a |
| 1,2,3,4-Tetrachlorobenzene | 634-66-2 | No | -- - -- | -- | -- |
| 1,2,4,5-Tetrachlorobenzene | 95-94-3 | Yes | 4.51 - 4.83 | 4.64 | USEPA 1995a |
| 1,2,4-Trichlorobenzene | 120-82-1 | Yes | 3.89 - 4.23 | 4.01 | USEPA 1995a |
| 1,2-Dichlorobenzene | 95-50-1 | Yes | 3.20 - 3.61 | 3.43 | USEPA 1995a |
| 1,3-Dichlorobenzene | 541-73-1 | Yes | Not reported | 3.50 | USEPA 1996b |
| 1,4-Dichlorobenzene | 106-46-7 | Yes | 3.26 - 3.62 | 3.42 | USEPA 1995a |
| 4-Bromophenyl-phenylether | 101-55-3 | Yes | 4.89 - 5.24 | 5.00 | USEPA 1995a |
| 4-Chlorophenyl-phenylether | 7005-72-3 | Yes | 4.08 - 5.09 | 4.95 | USEPA 1995a |
| Acenaphthene | 83-32-9 | Yes | 3.77 - 4.49 | 3.92 | USEPA 1995a |
| Acenaphthylene | 208-96-8 | Yes | Not reported | 4.10 | USEPA 1996b |
| Anthracene | 120-12-7 | Yes | 4.44 - 4.80 | 4.55 | USEPA 1995a |
| Benzo(a)anthracene | 56-55-3 | Yes | 5.61 - 5.79 | 5.70 | USEPA 1995a |
| Benzo(a)pyrene | 50-32-8 | Yes | 5.98 - 6.34 | 6.11 | USEPA 1995a |
| Benzo(b)fluoranthene | 205-99-2 | Yes | 5.79 - 6.40 | 6.20 | USEPA 1995a |
| Benzo(g,h,i)perylene | 191-24-2 | Yes | 6.58 - 7.05 | 6.70 | USEPA 1995a |
| Benzo(k)fluoranthene | 207-08-9 | Yes | 6.12 - 6.27 | 6.20 | USEPA 1995a |
| Chrysene | 218-01-9 | Yes | 5.41 - 5.79 | 5.70 | USEPA 1995a |
| Dibenz(a,h)anthracene | 53-70-3 | Yes | 6.50 - 6.88 | 6.69 | USEPA 1995a |
| Fluoranthene | 206-44-0 | Yes | 4.84 - 5.39 | 5.12 | USEPA 1995a |
| Fluorene | 86-73-7 | Yes | 4.04 - 4.40 | 4.21 | USEPA 1995a |
| Hexachlorobenzene | 118-74-1 | Yes | 5.23 - 6.92 | 5.89 | USEPA 1995a |
| Hexachlorobutadiene | 87-68-3 | Yes | 4.74 - 5.16 | 4.81 | USEPA 1995a |
| Hexachlorocyclopentadiene | 77-47-4 | Yes | 5.05 - 5.51 | 5.39 | USEPA 1995a |

Table 2
Bioaccumulative Chemicals List and Log $K_{ow}$ Values
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | CAS Number | "Standard" Facility Analyte? | Log $K_{ow}$ Range | Selected log $K_{ow}$ | Reference |
|---|---|---|---|---|---|
| Hexachloroethane | 67-72-1 | Yes | 3.82 - 4.14 | 4.00 | USEPA 1995a |
| Indeno(1,2,3-cd)pyrene | 193-39-5 | Yes | 6.58 - 6.72 | 6.65 | USEPA 1995a |
| Octachlorostyrene | 29082-74-4 | No | -- - -- | -- | -- |
| Pentachloroanisole | 1825-21-4 | No | -- - -- | -- | -- |
| Pentachlorobenzene | 608-93-5 | No | -- - -- | -- | -- |
| Pentachlorophenol | 87-86-5 | Yes | 5.01 - 5.24 | 5.09 | USEPA 1995a |
| Phenanthrene | 85-01-8 | Yes | 4.37 - 4.57 | 4.55 | USEPA 1995a |
| Pyrene | 129-00-0 | Yes | 4.76 - 5.52 | 5.11 | USEPA 1995a |
| Dioxins/Furans | | | | | |
| 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 35822-46-9 | No | -- - -- | -- | -- |
| 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 39227-28-6 | No | -- - -- | -- | -- |
| 1,2,3,4,7,8-Hexachlorodibenzofuran | 70648-26-9 | No | -- - -- | -- | -- |
| 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 57653-85-7 | No | -- - -- | -- | -- |
| 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 40321-76-4 | No | -- - -- | -- | -- |
| 1,2,3,7,8-Pentachlorodibenzofuran | 57117-41-6 | No | -- - -- | -- | -- |
| 2,3,4,7,8-Pentachlorodibenzofuran | 57117-31-4 | No | -- - -- | -- | -- |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | 1746-01-6 | No | -- - -- | -- | -- |
| 2,3,7,8-Tetrachlorodibenzofuran | 51207-31-9 | No | -- - -- | -- | -- |
| Explosives[7] | | | | | |
| 1,3,5-Trinitrobenzene | 99-35-4 | Yes | 1.18 - 1.37 | 1.18 | USEPA 1995a |
| 1,3-Dinitrobenzene | 99-65-0 | Yes | 1.49 - 1.63 | 1.50 | USEPA 1995a |
| 2,4,6-Trinitrotoluene | 118-96-7 | Yes | 1.60 - 2.70 | 2.09 | Talmage et al. 1999 |
| 2,4-Dinitrotoluene | 121-14-2 | Yes | 1.98 - 2.05 | 2.01 | USEPA 1995a |
| 2,6-Dinitrotoluene | 606-20-2 | Yes | 1.72 - 2.03 | 1.87 | USEPA 1995a |
| 2-Amino-4,6-dinitrotoluene | 35572-78-2 | Yes | -- - -- | 1.84 | SRC 2003 (estimated) |
| 2-Nitrotoluene | 88-72-7 | Yes | -- - -- | 2.30 | SRC 2003 |
| 3-Nitrotoluene | 99-08-1 | Yes | -- - -- | 2.45 | SRC 2003 |
| 4-Amino-2,6-dinitrotoluene | 19406-51-0 | Yes | -- - -- | 1.84 | SRC 2003 (estimated) |
| 4-Nitrotoluene | 99-99-0 | Yes | -- - -- | 2.37 | SRC 2003 |

Table 2
Bioaccumulative Chemicals List and Log $K_{ow}$ Values
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | CAS Number | "Standard" Facility Analyte? | Log $K_{ow}$ Range | Selected log $K_{ow}$ | Reference |
|---|---|---|---|---|---|
| HMX | 2691-41-0 | Yes | 0.06 - 0.26 | 0.15 | Talmage et al. 1999 |
| Nitrobenzene | 98-95-3 | Yes | 1.70 - 2.12 | 1.84 | USEPA 1995a |
| Perchlorate | 14797-73-0 | Yes | -- - -- | -5.84 | SRC 2003 (estimated) |
| RDX | 121-82-4 | Yes | 0.81 - 0.87 | 0.85 | Talmage et al. 1999 |
| Tetryl | 479-45-8 | Yes | -- - -- | 1.64 | SRC 2003 (estimated) |

[1] Terrestrial habitats (soils) only (see text)
[2] Listed as chromium VI but applied to total chromium
[3] Listed as methylmercury but applied to total mercury
[4] PCB congeners 8, 18, 28, 44, 52, 66, 77, 81, 101, 105, 118, 126, 128, 138, 153, 156, 169, 170, 180, 187, 195, 206, and 209 are also listed in USEPA (2000)
[5] Listed as "chlordane"
[6] Listed as "tetrachloroethane"
[7] Not on bioaccumulative chemicals list but detected explosives will also be evaluated on a site-specific basis

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Table 3
Soil Bioconcentration Factors For Plants (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| Metals | | | | | | |
| Antimony | 0.011 | 90th percentile | Bechtel Jacobs 1998a (Table D-1) | 0.010 | Median | Bechtel Jacobs 1998a (Table D-1) |
| Arsenic | 1.103 | 90th percentile | Bechtel Jacobs 1998a (Table 6) | 0.037 | Geometric mean | Bechtel Jacobs 1998a (Table 6) |
| Barium | 0.477 | 90th percentile | Bechtel Jacobs 1998a (Table D-1) | 0.154 | Geometric mean | Bechtel Jacobs 1998a (Table D-1) |
| Beryllium | 0.010 | Geometric mean | Baes et al. 1984 (Figure 2.1) | 0.010 | Geometric mean | Baes et al. 1984 (Figure 2.1) |
| Cadmium | 3.250 | 90th percentile | Bechtel Jacobs 1998a (Table 6) | 0.586 | Median | Bechtel Jacobs 1998a (Table 6) |
| Chromium | 0.084 | 90th percentile | Bechtel Jacobs 1998a (Table D-1) | 0.041 | Median | Bechtel Jacobs 1998a (Table D-1); USEPA 2007j (Table 4a) |
| Cobalt | 0.025 | 90th percentile | Bechtel Jacobs 1998a (Table D-1) | 0.008 | Geometric mean | Bechtel Jacobs 1998a (Table D-1) |
| Copper | 0.625 | 90th percentile | Bechtel Jacobs 1998a (Table 6) | 0.123 | Geometric mean | Bechtel Jacobs 1998a (Table 6) |
| Lead | 0.468 | 90th percentile | Bechtel Jacobs 1998a (Table 6) | 0.039 | Median | Bechtel Jacobs 1998a (Table 6) |
| Manganese | 0.234 | 90th percentile | Bechtel Jacobs 1998a (Table D-1) | 0.081 | Geometric mean | Bechtel Jacobs 1998a (Table D-1) |
| Mercury | 5.000 | 90th percentile | Bechtel Jacobs 1998a (Table 6) | 0.652 | Median | Bechtel Jacobs 1998a (Table 6) |
| Nickel | 1.411 | 90th percentile | Bechtel Jacobs 1998a (Table 6) | 0.018 | Median | Bechtel Jacobs 1998a (Table 6) |
| Selenium | 3.012 | 90th percentile | Bechtel Jacobs 1998a (Table 6) | 0.567 | Geometric mean | Bechtel Jacobs 1998a (Table 6) |

Table 3
Soil Bioconcentration Factors For Plants (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| Silver | 0.037 | 90th percentile | Bechtel Jacobs 1998a (Table D-1) | 0.014 | Median | Bechtel Jacobs 1998a (Table D-1); USEPA 2007j (Table 4a) |
| Vanadium | 0.010 | 90th percentile | Bechtel Jacobs 1998a (Table D-1) | 0.005 | Geometric mean | Bechtel Jacobs 1998a (Table D-1) |
| Zinc | 1.820 | 90th percentile | Bechtel Jacobs 1998a (Table 6) | 0.358 | Geometric mean | Bechtel Jacobs 1998a (Table 6) |
| Pesticides | | | | | | |
| 4,4'-DDD | -- | See Table 4 | -- | -- | See Table 4 | -- |
| 4,4'-DDE | -- | See Table 4 | -- | -- | See Table 4 | -- |
| 4,4'-DDT | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Aldrin | 0.139 | Calculated[1] | USEPA 2007j (Figure 5B) | 0.139 | Calculated | USEPA 2007j (Figure 5B) |
| alpha-BHC | 1.735 | Calculated | USEPA 2007j (Figure 5B) | 1.735 | Calculated | USEPA 2007j (Figure 5B) |
| alpha-Chlordane | 0.165 | Calculated | USEPA 2007j (Figure 5B) | 0.165 | Calculated | USEPA 2007j (Figure 5B) |
| beta-BHC | 1.719 | Calculated | USEPA 2007j (Figure 5B) | 1.719 | Calculated | USEPA 2007j (Figure 5B) |
| delta-BHC | 1.311 | Calculated | USEPA 2007j (Figure 5B) | 1.311 | Calculated | USEPA 2007j (Figure 5B) |
| Dieldrin | 0.41 | Median | USEPA 2007j (Table 4b) | 0.41 | Median | USEPA 2007j (Table 4b) |
| Endosulfan I | 1.687 | Calculated | USEPA 2007j (Figure 5B) | 1.687 | Calculated | USEPA 2007j (Figure 5B) |
| Endosulfan II | 0.886 | Calculated | USEPA 2007j (Figure 5B) | 0.886 | Calculated | USEPA 2007j (Figure 5B) |
| Endrin | 0.535 | Calculated | USEPA 2007j (Figure 5B) | 0.535 | Calculated | USEPA 2007j (Figure 5B) |
| gamma-BHC (Lindane) | 1.852 | Calculated | USEPA 2007j (Figure 5B) | 1.852 | Calculated | USEPA 2007j (Figure 5B) |
| gamma-Chlordane | 0.165 | Calculated | USEPA 2007j (Figure 5B) | 0.165 | Calculated | USEPA 2007j (Figure 5B) |
| Heptachlor | 0.174 | Calculated | USEPA 2007j (Figure 5B) | 0.174 | Calculated | USEPA 2007j (Figure 5B) |
| Heptachlor epoxide | 0.566 | Calculated | USEPA 2007j (Figure 5B) | 0.566 | Calculated | USEPA 2007j (Figure 5B) |
| Methoxychlor | 0.525 | Calculated | USEPA 2007j (Figure 5B) | 0.525 | Calculated | USEPA 2007j (Figure 5B) |
| Toxaphene | 0.355 | Calculated | USEPA 2007j (Figure 5B) | 0.355 | Calculated | USEPA 2007j (Figure 5B) |
| Polychlorinated Biphenyls | | | | | | |
| Aroclor-1016 | 0.323 | Calculated | USEPA 2007j (Figure 5B) | 0.323 | Calculated | USEPA 2007j (Figure 5B) |
| Aroclor-1221 | 0.749 | Calculated | USEPA 2007j (Figure 5B) | 0.749 | Calculated | USEPA 2007j (Figure 5B) |

Table 3
Soil Bioconcentration Factors For Plants (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| Aroclor-1232 | 0.515 | Calculated | USEPA 2007j (Figure 5B) | 0.515 | Calculated | USEPA 2007j (Figure 5B) |
| Aroclor-1242 | 0.323 | Calculated | USEPA 2007j (Figure 5B) | 0.323 | Calculated | USEPA 2007j (Figure 5B) |
| Aroclor-1248 | 0.184 | Calculated | USEPA 2007j (Figure 5B) | 0.184 | Calculated | USEPA 2007j (Figure 5B) |
| Aroclor-1254 | 0.139 | Calculated | USEPA 2007j (Figure 5B) | 0.139 | Calculated | USEPA 2007j (Figure 5B) |
| Aroclor-1260 | 0.105 | Calculated | USEPA 2007j (Figure 5B) | 0.105 | Calculated | USEPA 2007j (Figure 5B) |
| Volatile and Semivolatile Organic Compounds | | | | | | |
| 1,1,2,2-Tetrachloroethane | 1.000 | Assumed | -- | 1.000 | Assumed | -- |
| 1,2,4,5-Tetrachlorobenzene | 0.792 | Calculated | USEPA 2007j (Figure 5B) | 0.792 | Calculated | USEPA 2007j (Figure 5B) |
| 1,2,4-Trichlorobenzene | 1.426 | Calculated | USEPA 2007j (Figure 5B) | 1.426 | Calculated | USEPA 2007j (Figure 5B) |
| 1,2-Dichlorobenzene | 2.452 | Calculated | USEPA 2007j (Figure 5B) | 2.452 | Calculated | USEPA 2007j (Figure 5B) |
| 1,3-Dichlorobenzene | 2.296 | Calculated | USEPA 2007j (Figure 5B) | 2.296 | Calculated | USEPA 2007j (Figure 5B) |
| 1,4-Dichlorobenzene | 2.475 | Calculated | USEPA 2007j (Figure 5B) | 2.475 | Calculated | USEPA 2007j (Figure 5B) |
| 4-Bromophenyl-phenylether | 0.566 | Calculated | USEPA 2007j (Figure 5B) | 0.566 | Calculated | USEPA 2007j (Figure 5B) |
| 4-Chlorophenyl-phenylether | 0.593 | Calculated | USEPA 2007j (Figure 5B) | 0.593 | Calculated | USEPA 2007j (Figure 5B) |
| Acenaphthene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Acenaphthylene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Anthracene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Benzo(a)anthracene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Benzo(a)pyrene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Benzo(b)fluoranthene | 0.31 | Median | USEPA 2007j (Table 4b) | 0.31 | Median | USEPA 2007j (Table 4b) |
| Benzo(g,h,i)perylene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Benzo(k)fluoranthene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Chrysene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Dibenz(a,h)anthracene | 0.13 | Median | USEPA 2007j (Table 4b) | 0.13 | Median | USEPA 2007j (Table 4b) |
| Fluoranthene | 0.50 | Median | USEPA 2007j (Table 4b) | 0.50 | Median | USEPA 2007j (Table 4b) |
| Fluorene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Hexachlorobenzene | 0.246 | Calculated | USEPA 2007j (Figure 5B) | 0.246 | Calculated | USEPA 2007j (Figure 5B) |
| Hexachlorobutadiene | 0.675 | Calculated | USEPA 2007j (Figure 5B) | 0.675 | Calculated | USEPA 2007j (Figure 5B) |
| Hexachlorocyclopentadiene | 0.393 | Calculated | USEPA 2007j (Figure 5B) | 0.393 | Calculated | USEPA 2007j (Figure 5B) |
| Hexachloroethane | 1.439 | Calculated | USEPA 2007j (Figure 5B) | 1.439 | Calculated | USEPA 2007j (Figure 5B) |

Table 3
Soil Bioconcentration Factors For Plants (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| Indeno(1,2,3-cd)pyrene | 0.11 | Median | USEPA 2007j (Table 4b) | 0.11 | Median | USEPA 2007j (Table 4b) |
| Pentachlorophenol | 5.93 | Median | USEPA 2007j (Table 4c) | 5.93 | Median | USEPA 2007j (Table 4c) |
| Phenanthrene | -- | See Table 4 | -- | -- | See Table 4 | -- |
| Pyrene | 0.72 | Median | USEPA 2007j (Table 4b) | 0.72 | Median | USEPA 2007j (Table 4b) |
| Explosives | | | | | | |
| 1,3,5-Trinitrobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 1,3-Dinitrobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2,4,6-Trinitrotoluene | 4.23 | Median | USEPA 2007j (Table 4b) | 4.23 | Median | USEPA 2007j (Table 4b) |
| 2,4-Dinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2,6-Dinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2-Amino-4,6-dinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2-Nitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 3-Nitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 4-Amino-2,6-dinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 4-Nitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| HMX | 2.20 | Maximum | Johnson et al. 2009 | 0.56 | Mean | Johnson et al. 2009 |
| Nitrobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Perchlorate | 80.0 | Maximum | USEPA 2002 | 41.0 | Midpoint | USEPA 2002 |
| RDX | 0.43 | Median | USEPA 2007j (Table 4b) | 0.43 | Median | USEPA 2007j (Table 4b) |
| Tetryl | 1.00 | Assumed | -- | 1.00 | Assumed | -- |

[1] Calculated as described in the text using the "selected" log $K_{ow}$ from Table 2.

Table 4
Bioconcentration/Bioaccumulation Factor Models (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Plants[1] | Reference | Soil Invertebrates[2] | Reference | Benthic Invertebrates[3] | Reference |
|---|---|---|---|---|---|---|
| Metals | | | | | | |
| Antimony | $C_p = e^{(-3.233 + 0.938(\ln Cs))}$ | USEPA 2007j (Table 4a) | -- | -- | -- | -- |
| Arsenic | $C_p = e^{(-1.992 + 0.564(\ln Cs))}$ | Bechtel Jacobs 1998a (Table 7) | $C_w = e^{(-1.421 + 0.706(\ln Cs))}$ | Sample et al. 1998a (Table 12); USEPA 2007j (Table 4a) | $C_i = 10^{(-0.292 + 0.754(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - All) |
| Beryllium | $C_p = e^{(-0.5361 + 0.7345(\ln Cs))}$ | USEPA 2007j (Table 4a) | -- | -- | -- | -- |
| Cadmium | $C_p = e^{(-0.476 + 0.546(\ln Cs))}$ | Bechtel Jacobs 1998a (Table 7); USEPA 2007j (Table 4a) | $C_w = e^{(2.114 + 0.795(\ln Cs))}$ | Sample et al. 1998a (Table 12); USEPA 2007j (Table 4a) | $C_i = 10^{(-0.314 + 0.513(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Dep) |
| Chromium | -- | -- | -- | -- | $C_i = 10^{(0.2092 + 0.365(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - All) |
| Cobalt | -- | -- | -- | -- | -- | -- |
| Copper | $C_p = e^{(0.669 + 0.394(\ln Cs))}$ | Bechtel Jacobs 1998a (Table 7); USEPA 2007j (Table 4a) | $C_w = e^{(1.675 + 0.264(\ln Cs))}$ | Sample et al. 1998a (Table 12) | -- | -- |
| Lead | $C_p = e^{(-1.328 + 0.561(\ln Cs))}$ | Bechtel Jacobs 1998a (Table 7); USEPA 2007j (Table 4a) | $C_w = e^{(-0.218 + 0.807(\ln Cs))}$ | Sample et al. 1998a (Table 12); USEPA 2007j (Table 4a) | $C_i = 10^{(-0.515 + 0.653(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Dep) |
| Manganese | -- | -- | $C_w = e^{(-0.809 + 0.682(\ln Cs))}$ | Sample et al. 1998a (Table 12); USEPA 2007j (Table 4a) | -- | -- |
| Mercury | $C_p = e^{(-0.996 + 0.544(\ln Cs))}$ | Bechtel Jacobs 1998a (Table 7) | -- | -- | -- | -- |
| Nickel | $C_p = e^{(-2.224 + 0.748(\ln Cs))}$ | Bechtel Jacobs 1998a (Table 7); USEPA 2007j (Table 4a) | -- | -- | $C_i = 10^{(-0.440 + 0.695(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Dep) |
| Selenium | $C_p = e^{(-0.678 + 1.104(\ln Cs))}$ | Bechtel Jacobs 1998a (Table 7); USEPA 2007j (Table 4a) | $C_w = e^{(-0.075 + 0.733(\ln Cs))}$ | Sample et al. 1998a (Table 12); USEPA 2007j (Table 4a) | -- | -- |

Table 4
Bioconcentration/Bioaccumulation Factor Models (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Plants[1] | Reference | Soil Invertebrates[2] | Reference | Benthic Invertebrates[3] | Reference |
|---|---|---|---|---|---|---|
| Zinc | $C_p = e^{(1.575 + 0.555(\ln Cs))}$ | Bechtel Jacobs 1998a (Table 7); USEPA 2007j (Table 4a) | $C_w = e^{(4.449 + 0.328(\ln Cs))}$ | Sample et al. 1998a (Table 12); USEPA 2007j (Table 4a) | $C_i = 10^{(1.89 + 0.126(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Dep) |
| Pesticides | | | | | | |
| 4,4'-DDD | $C_p = e^{(-2.5119 + 0.7524(\ln Cs))}$ | USEPA 2007j (Table 4b) | $C_w = e^{(1.1613 + 0.6975(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- |
| 4,4'-DDE | $C_p = e^{(-2.5119 + 0.7524(\ln Cs))}$ | USEPA 2007j (Table 4b) | $C_w = e^{(2.4771 + 0.8804(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- |
| 4,4'-DDT | $C_p = e^{(-2.5119 + 0.7524(\ln Cs))}$ | USEPA 2007j (Table 4b) | $C_w = e^{(2.1247 + 0.8689(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- |
| PCBs | | | | | | |
| Aroclor-1016 | -- | -- | $C_w = e^{(1.410 + 1.361(\ln Cs))}$ | Sample et al. 1998a (Table 12) | $C_i = 10^{(0.590 + 1.110(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Benthos) |
| | | | | | $C_i = 10^{(1.60 + 0.939(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Adults) |
| Aroclor-1221 | -- | -- | $C_w = e^{(1.410 + 1.361(\ln Cs))}$ | Sample et al. 1998a (Table 12) | $C_i = 10^{(0.590 + 1.110(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Benthos) |
| | | | | | $C_i = 10^{(1.60 + 0.939(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Adults) |
| Aroclor-1232 | -- | -- | $C_w = e^{(1.410 + 1.361(\ln Cs))}$ | Sample et al. 1998a (Table 12) | $C_i = 10^{(0.590 + 1.110(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Benthos) |
| | | | | | $C_i = 10^{(1.60 + 0.939(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Adults) |
| Aroclor-1242 | -- | -- | $C_w = e^{(1.410 + 1.361(\ln Cs))}$ | Sample et al. 1998a (Table 12) | $C_i = 10^{(0.590 + 1.110(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Benthos) |
| | | | | | $C_i = 10^{(1.60 + 0.939(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Adults) |
| Aroclor-1248 | -- | -- | $C_w = e^{(1.410 + 1.361(\ln Cs))}$ | Sample et al. 1998a (Table 12) | $C_i = 10^{(0.590 + 1.110(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Benthos) |
| | | | | | $C_i = 10^{(1.60 + 0.939(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Adults) |
| Aroclor-1254 | -- | -- | $C_w = e^{(1.410 + 1.361(\ln Cs))}$ | Sample et al. 1998a (Table 12) | $C_i = 10^{(0.590 + 1.110(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Benthos) |
| | | | | | $C_i = 10^{(1.60 + 0.939(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Adults) |

Table 4
Bioconcentration/Bioaccumulation Factor Models (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Plants[1] | Reference | Soil Invertebrates[2] | Reference | Benthic Invertebrates[3] | Reference |
|---|---|---|---|---|---|---|
| Aroclor-1260 | -- | -- | $C_w = e^{(1.410 + 1.361(\ln Cs))}$ | Sample et al. 1998a (Table 12) | $C_i = 10^{(0.590 + 1.110(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Benthos) |
| | | | | | $C_i = 10^{(1.60 + 0.939(\log Csd))}$ | Bechtel Jacobs 1998b (Table 3 - Adults) |
| PAHs | | | | | | |
| Acenaphthene | $C_p = e^{(-5.562 - 0.8556(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Acenaphthylene | $C_p = e^{(-1.144 + 0.791(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Anthracene | $C_p = e^{(-0.9887 + 0.7784(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Benzo(a)anthracene | $C_p = e^{(-2.7078 + 0.5944(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Benzo(a)pyrene | $C_p = e^{(-2.0615 + 0.9750(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Benzo(g,h,i)perylene | $C_p = e^{(-0.9313 + 1.1829(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Benzo(k)fluoranthene | $C_p = e^{(-2.1579 + 0.8595(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Chrysene | $C_p = e^{(-2.7078 + 0.5944(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Fluorene | $C_p = e^{(-5.562 - 0.8556(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |
| Phenanthrene | $C_p = e^{(-0.1665 + 0.6203(\ln Cs))}$ | USEPA 2007j (Table 4b) | -- | -- | -- | -- |

[1] Where $C_p$ = Concentration in aboveground portion of plant (mg/kg dry wt) and $C_s$ = Concentration in soil (mg/kg dry wt)

[2] Where $C_w$ = Concentration in earthworm (mg/kg dry wt) and $C_s$ = Concentration in soil (mg/kg dry wt)

Table 4
Bioconcentration/Bioaccumulation Factor Models (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Small Mammal Omnivores[4] | Reference | Small Mammal Herbivores | Reference | Small Mammal Insectivores | Reference |
|---|---|---|---|---|---|---|
| Metals | | | | | | |
| Antimony | -- | -- | -- | -- | -- | -- |
| Arsenic | $C_m = e^{(-4.5796 + 0.7354(\ln Cs))}$ | Sample et al. 1998b (Table 8) | $C_m = e^{(-5.6531 + 1.1382(\ln Cs))}$ | Sample et al. 1998b (Table 8) | $C_m = e^{(-4.8471 + 0.8188(\ln Cs))}$ | Sample et al. 1998b (Table 8); USEPA 2007j (Table 4a) |
| Beryllium | -- | -- | -- | -- | -- | -- |
| Cadmium | $C_m = e^{(-1.5383 + 0.5660(\ln Cs))}$ | Sample et al. 1998b (Table 8) | $C_m = e^{(-1.2571 + 0.4723(\ln Cs))}$ | Sample et al. 1998b (Table 8); USEPA 2007j (Table 4a) | $C_m = e^{(0.8150 + 0.9638(\ln Cs))}$ | Sample et al. 1998b (Table 8) |
| Chromium | $C_m = e^{(-1.4945 + 0.7326(\ln Cs))}$ | Sample et al. 1998b (Table 8) | $C_m = e^{(-1.4599 + 0.7338(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(-1.4599 + 0.7338(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) |
| Cobalt | $C_m = e^{(-4.4669 + 1.3070(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(-4.4669 + 1.3070(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(-4.4669 + 1.3070(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) |
| Copper | $C_m = e^{(1.4592 + 0.2681(\ln Cs))}$ | Sample et al. 1998b (Table 8) | $C_m = e^{(2.0420 + 0.1444(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(2.1042 + 0.1783(\ln Cs))}$ | Sample et al. 1998b (Table 8) |
| Lead | $C_m = e^{(0.0761 + 0.4422(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(-0.6114 + 0.5181(\ln Cs))}$ | Sample et al. 1998b (Table 8) | $C_m = e^{(0.4819 + 0.4869(\ln Cs))}$ | Sample et al. 1998b (Table 8) |
| Manganese | -- | -- | -- | -- | -- | -- |
| Mercury | -- | -- | -- | -- | -- | -- |
| Nickel | $C_m = e^{(-0.2462 + 0.4658(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(-0.2462 + 0.4658(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(-0.2462 + 0.4658(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) |
| Selenium | $C_m = e^{(-0.4158 + 0.3764(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(-0.4158 + 0.3764(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) | $C_m = e^{(-0.4158 + 0.3764(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General); USEPA 2007j (Table 4a) |

Table 4
Bioconcentration/Bioaccumulation Factor Models (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Small Mammal Omnivores[4] | Reference | Small Mammal Herbivores | Reference | Small Mammal Insectivores | Reference |
|---|---|---|---|---|---|---|
| Zinc | $C_m = e^{(4.4713 + 0.0738(\ln Cs))}$ | Sample et al. 1998b (Table 8 - General) | $C_m = e^{(4.3632 + 0.0706(\ln Cs))}$ | Sample et al. 1998b (Table 8); USEPA 2007j (Table 4a) | $C_m = e^{(4.2479 + 0.1324(\ln Cs))}$ | Sample et al. 1998b (Table 8) |
| Pesticides | | | | | | |
| 4,4'-DDD | -- | -- | -- | -- | -- | -- |
| 4,4'-DDE | -- | -- | -- | -- | -- | -- |
| 4,4'-DDT | -- | -- | -- | -- | -- | -- |
| PCBs | | | | | | |
| Aroclor-1016 | -- | -- | -- | -- | -- | -- |
| Aroclor-1221 | -- | -- | -- | -- | -- | -- |
| Aroclor-1232 | -- | -- | -- | -- | -- | -- |
| Aroclor-1242 | -- | -- | -- | -- | -- | -- |
| Aroclor-1248 | -- | -- | -- | -- | -- | -- |
| Aroclor-1254 | -- | -- | -- | -- | -- | -- |

Table 4
Bioconcentration/Bioaccumulation Factor Models (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Small Mammal Omnivores[4] | Reference | Small Mammal Herbivores | Reference | Small Mammal Insectivores | Reference |
|---|---|---|---|---|---|---|
| Aroclor-1260 | -- | -- | -- | -- | -- | -- |
| PAHs | | | | | | |
| Acenaphthene | -- | -- | -- | -- | -- | -- |
| Acenaphthylene | -- | -- | -- | -- | -- | -- |
| Anthracene | -- | -- | -- | -- | -- | -- |
| Benzo(a)anthracene | -- | -- | -- | -- | -- | -- |
| Benzo(a)pyrene | -- | -- | -- | -- | -- | -- |
| Benzo(g,h,i)perylene | -- | -- | -- | -- | -- | -- |
| Benzo(k)fluoranthene | -- | -- | -- | -- | -- | -- |
| Chrysene | -- | -- | -- | -- | -- | -- |
| Fluorene | -- | -- | -- | -- | -- | -- |
| Phenanthrene | -- | -- | -- | -- | -- | -- |

[3] Where $C_i$ = Concentration in benthic invertebrate (mg/kg dry wt) and $C_{sd}$ = Concentration in sediment (mg/kg dry wt)

[4] Where $C_m$ = Concentration in whole-body small mammal (mg/kg dry wt) and $C_s$ = Concentration in soil (mg/kg dry wt)

Table 5
Soil Bioaccumulation Factors For Soil Invertebrates (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| **Metals** | | | | | | |
| Antimony | 1.000 | Assumed | -- | 1.000 | Assumed | -- |
| Arsenic | 0.523 | 90th percentile | Sample et al. 1998a (Table 11) | 0.258 | Arithmetic mean | Sample et al. 1998a (Table 11) |
| Barium | 0.160 | 90th percentile | Sample et al. 1998a (Table C.1) | 0.060 | Geometric mean | Sample et al. 1998a (Table C.1) |
| Beryllium | 1.182 | 90th percentile | Sample et al. 1998a (Table C.1) | 0.070 | Geometric mean | Sample et al. 1998a (Table C.1) |
| Cadmium | 40.69 | 90th percentile | Sample et al. 1998a (Table 11) | 7.660 | Geometric mean | Sample et al. 1998a (Table 11) |
| Chromium | 3.162 | 90th percentile | Sample et al. 1998a (Table 11) | 0.320 | Geometric mean | Sample et al. 1998a (Table 11) |
| Cobalt | 0.291 | 90th percentile | Sample et al. 1998a (Table C.1) | 0.113 | Geometric mean | Sample et al. 1998a (Table C.1) |
| Copper | 1.531 | 90th percentile | Sample et al. 1998a (Table 11) | 0.468 | Geometric mean | Sample et al. 1998a (Table 11) |
| Lead | 1.522 | 90th percentile | Sample et al. 1998a (Table 11) | 0.307 | Geometric mean | Sample et al. 1998a (Table 11) |
| Manganese | 0.124 | 90th percentile | Sample et al. 1998a (Table 11) | 0.050 | Geometric mean | Sample et al. 1998a (Table 11) |
| Mercury | 20.63 | 90th percentile | Sample et al. 1998a (Table 11) | 1.186 | Geometric mean | Sample et al. 1998a (Table 11) |
| Nickel | 4.730 | 90th percentile | Sample et al. 1998a (Table 11) | 1.656 | Arithmetic mean | Sample et al. 1998a (Table 11) |
| Selenium | 1.340 | 90th percentile | Sample et al. 1998a (Table 11) | 0.982 | Geometric mean | Sample et al. 1998a (Table 11) |
| Silver | 15.34 | 90th percentile | Sample et al. 1998a (Table C.1) | 2.045 | Median | Sample et al. 1998a (Table C.1); USEPA 2007j (Table 4a) |
| Vanadium | 0.088 | 90th percentile | Sample et al. 1998a (Table C.1) | 0.039 | Arithmetic mean | Sample et al. 1998a (Table C.1) |
| Zinc | 12.89 | 90th percentile | Sample et al. 1998a (Table 11) | 2.482 | Geometric mean | Sample et al. 1998a (Table 11) |
| **Pesticides** | | | | | | |
| 4,4'-DDD | 11.2 | Median | USEPA 2007j (Table 4b) | 11.2 | Median | USEPA 2007j (Table 4b) |
| 4,4'-DDE | 11.2 | Median | USEPA 2007j (Table 4b) | 11.2 | Median | USEPA 2007j (Table 4b) |
| 4,4'-DDT | 11.2 | Median | USEPA 2007j (Table 4b) | 11.2 | Median | USEPA 2007j (Table 4b) |
| Aldrin | 3.30 | Mean | Edwards and Bohlen 1992 | 3.30 | Mean | Edwards and Bohlen 1992 |
| alpha-BHC | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| alpha-Chlordane | 4.00 | Mean | Edwards and Bohlen 1992 | 4.00 | Mean | Edwards and Bohlen 1992 |
| beta-BHC | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| delta-BHC | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Dieldrin | 14.7 | Median | USEPA 2007j (Table 4b) | 14.7 | Median | USEPA 2007j (Table 4b) |
| Endosulfan I | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Endosulfan II | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Endrin | 3.60 | Mean | Edwards and Bohlen 1992 | 3.60 | Mean | Edwards and Bohlen 1992 |
| gamma-BHC (Lindane) | 26.6 | Maximum | Romijn et al. 1994 | 13.7 | Mean | Romijn et al. 1994 |

Table 5
Soil Bioaccumulation Factors For Soil Invertebrates (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| gamma-Chlordane | 4.00 | Mean | Edwards and Bohlen 1992 | 4.00 | Mean | Edwards and Bohlen 1992 |
| Heptachlor | 3.00 | Mean | Edwards and Bohlen 1992 | 3.00 | Mean | Edwards and Bohlen 1992 |
| Heptachlor epoxide | 10.0 | Mean | Beyer and Gish 1980 | 10.0 | Mean | Beyer and Gish 1980 |
| Methoxychlor | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Toxaphene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Polychlorinated Biphenyls | | | | | | |
| Aroclor-1016 | 15.91 | 90th percentile | Sample et al. 1998a (Table 11) | 4.30 | Geometric mean | Sample et al. 1998a (Table 11) |
| Aroclor-1221 | 15.91 | 90th percentile | Sample et al. 1998a (Table 11) | 4.30 | Geometric mean | Sample et al. 1998a (Table 11) |
| Aroclor-1232 | 15.91 | 90th percentile | Sample et al. 1998a (Table 11) | 4.30 | Geometric mean | Sample et al. 1998a (Table 11) |
| Aroclor-1242 | 15.91 | 90th percentile | Sample et al. 1998a (Table 11) | 4.30 | Geometric mean | Sample et al. 1998a (Table 11) |
| Aroclor-1248 | 15.91 | 90th percentile | Sample et al. 1998a (Table 11) | 4.30 | Geometric mean | Sample et al. 1998a (Table 11) |
| Aroclor-1254 | 15.91 | 90th percentile | Sample et al. 1998a (Table 11) | 4.30 | Geometric mean | Sample et al. 1998a (Table 11) |
| Aroclor-1260 | 15.91 | 90th percentile | Sample et al. 1998a (Table 11) | 4.30 | Geometric mean | Sample et al. 1998a (Table 11) |
| Volatile and Semivolatile Organic Compounds | | | | | | |
| 1,1,2,2-Tetrachloroethane | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 1,2,4,5-Tetrachlorobenzene | 0.50 | Mean | Beyer 1996 | 0.50 | Mean | Beyer 1996 |
| 1,2,4-Trichlorobenzene | 0.56 | Mean | Beyer 1996 | 0.56 | Mean | Beyer 1996 |
| 1,2-Dichlorobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 1,3-Dichlorobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 1,4-Dichlorobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 4-Bromophenyl-phenylether | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 4-Chlorophenyl-phenylether | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Acenaphthene[1] | 1.47 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.30 | Median | Beyer and Stafford 1993 |
| Acenaphthylene[1] | 22.9 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.22 | Median | Beyer and Stafford 1993 |
| Anthracene[1] | 2.42 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.32 | Median | Beyer and Stafford 1993 |
| Benzo(a)anthracene[1] | 1.59 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.27 | Median | Beyer and Stafford 1993 |
| Benzo(a)pyrene[1] | 1.33 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.34 | Median | Beyer and Stafford 1993 |
| Benzo(b)fluoranthene[1] | 2.60 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.21 | Median | Beyer and Stafford 1993 |
| Benzo(g,h,i)perylene[1] | 2.94 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.15 | Median | Beyer and Stafford 1993 |

Table 5
Soil Bioaccumulation Factors For Soil Invertebrates (Dry Weight)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| Benzo(k)fluoranthene[1] | 2.60 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.21 | Median | Beyer and Stafford 1993 |
| Chrysene[1] | 2.29 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.44 | Median | Beyer and Stafford 1993 |
| Dibenz(a,h)anthracene[1] | 2.31 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.49 | Median | Beyer and Stafford 1993 |
| Fluoranthene[1] | 3.04 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.37 | Median | Beyer and Stafford 1993 |
| Fluorene[1] | 9.57 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.20 | Median | Beyer and Stafford 1993 |
| Hexachlorobenzene | 1.69 | Mean | Beyer 1996 | 1.69 | Mean | Beyer 1996 |
| Hexachlorobutadiene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Hexachlorocyclopentadiene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Hexachloroethane | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Indeno(1,2,3-cd)pyrene[1] | 2.86 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.41 | Median | Beyer and Stafford 1993 |
| Pentachlorophenol | 14.6 | Median | USEPA 2007j (Table 4c) | 14.6 | Median | USEPA 2007j (Table 4c) |
| Phenanthrene[1] | 1.72 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.28 | Median | Beyer and Stafford 1993 |
| Pyrene[1] | 1.75 | Modeled from $K_{ow}$ | USEPA 2007j (Tables 4 and 5) | 0.39 | Median | Beyer and Stafford 1993 |
| Explosives | | | | | | |
| 1,3,5-Trinitrobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 1,3-Dinitrobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2,4,6-Trinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2,4-Dinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2,6-Dinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2-Amino-4,6-dinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 2-Nitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 3-Nitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 4-Amino-2,6-dinitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| 4-Nitrotoluene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| HMX | 1.00 | Maximum | Johnson et al. 2009 | 0.54 | Mean | Johnson et al. 2009 |
| Nitrobenzene | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| Perchlorate | 1.00 | Assumed | -- | 1.00 | Assumed | -- |
| RDX | 13.0 | Maximum | Johnson et al. 2009 | 6.40 | Mean | Johnson et al. 2009 |
| Tetryl | 1.00 | Assumed | -- | 1.00 | Assumed | -- |

1 - Eco-SSL values are used only for the SERA because they are modeled values; measured median values are available from the literature and are applied to the BERA

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Table 6a
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Omnivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| **Metals** | | | | | | |
| Antimony[1] | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Arsenic | 0.014 | 90th percentile | Sample et al. 1998b (Table 7) | 0.003 | Geometric mean | Sample et al. 1998b (Table 7) |
| Barium[1] | 0.069 | 90th percentile | Sample et al. 1998b (Table 7) | 0.046 | Median | Sample et al. 1998b (Table 7) |
| Beryllium[1] | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Cadmium | 0.462 | 90th percentile | Sample et al. 1998b (Table 7) | 0.144 | Geometric mean | Sample et al. 1998b (Table 7) |
| Chromium | 0.349 | 90th percentile | Sample et al. 1998b (Table 7) | 0.070 | Median | Sample et al. 1998b (Table 7) |
| Cobalt | 0.025 | 90th percentile | Sample et al. 1998b (Table 7) | 0.016 | Median | Sample et al. 1998b (Table 7) |
| Copper | 0.554 | 90th percentile | Sample et al. 1998b (Table 7) | 0.111 | Geometric mean | Sample et al. 1998b (Table 7) |
| Lead | 0.286 | 90th percentile | Sample et al. 1998b (Table 7) | 0.055 | Geometric mean | Sample et al. 1998b (Table 7) |
| Manganese | 0.037 | 90th percentile | Sample et al. 1998b (Table C.1) | 0.031 | Median | Sample et al. 1998b (Table C.1) |
| Mercury | 0.130 | 90th percentile | Sample et al. 1998b (Table 7) | 0.054 | Median | Sample et al. 1998b (Table 7) |
| Nickel | 0.589 | 90th percentile | Sample et al. 1998b (Table 7) | 0.168 | Median | Sample et al. 1998b (Table 7) |
| Selenium | 1.263 | 90th percentile | Sample et al. 1998b (Table 7) | 0.258 | Geometric mean | Sample et al. 1998b (Table 7) |
| Silver | 0.810 | 90th percentile | Sample et al. 1998b (Table C.1) | 0.151 | Median | Sample et al. 1998b (Table C.1) |
| Vanadium | 0.013 | 90th percentile | Sample et al. 1998b (Table C.1) | 0.010 | Median | Sample et al. 1998b (Table C.1) |
| Zinc | 2.782 | 90th percentile | Sample et al. 1998b (Table 7) | 0.509 | Geometric mean | Sample et al. 1998b (Table 7) |
| **Pesticides** | | | | | | |
| 4,4'-DDD | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4,4'-DDE | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4,4'-DDT | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aldrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| alpha-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| alpha-Chlordane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| beta-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| delta-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Dieldrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endosulfan I | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endosulfan II | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| gamma-BHC (Lindane) | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |

Table 6a
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Omnivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| gamma-Chlordane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Heptachlor | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Heptachlor epoxide | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Methoxychlor | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Toxaphene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Polychlorinated Biphenyls | | | | | | |
| Aroclor-1016 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1221 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1232 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1242 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1248 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1254 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1260 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Volatile and Semivolatile Organic Compounds | | | | | | |
| 1,1,2,2-Tetrachloroethane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2,4,5-Tetrachlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2,4-Trichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,3-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,4-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4-Bromophenyl-phenylether | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4-Chlorophenyl-phenylether | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Acenaphthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Acenaphthylene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(a)anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(a)pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(b)fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(g,h,i)perylene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(k)fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Chrysene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Dibenz(a,h)anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |

Table 6a
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Omnivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| Fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Fluorene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Hexachlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachlorobutadiene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachlorocyclopentadiene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachloroethane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Indeno(1,2,3-cd)pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Pentachlorophenol | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Phenanthrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Explosives | | | | | | |
| 1,3,5-Trinitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 1,3-Dinitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2,4,6-Trinitrotoluene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| 2,4-Dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2,6-Dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2-Amino-4,6-dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 3-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 4-Amino-2,6-dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 4-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| HMX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| Nitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| Perchlorate | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| RDX | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Tetryl | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |

NA - Not Available
1 - Eco-SSL equations were not used for these chemicals because they were based upon diet-to-biota factors for cattle. Instead, the process discussed in Section 1.2.1.3 was used.

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Table 6b
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Herbivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| **Metals** | | | | | | |
| Antimony[1] | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Arsenic | 0.016 | 90th percentile | Sample et al. 1998b (Table 7) | 0.005 | Geometric mean | Sample et al. 1998b (Table 7) |
| Barium[1] | 0.253 | 90th percentile | Sample et al. 1998b (Table 7) | 0.069 | Geometric mean | Sample et al. 1998b (Table 7) |
| Beryllium[1] | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Cadmium | 0.448 | 90th percentile | Sample et al. 1998b (Table 7) | 0.134 | Geometric mean | Sample et al. 1998b (Table 7) |
| Chromium | 0.309 | 90th percentile | Sample et al. 1998b (Table 7) | 0.088 | Median | Sample et al. 1998b (Table 7) |
| Cobalt | 0.140 | 90th percentile | Sample et al. 1998b (Table 7) | 0.032 | Geometric mean | Sample et al. 1998b (Table 7) |
| Copper | 1.290 | 90th percentile | Sample et al. 1998b (Table 7) | 0.109 | Geometric mean | Sample et al. 1998b (Table 7) |
| Lead | 0.187 | 90th percentile | Sample et al. 1998b (Table 7) | 0.041 | Geometric mean | Sample et al. 1998b (Table 7) |
| Manganese | 0.079 | 90th percentile | Sample et al. 1998b (Table C.1) | 0.022 | Geometric mean | Sample et al. 1998b (Table C.1) |
| Mercury | 0.192 | 90th percentile | Sample et al. 1998b (Table 7 - General) | 0.067 | Geometric mean | Sample et al. 1998b (Table 7 - General) |
| Nickel | 0.898 | 90th percentile | Sample et al. 1998b (Table 7) | 0.263 | Geometric mean | Sample et al. 1998b (Table 7) |
| Selenium | 1.1867 | 90th percentile | Sample et al. 1998b (Table 7 - General) | 0.273 | Geometric mean | Sample et al. 1998b (Table 7 - General) |
| Silver | 0.007 | 90th percentile | Sample et al. 1998b (Table C.1) | 0.006 | Geometric mean | Sample et al. 1998b (Table C.1) |
| Vanadium | 0.019 | 90th percentile | Sample et al. 1998b (Table C.1) | 0.013 | Median | Sample et al. 1998b (Table C.1) |
| Zinc | 2.317 | 90th percentile | Sample et al. 1998b (Table 7) | 0.293 | Geometric mean | Sample et al. 1998b (Table 7) |
| **Pesticides** | | | | | | |
| 4,4'-DDD | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4,4'-DDE | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4,4'-DDT | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aldrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| alpha-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| alpha-Chlordane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| beta-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| delta-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Dieldrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endosulfan I | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endosulfan II | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |

Table 6b
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Herbivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| gamma-BHC (Lindane) | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| gamma-Chlordane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Heptachlor | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Heptachlor epoxide | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Methoxychlor | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Toxaphene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Polychlorinated Biphenyls | | | | | | |
| Aroclor-1016 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1221 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1232 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1242 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1248 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1254 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1260 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Volatile and Semivolatile Organic Compounds | | | | | | |
| 1,1,2,2-Tetrachloroethane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2,4,5-Tetrachlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2,4-Trichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,3-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,4-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4-Bromophenyl-phenylether | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4-Chlorophenyl-phenylether | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Acenaphthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Acenaphthylene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(a)anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(a)pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(b)fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(g,h,i)perylene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(k)fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Chrysene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |

Table 6b
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Herbivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| Dibenz(a,h)anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Fluorene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Hexachlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachlorobutadiene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachlorocyclopentadiene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachloroethane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Indeno(1,2,3-cd)pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Pentachlorophenol | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Phenanthrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Explosives | | | | | | |
| 1,3,5-Trinitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 1,3-Dinitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2,4,6-Trinitrotoluene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| 2,4-Dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2,6-Dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2-Amino-4,6-dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 3-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 4-Amino-2,6-dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 4-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| HMX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| Nitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| Perchlorate | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| RDX | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Tetryl | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |

NA - Not Available
1 - Eco-SSL equations were not used for these chemicals because they were based upon diet-to-biota factors for cattle. Instead, the process discussed in Section 1.2.1.3 was used.

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Table 6c
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Insectivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| **Metals** | | | | | | |
| Antimony[1] | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Arsenic | 0.015 | 90th percentile | Sample et al. 1998b (Table 7 - General) | 0.004 | Geometric mean | Sample et al. 1998b (Table 7 - General) |
| Barium[1] | 0.112 | 90th percentile | Sample et al. 1998b (Table 7 - General) | 0.055 | Geometric mean | Sample et al. 1998b (Table 7 - General) |
| Beryllium[1] | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Cadmium | 7.017 | 90th percentile | Sample et al. 1998b (Table 7) | 2.212 | Geometric mean | Sample et al. 1998b (Table 7) |
| Chromium | 0.333 | 90th percentile | Sample et al. 1998b (Table 7 - General) | 0.085 | Median | Sample et al. 1998b (Table 7 - General) |
| Cobalt | 0.100 | 90th percentile | Sample et al. 1998b (Table 7 - General) | 0.021 | Median | Sample et al. 1998b (Table 7 - General) |
| Copper | 1.117 | 90th percentile | Sample et al. 1998b (Table 7) | 0.502 | Geometric mean | Sample et al. 1998b (Table 7) |
| Lead | 0.339 | 90th percentile | Sample et al. 1998b (Table 7) | 0.148 | Geometric mean | Sample et al. 1998b (Table 7) |
| Manganese | 0.059 | 90th percentile | Sample et al. 1998b (Table C.1 - General) | 0.024 | Geometric mean | Sample et al. 1998b (Table C.1 - General) |
| Mercury | 0.192 | 90th percentile | Sample et al. 1998b (Table 7 - General) | 0.067 | Geometric mean | Sample et al. 1998b (Table 7 - General) |
| Nickel | 0.578 | 90th percentile | Sample et al. 1998b (Table 7) | 0.349 | Arithmetic Mean | Sample et al. 1998b (Table 7) |
| Selenium | 1.187 | 90th percentile | Sample et al. 1998b (Table 7 - General) | 0.273 | Geometric mean | Sample et al. 1998b (Table 7 - General) |
| Silver | 0.501 | 90th percentile | Sample et al. 1998b (Table C.1 - General) | 0.036 | Geometric mean | Sample et al. 1998b (Table C.1 - General) |
| Vanadium | 0.018 | 90th percentile | Sample et al. 1998b (Table C.1 - General) | 0.012 | Median | Sample et al. 1998b (Table C.1 - General); USEPA 2007j (Table 4a) |
| Zinc | 2.901 | 90th percentile | Sample et al. 1998b (Table 7) | 0.862 | Geometric mean | Sample et al. 1998b (Table 7) |
| **Pesticides** | | | | | | |
| 4,4'-DDD | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4,4'-DDE | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4,4'-DDT | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |

Table 6c
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Insectivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| Aldrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| alpha-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| alpha-Chlordane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| beta-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| delta-BHC | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Dieldrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endosulfan I | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endosulfan II | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Endrin | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| gamma-BHC (Lindane) | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| gamma-Chlordane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Heptachlor | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Heptachlor epoxide | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Methoxychlor | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Toxaphene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Polychlorinated Biphenyls | | | | | | |
| Aroclor-1016 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1221 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1232 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1242 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1248 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1254 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Aroclor-1260 | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Volatile and Semivolatile Organic Compounds | | | | | | |
| 1,1,2,2-Tetrachloroethane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2,4,5-Tetrachlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2,4-Trichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,2-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,3-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 1,4-Dichlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |

Table 6c
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Insectivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| 4-Bromophenyl-phenylether | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| 4-Chlorophenyl-phenylether | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Acenaphthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Acenaphthylene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(a)anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(a)pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(b)fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(g,h,i)perylene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Benzo(k)fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Chrysene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Dibenz(a,h)anthracene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Fluoranthene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Fluorene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Hexachlorobenzene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachlorobutadiene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachlorocyclopentadiene | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Hexachloroethane | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Indeno(1,2,3-cd)pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Pentachlorophenol | NA | -- | See Section 1.2.1.3 (Small Mammals) | NA | -- | See Section 1.2.1.3 (Small Mammals) |
| Phenanthrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Pyrene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Explosives | | | | | | |
| 1,3,5-Trinitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 1,3-Dinitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2,4,6-Trinitrotoluene | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| 2,4-Dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2,6-Dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2-Amino-4,6-dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 2-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |

Table 6c
Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Insectivores
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | Baseline | | |
|---|---|---|---|---|---|---|
| | Value | Basis | Reference | Value | Basis | Reference |
| 3-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 4-Amino-2,6-dinitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| 4-Nitrotoluene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| HMX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| Nitrobenzene | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| Perchlorate | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |
| RDX | 0.0 | Assumed | USEPA 2007j (Table 4b) | 0.0 | Assumed | USEPA 2007j (Table 4b) |
| Tetryl | 0.0 | Assumed | per USEPA 2007j for TNT/RDX | 0.0 | Assumed | per USEPA 2007j for TNT/RDX |

NA - Not Available
1 - Eco-SSL equations were not used for these chemicals because they were based upon diet-to-biota factors for cattle. Instead, the process discussed in Section 1.2.1.3 was used.

Table 7
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Benthic Invertebrates
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | | | |
|---|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Principal Organisms | Basis | Reference |
| Metals | | | | | | |
| Arsenic | -- | 0.690 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - All) |
| Arsenic | -- | 0.679 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Cadmium | -- | 3.073 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Cadmium | -- | 13.37 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Chromium | -- | 0.468 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - All) |
| Chromium | -- | 0.004 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Copper | -- | 7.957 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Copper | -- | 2.029 | Fresh/Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Lead | -- | 0.326 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Lead | -- | 0.195 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Mercury | -- | 2.868 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - All) |
| Mercury | -- | 1.153 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Nickel | -- | 0.214 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Nickel | -- | 0.120 | Marine | Molluscs | Average median | Thomann et al. 1995 |
| Selenium | -- | 1.000 | -- | -- | Assumed | -- |
| Selenium | -- | 5.550 | Marine | Molluscs | Average median | Thomann et al. 1995 |
| Silver | -- | 0.180 | Fresh | Oligochaete | Mean | Hirsch 1998 |
| Silver | -- | 8.515 | Marine | Molluscs | Average median | Thomann et al. 1995 |
| Zinc | -- | 4.759 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Zinc | -- | 9.647 | Fresh/Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Pesticides | | | | | | |
| 4,4'-DDD | 0.88 | 10.8 | Marine/Estuarine | Worms | Single value | USACOE 2010 |
| 4,4'-DDD | 5.54 | 39.0 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| 4,4'-DDE | 0.88 | 10.8 | Marine/Estuarine | Worms | Single value | DDD value |
| 4,4'-DDE | 19.8 | 140 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| 4,4'-DDT | 0.16 | 1.96 | Marine/Estuarine | Worms | 90th percentile | USACOE 2010 |
| 4,4'-DDT | 0.48 | 3.41 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Aldrin | 0.42 | 2.96 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 |
| alpha-BHC | 1.00 | 12.3 | Marine | Crustaceans | Single value | USACOE 2010 |
| alpha-BHC | 0.74 | 5.22 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 |
| alpha-Chlordane | 0.88 | 10.8 | Marine/Estuarine | Worms | Single value | USACOE 2010 |
| alpha-Chlordane | 1.21 | 8.51 | Marine/Estuarine | Molluscs | 90th percentile | USACOE 2010 (total chlordane) |

Table 7
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Benthic Invertebrates
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | | | |
|---|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Principal Organisms | Basis | Reference |
| beta-BHC | 1.00 | 12.3 | Marine | Crustaceans | Single value | alpha-BHC value |
| beta-BHC | 0.74 | 5.22 | Marine/Estuarine | Molluscs | Single value | alpha-BHC value |
| delta-BHC | 1.00 | 12.3 | Marine | Crustaceans | Single value | alpha-BHC value |
| delta-BHC | 0.74 | 5.22 | Marine/Estuarine | Molluscs | Single value | alpha-BHC value |
| Dieldrin | -- | 4.92 | Fresh | Lumbriculus | Geometric mean | Standley 1997 |
| Dieldrin | 0.98 | 6.89 | Marine/Estuarine | Molluscs | 90th percentile | USACOE 2010 |
| Endosulfan I | 0.059 | 0.42 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 (endosulfan sulfate) |
| Endosulfan II | 0.059 | 0.42 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 (endosulfan sulfate) |
| Endrin | 0.49 | 3.43 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 (endrin aldehyde) |
| gamma-BHC (Lindane) | 0.91 | 11.2 | Marine/Estuarine | Crustaceans/worms | 90th percentile | USACOE 2010 |
| gamma-BHC (Lindane) | 0.67 | 4.75 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 |
| gamma-Chlordane | 1.23 | 15.2 | Marine/Estuarine | Worms | Single value | USACOE 2010 |
| gamma-Chlordane | 1.21 | 8.51 | Marine/Estuarine | Molluscs | 90th percentile | USACOE 2010 (total chlordane) |
| Heptachlor | 0.061 | 0.43 | Fresh/Marine | Molluscs | 90th percentile | USACOE 2010 |
| Heptachlor Epoxide | 0.302 | 2.13 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 |
| Methoxychlor | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Toxaphene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Polychlorinated Biphenyls | | | | | | |
| Aroclor-1016 | -- | 21.9 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1016 | -- | 64.1 | Fresh | Adult insects | 90th percentile | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1221 | -- | 21.9 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1221 | -- | 64.1 | Fresh | Adult insects | 90th percentile | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1232 | -- | 21.9 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1232 | -- | 64.1 | Fresh | Adult insects | 90th percentile | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1242 | -- | 21.9 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1242 | -- | 64.1 | Fresh | Adult insects | 90th percentile | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1248 | -- | 21.9 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1248 | -- | 64.1 | Fresh | Adult insects | 90th percentile | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1254 | -- | 21.9 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1254 | -- | 64.1 | Fresh | Adult insects | 90th percentile | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1254 | 0.81 | 5.70 | Marine/Estuarine | Molluscs | 90th percentile | USACOE 2010 |
| Aroclor-1260 | -- | 21.9 | Fresh | Invertebrate infauna | 90th percentile | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1260 | -- | 64.1 | Fresh | Adult insects | 90th percentile | Bechtel Jacobs 1998b (Table 2 - adult) |

Table 7
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Benthic Invertebrates
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | | | |
|---|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Principal Organisms | Basis | Reference |
| Volatile and Semivolatile Organic Compounds | | | | | | |
| 1,1,2,2-Tetrachloroethane | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 1,2,4,5-Tetrachlorobenzene | -- | 0.62 | Fresh | Amphipods/oligochaetes | Maximum | Oliver and Niimi 1988 |
| 1,2,4-Trichlorobenzene | -- | 0.48 | Fresh | Amphipods/oligochaetes | Maximum | Oliver and Niimi 1988 |
| 1,2-Dichlorobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 1,3-Dichlorobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 1,4-Dichlorobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 4-Bromophenyl-Phenylether | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 4-Chlorophenyl-Phenylether | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Acenaphthene | 2.04 | 25.1 | Estuarine | Polychaetes | Single value | Maruya et al. 1997 |
| Acenaphthene | 0.76 | 5.37 | Fresh/Marine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Acenaphthylene | 2.04 | 25.1 | Estuarine | Polychaetes | Single value | acenaphthene value |
| Acenaphthylene | 1.05 | 7.38 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Anthracene | 0.614 | 7.55 | Marine/Estuarine | Crustaceans/worms | 90th percentile | USACOE 2010 |
| Anthracene | 0.465 | 3.28 | Fresh/Marine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(a)anthracene | 0.209 | 2.56 | Fresh/Marine | Crustaceans/worms/insects | 90th percentile | USACOE 2010 |
| Benzo(a)anthracene | 0.68 | 4.79 | Fresh/Marine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(a)pyrene | 0.70 | 8.65 | Fresh/Marine | Crustaceans/worms | 90th percentile | USACOE 2010 |
| Benzo(a)pyrene | 0.264 | 1.86 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(b)fluoranthene | 0.250 | 3.07 | Marine/Estuarine | Crustaceans/worms | 90th percentile | USACOE 2010 |
| Benzo(b)fluoranthene | 5.24 | 36.9 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(g,h,i)perylene | 0.151 | 1.86 | Marine/Estuarine | Worms | 90th percentile | USACOE 2010 |
| Benzo(g,h,i)perylene | 0.172 | 1.21 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(k)fluoranthene | 0.214 | 2.63 | Marine/Estuarine | Worms | 90th percentile | USACOE 2010 |
| Benzo(k)fluoranthene | 0.555 | 3.91 | Estuarine | Clams | 90th percentile | Maruya et al. 1997 |
| Chrysene | 0.249 | 3.06 | Marine/Estuarine | Crustaceans/worms | 90th percentile | USACOE 2010 |
| Chrysene | 0.546 | 3.85 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Dibenz(a,h)anthracene | 2.00 | 24.6 | Estuarine | Polychaetes | Maximum | Maruya et al. 1997 (all PAHs) |
| Dibenz(a,h)anthracene | 0.188 | 1.32 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Fluoranthene | 0.172 | 2.12 | Fresh/Marine | Crustaceans/worms | 90th percentile | USACOE 2010 |
| Fluoranthene | 0.724 | 5.10 | Fresh/Marine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Fluorene | 0.88 | 10.9 | Estuarine | Polychaetes | 90th percentile | Maruya et al. 1997 |
| Fluorene | 1.32 | 9.31 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |

Table 7
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Benthic Invertebrates
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | | | |
|---|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Principal Organisms | Basis | Reference |
| Hexachlorobenzene | -- | 0.86 | Fresh | Amphipods/oligochaetes | Maximum | Oliver and Niimi 1988 |
| Hexachlorobenzene | 6.00 | 42.3 | Marine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Hexachlorobutadiene | -- | 0.61 | Fresh | Amphipods/oligochaetes | Maximum | Oliver and Niimi 1988 |
| Hexachlorocyclopentadiene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Hexachloroethane | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Indeno(1,2,3-cd)pyrene | 0.122 | 1.50 | Marine/Estuarine | Worms | 90th percentile | USACOE 2010 |
| Indeno(1,2,3-cd)pyrene | 0.324 | 2.28 | Marine/Estuarine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Pentachlorophenol | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Phenanthrene | 0.285 | 3.50 | Marine/Estuarine | Worms | 90th percentile | USACOE 2010 |
| Phenanthrene | 0.659 | 4.65 | Fresh/Marine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Pyrene | 1.52 | 18.7 | Fresh/Marine | Crustaceans/worms | 90th percentile | USEPA 2009a; USACOE 2010 |
| Pyrene | 0.415 | 2.93 | Fresh/Marine | Molluscs/bivalves | 90th percentile | USEPA 2009a; USACOE 2010 |
| Explosives | | | | | | |
| 1,3,5-Trinitrobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 1,3-Dinitrobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2,4,6-Trinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2,4-Dinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2,6-Dinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2-Amino-4,6-dinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2-Nitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 3-Nitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 4-Amino-2,6-dinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 4-Nitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| HMX | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Nitrobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Perchlorate | 1.00 | 1.00 | -- | -- | Assumed | -- |
| RDX | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Tetryl | 1.00 | 1.00 | -- | -- | Assumed | -- |

[1] Wet-weight (ww) BSAFs are converted to dry-weight (dw) using the following values:

| | | | | | |
|---|---|---|---|---|---|
| Lipids (%): | 1.48 | bivalves | 2.58 | macroinvertebrates | USACOE 2010 |
| TOC (%): | 1 | Assumed (default) | | | |
| Percent soilds: | 0.21 | USEPA 1993a | | | |

Table 7
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Benthic Invertebrates
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Baseline | | | | | |
|---|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Principal Organisms | Basis | Reference |
| Metals | | | | | | |
| Arsenic | -- | 0.172 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - All) |
| Arsenic | -- | 0.679 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Cadmium | -- | 0.410 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Cadmium | -- | 13.37 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Chromium | -- | 0.115 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - All) |
| Chromium | -- | 0.004 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Copper | -- | 0.824 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Copper | -- | 2.029 | Fresh/Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Lead | -- | 0.082 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Lead | -- | 0.195 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Mercury | -- | 1.186 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - All) |
| Mercury | -- | 1.153 | Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Nickel | -- | 0.134 | Fresh | Invertebrate infauna | Median | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Nickel | -- | 0.120 | Marine | Molluscs | Average median | Thomann et al. 1995 |
| Selenium | -- | 1.000 | -- | -- | Assumed | -- |
| Selenium | -- | 5.550 | Marine | Molluscs | Average median | Thomann et al. 1995 |
| Silver | -- | 0.180 | Fresh | Oligochaete | Mean | Hirsch 1998 |
| Silver | -- | 8.515 | Marine | Molluscs | Average median | Thomann et al. 1995 |
| Zinc | -- | 0.897 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Dep) |
| Zinc | -- | 9.647 | Fresh/Marine | Molluscs | Average median | PTI 1995; Thomann et al. 1995 |
| Pesticides | | | | | | |
| 4,4'-DDD | 0.88 | 10.8 | Marine/Estuarine | Worms | Single value | USACOE 2010 |
| 4,4'-DDD | 0.50 | 3.52 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| 4,4'-DDE | 0.88 | 10.8 | Marine/Estuarine | Worms | Single value | DDD value |
| 4,4'-DDE | 3.48 | 24.5 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| 4,4'-DDT | 0.12 | 1.42 | Marine/Estuarine | Worms | Median | USACOE 2010 |
| 4,4'-DDT | 0.13 | 0.92 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Aldrin | 0.42 | 2.96 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 |
| alpha-BHC | 1.00 | 12.3 | Marine | Crustaceans | Single value | USACOE 2010 |
| alpha-BHC | 0.74 | 5.22 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 |
| alpha-Chlordane | 0.88 | 10.8 | Marine/Estuarine | Worms | Single value | USACOE 2010 |
| alpha-Chlordane | 0.48 | 3.37 | Marine/Estuarine | Molluscs | Median | USACOE 2010 (total chlordane) |

Table 7
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Benthic Invertebrates
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Baseline | | | | | |
|---|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Principal Organisms | Basis | Reference |
| beta-BHC | 1.00 | 12.3 | Marine | Crustaceans | Single value | alpha-BHC value |
| beta-BHC | 0.74 | 5.22 | Marine/Estuarine | Molluscs | Single value | alpha-BHC value |
| delta-BHC | 1.00 | 12.3 | Marine | Crustaceans | Single value | alpha-BHC value |
| delta-BHC | 0.74 | 5.22 | Marine/Estuarine | Molluscs | Single value | alpha-BHC value |
| Dieldrin | -- | 4.92 | Fresh | Lumbriculus | Geometric mean | Standley 1997 |
| Dieldrin | 0.49 | 3.46 | Marine/Estuarine | Molluscs | Median | USACOE 2010 |
| Endosulfan I | 0.059 | 0.42 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 (endosulfan sulfate) |
| Endosulfan II | 0.059 | 0.42 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 (endosulfan sulfate) |
| Endrin | 0.49 | 3.43 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 (endrin aldehyde) |
| gamma-BHC (Lindane) | 0.20 | 2.46 | Marine/Estuarine | Crustaceans/worms | Median | USACOE 2010 |
| gamma-BHC (Lindane) | 0.67 | 4.75 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 |
| gamma-Chlordane | 1.23 | 15.2 | Marine/Estuarine | Worms | Single value | USACOE 2010 |
| gamma-Chlordane | 0.48 | 3.37 | Marine/Estuarine | Molluscs | Median | USACOE 2010 (total chlordane) |
| Heptachlor | 0.046 | 0.33 | Fresh/Marine | Molluscs | Median | USACOE 2010 |
| Heptachlor Epoxide | 0.302 | 2.13 | Marine/Estuarine | Molluscs | Single value | USACOE 2010 |
| Methoxychlor | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Toxaphene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Polychlorinated Biphenyls | | | | | | |
| Aroclor-1016 | -- | 4.49 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1016 | -- | 36.2 | Fresh | Adult insects | Median | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1221 | -- | 4.49 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1221 | -- | 36.2 | Fresh | Adult insects | Median | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1232 | -- | 4.49 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1232 | -- | 36.2 | Fresh | Adult insects | Median | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1242 | -- | 4.49 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1242 | -- | 36.2 | Fresh | Adult insects | Median | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1248 | -- | 4.49 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1248 | -- | 36.2 | Fresh | Adult insects | Median | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1254 | -- | 4.49 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1254 | -- | 36.2 | Fresh | Adult insects | Median | Bechtel Jacobs 1998b (Table 2 - adult) |
| Aroclor-1254 | 0.37 | 2.61 | Marine/Estuarine | Molluscs | Median | USACOE 2010 |
| Aroclor-1260 | -- | 4.49 | Fresh | Invertebrate infauna | Geometric mean | Bechtel Jacobs 1998b (Table 2 - Infauna) |
| Aroclor-1260 | -- | 36.2 | Fresh | Adult insects | Median | Bechtel Jacobs 1998b (Table 2 - adult) |

Table 7
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Benthic Invertebrates
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Baseline | | | | | |
|---|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Principal Organisms | Basis | Reference |
| Volatile and Semivolatile Organic Compounds | | | | | | |
| 1,1,2,2-Tetrachloroethane | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 1,2,4,5-Tetrachlorobenzene | -- | 0.40 | Fresh | Amphipods/oligochaetes | Mean | Oliver and Niimi 1988 |
| 1,2,4-Trichlorobenzene | -- | 0.26 | Fresh | Amphipods/oligochaetes | Mean | Oliver and Niimi 1988 |
| 1,2-Dichlorobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 1,3-Dichlorobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 1,4-Dichlorobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 4-Bromophenyl-Phenylether | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 4-Chlorophenyl-Phenylether | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Acenaphthene | 2.04 | 25.1 | Estuarine | Polychaetes | Single value | Maruya et al. 1997 |
| Acenaphthene | 0.052 | 0.37 | Fresh/Marine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Acenaphthylene | 2.04 | 25.1 | Estuarine | Polychaetes | Single value | acenaphthene value |
| Acenaphthylene | 0.128 | 0.90 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Anthracene | 0.326 | 4.00 | Marine/Estuarine | Crustaceans/worms | Median | USACOE 2010 |
| Anthracene | 0.108 | 0.76 | Fresh/Marine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Benzo(a)anthracene | 0.092 | 1.14 | Fresh/Marine | Crustaceans/worms/insects | Median | USACOE 2010 |
| Benzo(a)anthracene | 0.067 | 0.472 | Fresh/Marine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Benzo(a)pyrene | 0.035 | 0.430 | Fresh/Marine | Crustaceans/worms | Median | USACOE 2010 |
| Benzo(a)pyrene | 0.030 | 0.21 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Benzo(b)fluoranthene | 0.002 | 0.028 | Marine/Estuarine | Crustaceans/worms | Median | USACOE 2010 |
| Benzo(b)fluoranthene | 0.001 | 0.010 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Benzo(g,h,i)perylene | 0.002 | 0.021 | Marine/Estuarine | Worms | Median | USACOE 2010 |
| Benzo(g,h,i)perylene | 0.035 | 0.25 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Benzo(k)fluoranthene | 0.141 | 1.73 | Marine/Estuarine | Worms | Median | USACOE 2010 |
| Benzo(k)fluoranthene | 0.291 | 2.05 | Estuarine | Clams | Median | Maruya et al. 1997 |
| Chrysene | 0.106 | 1.31 | Marine/Estuarine | Crustaceans/worms | Median | USACOE 2010 |
| Chrysene | 0.139 | 0.98 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Dibenz(a,h)anthracene | 0.200 | 2.46 | Estuarine | Polychaetes | Median | Maruya et al. 1997 (all PAHs) |
| Dibenz(a,h)anthracene | 0.033 | 0.24 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Fluoranthene | 0.089 | 1.09 | Fresh/Marine | Crustaceans/worms | Median | USACOE 2010 |
| Fluoranthene | 0.103 | 0.73 | Fresh/Marine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Fluorene | 0.299 | 3.67 | Estuarine | Polychaetes | Median | Maruya et al. 1997 |
| Fluorene | 0.176 | 1.24 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |

Table 7
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Benthic Invertebrates
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Baseline | | | | | |
|---|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Principal Organisms | Basis | Reference |
| Hexachlorobenzene | -- | 0.51 | Fresh | Amphipods/oligochaetes | Mean | Oliver and Niimi 1988 |
| Hexachlorobenzene | 0.686 | 4.84 | Marine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Hexachlorobutadiene | -- | 0.39 | Fresh | Amphipods/oligochaetes | Mean | Oliver and Niimi 1988 |
| Hexachlorocyclopentadiene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Hexachloroethane | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Indeno(1,2,3-cd)pyrene | 0.002 | 0.022 | Marine/Estuarine | Worms | Median | USACOE 2010 |
| Indeno(1,2,3-cd)pyrene | 0.031 | 0.22 | Marine/Estuarine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Pentachlorophenol | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Phenanthrene | 0.247 | 3.03 | Marine/Estuarine | Worms | Median | USACOE 2010 |
| Phenanthrene | 0.105 | 0.74 | Fresh/Marine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Pyrene | 0.290 | 3.56 | Fresh/Marine | Crustaceans/worms | Median | USEPA 2009a; USACOE 2010 |
| Pyrene | 0.093 | 0.66 | Fresh/Marine | Molluscs/bivalves | Median | USEPA 2009a; USACOE 2010 |
| Explosives | | | | | | |
| 1,3,5-Trinitrobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 1,3-Dinitrobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2,4,6-Trinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2,4-Dinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2,6-Dinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2-Amino-4,6-dinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 2-Nitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 3-Nitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 4-Amino-2,6-dinitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| 4-Nitrotoluene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| HMX | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Nitrobenzene | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Perchlorate | 1.00 | 1.00 | -- | -- | Assumed | -- |
| RDX | 1.00 | 1.00 | -- | -- | Assumed | -- |
| Tetryl | 1.00 | 1.00 | -- | -- | Assumed | -- |

[1] Wet-weight (ww) BSAFs are converted to dry-weight (dw) using the following values:

| | | | | | |
|---|---|---|---|---|---|
| Lipids (%): | 1.48 | bivalves | 2.58 | macroinvertebrates | USACOE 2010 |
| TOC (%): | 1 | Assumed (default) | | | |
| Percent soilds: | 0.21 | USEPA 1993a | | | |

Table 8
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Fish
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | | |
|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Basis | Reference |
| Metals | | | | | |
| Arsenic | -- | 0.126 | Fresh | Mean | Pascoe et al. 1996 |
| Cadmium | -- | 0.164 | Fresh | Mean | Pascoe et al. 1996 |
| Cadmium | -- | 0.220 | Marine | Median | PTI 1995 |
| Chromium | -- | 0.038 | Fresh | Mean | Krantzberg and Boyd 1992 |
| Copper | -- | 0.100 | Fresh | Mean | Krantzberg and Boyd 1992 |
| Lead | -- | 0.070 | Fresh | Mean | Krantzberg and Boyd 1992 |
| Lead | -- | 0.130 | Marine | Median | PTI 1995 |
| Mercury | -- | 4.58 | Fresh | Maximum | Cope et al. 1990 |
| Nickel | -- | 1.00 | -- | Assumed | -- |
| Selenium | -- | 1.00 | -- | Assumed | -- |
| Silver | -- | 1.00 | -- | Assumed | -- |
| Zinc | -- | 0.147 | Fresh | Mean | Pascoe et al. 1996 |
| Zinc | -- | 1.30 | Marine | Median | PTI 1995 |
| Pesticides | | | | | |
| 4,4'-DDD | 1.54 | 36.9 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| 4,4'-DDE | 17.3 | 414 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| 4,4'-DDT | 1.75 | 41.9 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Aldrin | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| alpha-BHC | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| alpha-Chlordane | 2.61 | 62.7 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| beta-BHC | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| delta-BHC | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Dieldrin | 5.40 | 130 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Endosulfan I | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Endosulfan II | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Endrin | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| gamma-BHC (Lindane) | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| gamma-Chlordane | 2.00 | 48.1 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Heptachlor | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Heptachlor Epoxide | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |

Table 8
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Fish
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | | |
|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Basis | Reference |
| Methoxychlor | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Toxaphene | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Polychlorinated Biphenyls | | | | | |
| Aroclor-1016 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1221 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1232 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1242 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1248 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1254 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1260 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Volatile and Semivolatile Organic Compounds | | | | | |
| 1,1,2,2-Tetrachloroethane | 1.00 | 1.00 | -- | Assumed | -- |
| 1,2,4,5-Tetrachlorobenzene | 0.036 | 0.86 | Marine | Median | Parkerton et al. 1993 |
| 1,2,4-Trichlorobenzene | 0.175 | 4.20 | Marine | 90th percentile | USEPA 2009a |
| 1,2-Dichlorobenzene | 0.112 | 2.69 | Marine | Single value | USEPA 2009a |
| 1,3-Dichlorobenzene | 0.020 | 0.48 | Marine | Single value | USEPA 2009a |
| 1,4-Dichlorobenzene | 0.014 | 0.34 | Marine | Single value | USEPA 2009a |
| 4-Bromophenyl-Phenylether | 1.00 | 1.00 | -- | Assumed | -- |
| 4-Chlorophenyl-Phenylether | 1.00 | 1.00 | -- | Assumed | -- |
| Acenaphthene | 0.043 | 1.03 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Acenaphthylene | 0.027 | 0.64 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Anthracene | 0.013 | 0.31 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(a)anthracene | 0.031 | 0.74 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(a)pyrene | 0.004 | 0.08 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(b)fluoranthene | 0.004 | 0.09 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(g,h,i)perylene | 0.057 | 1.36 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Benzo(k)fluoranthene | 0.004 | 0.09 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Chrysene | 0.022 | 0.54 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Dibenz(a,h)anthracene | 0.004 | 0.09 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Fluoranthene | 0.010 | 0.23 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |

Table 8
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Fish
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Screening | | | | |
|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Basis | Reference |
| Fluorene | 0.124 | 2.99 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Hexachlorobenzene | 0.090 | 2.16 | Fresh/Marine | Median | USEPA 1997c |
| Hexachlorobutadiene | 0.036 | 0.86 | Marine | Median | Parkerton et al. 1993 |
| Hexachlorocyclopentadiene | 1.00 | 1.00 | -- | Assumed | -- |
| Hexachloroethane | 1.00 | 1.00 | -- | Assumed | -- |
| Indeno(1,2,3-cd)pyrene | 0.040 | 0.96 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Pentachlorophenol | 0.41 | 9.84 | Marine | Median | Parkerton et al. 1993 |
| Phenanthrene | 0.062 | 1.50 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Pyrene | 0.046 | 1.11 | Fresh/Marine | 90th percentile | USEPA 2009a; USACOE 2010 |
| Explosives | | | | | |
| 1,3,5-Trinitrobenzene | 1.00 | 1.00 | -- | Assumed | -- |
| 1,3-Dinitrobenzene | 1.00 | 1.00 | -- | Assumed | -- |
| 2,4,6-Trinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 2,4-Dinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 2,6-Dinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 2-Amino-4,6-dinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 2-Nitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 3-Nitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 4-Amino-2,6-dinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 4-Nitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| HMX | 1.00 | 1.00 | -- | Assumed | -- |
| Nitrobenzene | 1.00 | 1.00 | -- | Assumed | -- |
| Perchlorate | 1.00 | 1.00 | -- | Assumed | -- |
| RDX | 1.00 | 1.00 | -- | Assumed | -- |
| Tetryl | 1.00 | 1.00 | -- | Assumed | -- |

[1] Wet-weight (ww) BSAFs are converted to dry-weight (dw) using the following values:

| | | |
|---|---|---|
| Lipids (%): | 6 | USEPA 1997a; USACOE 2010 |
| TOC (%): | 1 | Assumed (default) |
| Percent soilds: | 0.25 | USEPA 1993a |

Table 8
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Fish
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Baseline | | | | |
|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Basis | Reference |
| Metals | | | | | |
| Arsenic | -- | 0.126 | Fresh | Mean | Pascoe et al. 1996 |
| Cadmium | -- | 0.164 | Fresh | Mean | Pascoe et al. 1996 |
| Cadmium | -- | 0.220 | Marine | Median | PTI 1995 |
| Chromium | -- | 0.038 | Fresh | Mean | Krantzberg and Boyd 1992 |
| Copper | -- | 0.100 | Fresh | Mean | Krantzberg and Boyd 1992 |
| Lead | -- | 0.070 | Fresh | Mean | Krantzberg and Boyd 1992 |
| Lead | -- | 0.130 | Marine | Median | PTI 1995 |
| Mercury | -- | 3.25 | Fresh | Mean | Cope et al. 1990 |
| Nickel | -- | 1.00 | -- | Assumed | -- |
| Selenium | -- | 1.00 | -- | Assumed | -- |
| Silver | -- | 1.00 | -- | Assumed | -- |
| Zinc | -- | 0.147 | Fresh | Mean | Pascoe et al. 1996 |
| Zinc | -- | 1.30 | Marine | Median | PTI 1995 |
| Pesticides | | | | | |
| 4,4'-DDD | 0.74 | 17.7 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| 4,4'-DDE | 1.22 | 29.2 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| 4,4'-DDT | 0.80 | 19.1 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Aldrin | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| alpha-BHC | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| alpha-Chlordane | 1.02 | 24.4 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| beta-BHC | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| delta-BHC | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Dieldrin | 0.77 | 18.4 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Endosulfan I | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Endosulfan II | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Endrin | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| gamma-BHC (Lindane) | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| gamma-Chlordane | 1.14 | 27.3 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Heptachlor | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Heptachlor Epoxide | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |

Table 8
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Fish
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Baseline | | | | |
|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Basis | Reference |
| Methoxychlor | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Toxaphene | 1.80 | 43.2 | Fresh/Marine | Median | USEPA 1997c |
| Polychlorinated Biphenyls | | | | | |
| Aroclor-1016 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1221 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1232 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1242 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1248 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1254 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Aroclor-1260 | 1.85 | 44.4 | Fresh/Marine | Median | USEPA 1997c |
| Volatile and Semivolatile Organic Compounds | | | | | |
| 1,1,2,2-Tetrachloroethane | 1.00 | 1.00 | -- | Assumed | -- |
| 1,2,4,5-Tetrachlorobenzene | 0.036 | 0.86 | Marine | Median | Parkerton et al. 1993 |
| 1,2,4-Trichlorobenzene | 0.132 | 3.17 | Marine | Median | USEPA 2009a |
| 1,2-Dichlorobenzene | 0.112 | 2.69 | Marine | Single value | USEPA 2009a |
| 1,3-Dichlorobenzene | 0.020 | 0.48 | Marine | Single value | USEPA 2009a |
| 1,4-Dichlorobenzene | 0.014 | 0.34 | Marine | Single value | USEPA 2009a |
| 4-Bromophenyl-Phenylether | 1.00 | 1.00 | -- | Assumed | -- |
| 4-Chlorophenyl-Phenylether | 1.00 | 1.00 | -- | Assumed | -- |
| Acenaphthene | 0.035 | 0.84 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Acenaphthylene | 0.014 | 0.33 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Anthracene | 0.008 | 0.20 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Benzo(a)anthracene | 0.002 | 0.06 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Benzo(a)pyrene | 0.002 | 0.05 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Benzo(b)fluoranthene | 0.003 | 0.06 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Benzo(g,h,i)perylene | 0.004 | 0.10 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Benzo(k)fluoranthene | 0.002 | 0.06 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Chrysene | 0.003 | 0.06 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Dibenz(a,h)anthracene | 0.002 | 0.05 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Fluoranthene | 0.003 | 0.07 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |

Table 8
Biota Sediment Accumulation Factors (Wet Weight) and Sediment Bioaccumulation Factors (Dry Weight) for Fish
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Baseline | | | | |
|---|---|---|---|---|---|
| | BSAF (ww) | BAF (dw)[1] | Type | Basis | Reference |
| Fluorene | 0.024 | 0.57 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Hexachlorobenzene | 0.090 | 2.16 | Fresh/Marine | Median | USEPA 1997c |
| Hexachlorobutadiene | 0.036 | 0.86 | Marine | Median | Parkerton et al. 1993 |
| Hexachlorocyclopentadiene | 1.00 | 1.00 | -- | Assumed | -- |
| Hexachloroethane | 1.00 | 1.00 | -- | Assumed | -- |
| Indeno(1,2,3-cd)pyrene | 0.002 | 0.06 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Pentachlorophenol | 0.41 | 9.84 | Marine | Median | Parkerton et al. 1993 |
| Phenanthrene | 0.008 | 0.20 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Pyrene | 0.003 | 0.08 | Fresh/Marine | Median | USEPA 2009a; USACOE 2010 |
| Explosives | | | | | |
| 1,3,5-Trinitrobenzene | 1.00 | 1.00 | -- | Assumed | -- |
| 1,3-Dinitrobenzene | 1.00 | 1.00 | -- | Assumed | -- |
| 2,4,6-Trinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 2,4-Dinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 2,6-Dinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 2-Amino-4,6-dinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 2-Nitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 3-Nitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 4-Amino-2,6-dinitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| 4-Nitrotoluene | 1.00 | 1.00 | -- | Assumed | -- |
| HMX | 1.00 | 1.00 | -- | Assumed | -- |
| Nitrobenzene | 1.00 | 1.00 | -- | Assumed | -- |
| Perchlorate | 1.00 | 1.00 | -- | Assumed | -- |
| RDX | 1.00 | 1.00 | -- | Assumed | -- |
| Tetryl | 1.00 | 1.00 | -- | Assumed | -- |

[1] Wet-weight (ww) BSAFs are converted to dry-weight (dw) using the following values:

| | | |
|---|---|---|
| Lipids (%): | 6 | USEPA 1997a; USACOE 2010 |
| TOC (%): | 1 | Assumed (default) |
| Percent soilds: | 0.25 | USEPA 1993a |

Table 9
Exposure Parameters for Upper Trophic Level Ecological Receptors - Screening
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Receptor | Body Weight (kg) | | Water Ingestion Rate (L/day) | | Food Ingestion Rate (kg/day - dry) | |
|---|---|---|---|---|---|---|
| | Value | Reference | Value | Reference | Value | Reference |
| **Birds** | | | | | | |
| Pearly-eyed thrasher | 0.080 | Dunning 2008 (minimum for male/female - Puerto Rico) | 0.0157 | allometric equation (USEPA 1993a)[1] | 0.0174 | allometric equation (Nagy 2001)[3] |
| Green heron | 0.138 | Dunning 2008 (minimum for male/female - Caibbean) | 0.0214 | allometric equation (USEPA 1993a)[1] | 0.0257 | allometric equation (Nagy 2001)[4] |
| Red-tailed hawk | 0.957 | USEPA 1993a (lowest of 6 adult values [3 male/3 female]) | 0.0680 | allometric equation (USEPA 1993a)[1] | 0.0395 | Sample and Suter 1994 |
| Spotted sandpiper | 0.029 | Dunning 2008 (minimum - Pennsylvania [gender not reported]) | 0.0089 | allometric equation (USEPA 1993a)[1] | 0.0105 | allometric equation (Nagy 2001)[4] |
| **Mammals** | | | | | | |
| Norway rat | 0.168 | Silva and Downing 1995 (minimum for male/female - Arkansas) | 0.0516 | allometric equation (USEPA 1993a)[2] | 0.0398 | allometric equation (Nagy 2001)[5] |
| Indian mongoose | 0.312 | Silva and Downing 1995 (minimum for male/female - Puerto Rico) | 0.0933 | allometric equation (USEPA 1993a)[2] | 0.0460 | allometric equation (Nagy 2001)[6] |

1 - All birds equation: $0.059\ (BW)^{0.67}$ (maximum body weight used: thrasher - 0.138 kg; heron - 0.220 kg; hawk - 1.235 kg; sandpiper - 0.0598 kg)
2 - All mammals equation: $0.099\ (BW)^{0.90}$ (maximum body weight used: rat - 0.485 kg; mongoose - 0.936 kg)
3 - Insectivorous birds equation: $(0.54*((BW*1000)^{0.705}))/1000$ (maximum body weight used: 0.138 kg)
4 - All birds equation: $(0.638*((BW*1000)^{0.685)})/1000$ (maximum body weight used: heron - 0.220 kg; sandpiper - 0.0598 kg)
5 - Rodent equation used: $(0.332*((BW*1000)^{0.774}))/1000$ (maximum body weight used - 0.485 kg)
6 - Carnivore equation used: $(0.153*((BW*1000)^{0.834)})/1000$ (maximum body weight used - 0.936 kg)

Table 9
Exposure Parameters for Upper Trophic Level Ecological Receptors - Screening
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Receptor | Dietary Composition (percent) | | | | | | | Soil/ Sediment Ingestion (percent) | |
|---|---|---|---|---|---|---|---|---|---|
| | Terrestrial Plants | Soil Invertebrates | Small Mammals | Fish | Aquatic Plants | Aquatic Invertebrates | Reference | Value | Reference |
| Birds | | | | | | | | | |
| Pearly-eyed thrasher | 0 | 95.4 | 0 | 0 | 0 | 0 | Exclusive diet | 4.6 | Sample and Suter 1994 (value is for American robin) |
| Green heron | 0 | 0 | 0 | 100 | 0 | 0 | Exclusive diet | 0 | Sample et al. 1997 |
| Red-tailed hawk | 0 | 0 | 100 | 0 | 0 | 0 | USEPA 1993a; Sample and Suter 1994 | 0 | Sample and Suter 1994 |
| Spotted sandpiper | 0 | 0 | 0 | 0 | 0 | 82.0 | USEPA 1993a | 18.0 | Beyer et al. 1994 |
| Mammals | | | | | | | | | |
| Norway rat | 98.0 | 0 | 0 | 0 | 0 | 0 | Exclusive diet | 2.0 | Beyer et al. 1994 (value is for deer mouse) |
| Indian Mongoose | 0 | 97.2 | 0 | 0 | 0 | 0 | Exclusive diet | 2.8 | Beyer et al. 1994 (value is for red fox) |

Table 10
Exposure Parameters for Upper Trophic Level Ecological Receptors - Baseline
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Receptor | Body Weight (kg) | | Water Ingestion Rate (L/day) | | Food Ingestion Rate (kg/day - dry) | | Home Range (ha) | |
|---|---|---|---|---|---|---|---|---|
| | Value | Reference | Value | Reference | Value | Reference | Value | Reference |
| **Birds** | | | | | | | | |
| Pearly-eyed thrasher | 0.104 | Dunning 2008 (mean for male/female - Puerto Rico) | 0.0129 | allometric equation (USEPA 1993a)[1] | 0.0123 | allometric equation (Nagy 2001)[3] | No data | -- |
| Green heron | 0.187 | Dunning 2008 (mean for male/female - Caibbean) | 0.0192 | allometric equation (USEPA 1993a)[1] | 0.0230 | allometric equation (Nagy 2001)[4] | No data | -- |
| Red-tailed hawk | 1.134 | USEPA 1993a (mean of 6 adult values [3 male/3 female]) | 0.0642 | allometric equation (USEPA 1993a)[1] | 0.0363 | Sample and Suter 1994 | 859 | USEPA 1993a (mean for male/female adults) |
| Spotted sandpiper | 0.040 | Dunning 2008 (mean - Pennsylvania [gender not reported]) | 0.0069 | allometric equation (USEPA 1993a)[1] | 0.0080 | allometric equation (Nagy 2001)[4] | 0.25 | USEPA 1993a (approximate) |
| **Mammals** | | | | | | | | |
| Norway rat | 0.209 | Silva and Downing 1995 (mean for male/female - Arkansas) | 0.0242 | allometric equation (USEPA 1993a)[2] | 0.0207 | allometric equation (Nagy 2001)[5] | 0.24 | Stroud 1982 |
| Indian mongoose | 0.528 | Silva and Downing 1995 (mean for male/female - Puerto Rico) | 0.0557 | allometric equation (USEPA 1993a)[2] | 0.0285 | allometric equation (Nagy 2001)[6] | 3.20 | Nellis 1989 |

1 - All birds equation: $0.059\ (BW)^{0.67}$
2 - All mammals equation: $0.099\ (BW)^{0.90}$
3 - Omnivorous birds equation: $(0.67*((BW*1000)^{0.627}))/1000$
4 - All birds equation: $(0.638*((BW*1000)^{0.685)})/1000$
5 - Rodent equation used: $(0.332*((BW*1000)^{0.774}))/1000$
6 - Carnivore equation used: $(0.153*((BW*1000)^{0.834)})/1000$

Table 10
Exposure Parameters for Upper Trophic Level Ecological Receptors - Baseline
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Receptor | Dietary Composition (percent) | | | | | | | Soil/ Sediment Ingestion (percent) | |
|---|---|---|---|---|---|---|---|---|---|
| | Terrestrial Plants | Soil Invertebrates | Small Mammals | Fish | Aquatic Plants | Aquatic Invertebrates | Reference | Value | Reference |
| Birds | | | | | | | | | |
| Pearly-eyed thrasher | 20.0 | 75.4 | 0 | 0 | 0 | 0 | Oberle 2000 (estimated based on description of diet) | 4.6 | Sample and Suter 1994 (value is for American robin) |
| Green heron | 0 | 0 | 0 | 71.0 | 0 | 29.0 | Sample et al. 1997 | 0 | Sample et al. 1997 |
| Red-tailed hawk | 0 | 0 | 100 | 0 | 0 | 0 | USEPA 1993a; Sample and Suter 1994 | 0 | Sample and Suter 1994 |
| Spotted sandpiper | 0 | 0 | 0 | 0 | 0 | 82.0 | USEPA 1993a | 18.0 | Beyer et al. 1994 |
| Mammals | | | | | | | | | |
| Norway rat | 49.0 | 49.0 | 0 | 0 | 0 | 0 | Linzey 1998 (estimated based on description of diet) | 2.0 | Beyer et al. 1994 (value is for deer mouse) |
| Indian mongoose | 11.1 | 56.4 | 29.7 | 0 | 0 | 0 | Nellis 1989 | 2.8 | Beyer et al. 1994 (value is for red fox) |

Table 11
Uncertainty Factors
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Convert From | Convert To | Uncertainty Factor |
|---|---|---|
| Chronic NOAEL or NOEC | Chronic NOAEL or NOEC | 1 |
| Chronic LOAEL or LOEC | Chronic NOAEL or NOEC | 5 |
| Chronic NOAEL or NOEC | Chronic LOAEL or LOEC | 5 |
| Subchronic NOAEL or NOEC | Chronic NOAEL or NOEC | 10 |
| Subchronic LOAEL or LOEC | Chronic NOAEL or NOEC | 20 |
| Acute NOAEL or NOEC | Chronic NOAEL or NOEC | 30 |
| Acute LOAEL or LOEC | Chronic NOAEL or NOEC | 50 |
| LD50 or LC50 | Chronic NOAEL or NOEC | 100 |

Uncertainty factors from Wentsel et al. (1996)
Durations are defined as follows (USEPA 1999; Sample et al. 1996):
- Acute: <3 days (plants, invertebrates) and <14 days (fish, birds, mammals)
- Subchronic: 3 - 6 days (plants, invertebrates) and 14 - 90 days (fish, birds, mammals)
- Chronic: >7 days (plants, invertebrates) and >90 days or during critical life stage (fish, birds, mammals)

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Table 12
Fresh Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Hardness (mg/L) | pH | Reference | Comments |
|---|---|---|---|---|---|---|---|
| Inorganics | | | | | | | |
| Aluminum | 87.0 | ug/L | AWQC | | | USEPA 2009b | |
| Antimony | 30.0 | ug/L | FCV | | | Suter and Tsao 1996 | |
| Arsenic, 3+ (applied to total As) | 150 | ug/L | AWQC | | | USEPA 2009b | |
| Barium | 4.00 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Beryllium | 0.66 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Cadmium (total) | 0.27 | ug/L | AWQC | 100 | | USEPA 2009b | |
| Cadmium (dissolved) | 0.25 | ug/L | AWQC | 100 | | USEPA 2009b | |
| Chromium (total), hexavalent | 11.4 | ug/L | AWQC | | | USEPA 2009b | |
| Chromium (dissolved), hexavalent | 11.0 | ug/L | AWQC; WQS | | | USEPA 2009b; PREQB 2003 | |
| Cobalt | 23.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Copper (total) | 9.33 | ug/L | AWQC; WQS | 100 | | USEPA 2006a; PREQB 2003 | |
| Copper (dissolved) | 8.96 | ug/L | AWQC | 100 | | USEPA 2006a | |
| Cyanide, free | 5.20 | ug/L | AWQC; WQS | | | USEPA 2009b; PREQB 2003 | |
| Iron | 1,000 | ug/L | AWQC | | | USEPA 2009b | |
| Lead (total) | 3.18 | ug/L | AWQC; WQS | 100 | | USEPA 2009b; PREQB 2003 | |
| Lead (dissolved) | 2.52 | ug/L | AWQC | 100 | | USEPA 2009b | |
| Manganese | 120 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Mercury (total), non-methyl forms | 0.05 | ug/L | WQS | | | PREQB 2003 | |
| Mercury (dissolved), non-methyl forms | 0.77 | ug/L | AWQC | | | USEPA 2009b | |
| Nickel (total) | 52.2 | ug/L | AWQC; WQS | 100 | | USEPA 2009b; PREQB 2003 | |
| Nickel (dissolved) | 52.0 | ug/L | AWQC | 100 | | USEPA 2009b | |
| Selenium (total) | 5.00 | ug/L | AWQC; WQS | | | USEPA 2009b; PREQB 2003 | |
| Selenium (dissolved) | 4.61 | ug/L | AWQC | | | USEPA 2009b | |
| Silver | 0.36 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Thallium | 12.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Vanadium | 20.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Zinc (total) | 120 | ug/L | AWQC; WQS | 100 | | USEPA 2009b; PREQB 2003 | |
| Zinc (dissolved) | 118 | ug/L | AWQC | 100 | | USEPA 2009b | |

Table 12
Fresh Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Hardness (mg/L) | pH | Reference | Comments |
|---|---|---|---|---|---|---|---|
| Pesticides | | | | | | | |
| 4,4'-DDD | 0.011 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 4,4'-DDE | 0.013 | ug/L | SCV | | | DDT value | |
| 4,4'-DDT | 0.013 | ug/L | SCV | | | USEPA 1996a | |
| Aldrin | 0.30 | ug/L | | | | USEPA 2001 | USEPA Region 4 value |
| alpha-BHC | 2.20 | ug/L | SCV | | | Suter and Tsao 1996 | |
| alpha-Chlordane | 0.17 | ug/L | SCV | | | Suter and Tsao 1996 | |
| beta-BHC | 2.20 | ug/L | SCV | | | Suter and Tsao 1996 | |
| delta-BHC | 2.20 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Dieldrin | 0.056 | ug/L | AWQC FCV | | | USEPA 2009b | |
| Endosulfan I | 0.056 | ug/L | AWQC; WQS | | | USEPA 2009b; PREQB 2003 | |
| Endosulfan II | 0.056 | ug/L | AWQC; WQS | | | USEPA 2009b; PREQB 2003 | |
| Endosulfan sulfate | 0.056 | ug/L | | | | Endosulfan value | |
| Endrin | 0.036 | ug/L | AWQC; WQS FCV | | | USEPA 2009b; PREQB 2003 | |
| Endrin aldehyde | 0.15 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Endrin ketone | 0.15 | ug/L | | | | Endrin aldehyde value | |
| gamma-BHC (Lindane) | 0.08 | ug/L | FCV | | | USEPA 1996a | |
| gamma-Chlordane | 0.17 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Heptachlor | 0.0069 | ug/L | SCV | | | USEPA 1996a | |
| Heptachlor epoxide | 0.0069 | ug/L | | | | Heptachlor value | |
| Methoxychlor | 0.03 | ug/L | AWQC; WQS | | | USEPA 2009b; PREQB 2003 | |
| Toxaphene | 0.011 | ug/L | SCV | | | USEPA 1996a | |
| Polychlorinated Biphenyls | | | | | | | |
| Aroclor-1016 | 0.14 | ug/L | SCV | | | Suter and Tsao 1996 | PCBs |
| Aroclor-1221 | 0.28 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Aroclor-1232 | 0.58 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Aroclor-1242 | 0.053 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Aroclor-1248 | 0.081 | ug/L | SCV | | | Suter and Tsao 1996 | |

Table 12
Fresh Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Hardness (mg/L) | pH | Reference | Comments |
|---|---|---|---|---|---|---|---|
| Aroclor-1254 | 0.033 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Aroclor-1260 | 0.14 | ug/L | SCV | | | Suter and Tsao 1996 | PCBs |
| Semivolatile Organic Compounds | | | | | | | |
| 1,1-Biphenyl | 14.0 | ug/L | SCV | | | USEPA 1996a | |
| 1,2,3-Trichlorobenzene | 8.00 | ug/L | | | | Buchman 2008 | Canadian Water Quality Guideline |
| 1,2,4,5-Tetrachlorobenzene | 3.00 | ug/L | FCV | | | Buchman 2008 | USEPA Region 5 value |
| 1,2,4-Trichlorobenzene | 110 | ug/L | SCV | | | USEPA 1996a | |
| 1,2-Dichlorobenzene | 14.0 | ug/L | SCV | | | USEPA 1996a | |
| 1,3-Dichlorobenzene | 71.0 | ug/L | SCV | | | USEPA 1996a | |
| 1,4-Dichlorobenzene | 15.0 | ug/L | SCV | | | USEPA 1996a | |
| 1,4-Dioxane | -- | -- | -- | -- | -- | -- | |
| 2,2'-Oxybis(1-chloropropane) | -- | -- | -- | -- | -- | -- | |
| 2,3,4,6-Tetrachlorophenol | 1.20 | ug/L | FCV | | | USEPA 2006b | USEPA Region 5 value |
| 2,4,5-Trichlorophenol | 63.0 | ug/L | | | | Buchman 2008 | |
| 2,4,6-Trichlorophenol | 4.90 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| 2,4-Dichlorophenol | 11.0 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| 2,4-Dimethylphenol | 100 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| 2,4-Dinitrophenol | 19.0 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| 2,4-Dinitrotoluene | 44.0 | ug/L | SCV | | | Buchman 2008 | USEPA Region 5 value |
| 2,6-Dinitrotoluene | 81.0 | ug/L | SCV | | | USEPA 2006b | Ohio EPA (2002) value |
| 2-Chloronaphthalene | 0.40 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| 2-Chlorophenol | 24.0 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| 2-Methylnaphthalene | 330 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| 2-Methylphenol | 13.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 2-Nitroaniline | -- | -- | -- | -- | -- | -- | |
| 2-Nitrophenol | 1,920 | ug/L | | | | USEPA 2006b | TRNCC (2000; 2001) value |
| 3- and 4-Methylphenol | 543 | ug/L | | | | 4-Methylphenol value | |
| 3,3'-Dichlorobenzidine | 4.50 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| 3-Nitroaniline | -- | -- | -- | -- | -- | -- | |
| 4,6-Dinitro-2-methylphenol | 2.30 | ug/L | | | | USEPA 2001 | USEPA Region 4 value |

Table 12
Fresh Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Hardness (mg/L) | pH | Reference | Comments |
|---|---|---|---|---|---|---|---|
| 4-Bromophenyl-phenylether | 1.50 | ug/L | SCV | | | USEPA 1996a | |
| 4-Chloro-3-methylphenol | 0.30 | ug/L | | | | USEPA 2001 | USEPA Region 4 value |
| 4-Chloroaniline | 232 | ug/L | | | | USEPA 2006b | USEPA Region 5 value |
| 4-Chlorophenyl-phenylether | -- | -- | -- | -- | -- | -- | |
| 4-Methylphenol | 543 | ug/L | | | | USEPA 2006b | TRNCC (2000; 2001) value |
| 4-Nitroaniline | -- | -- | -- | -- | -- | -- | |
| 4-Nitrophenol | 300 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Acenaphthene | 23.0 | ug/L | FCV | | | USEPA 1996a | |
| Acenaphthylene | 4,840 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Acetophenone | -- | -- | -- | -- | -- | -- | |
| Anthracene | 0.73 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Atrazine | 1.80 | ug/L | | | | Buchman 2008 | Canadian Water Quality Guideline |
| Benzaldehyde | -- | -- | -- | -- | -- | -- | |
| Benzo(a)anthracene | 0.027 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Benzo(a)pyrene | 0.014 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Benzo(b)fluoranthene | 9.07 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Benzo(g,h,i)perylene | 7.64 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Benzo(k)fluoranthene | -- | -- | -- | -- | -- | -- | |
| Benzoic acid | 42.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Benzyl alcohol | 8.60 | ug/L | SCV | | | Suter and Tsao 1996 | |
| bis(2-Chloroethoxy)methane | -- | -- | -- | -- | -- | -- | |
| bis(2-Chloroethyl)ether | 1,900 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| bis(2-Ethylhexyl)phthalate | 3.00 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Butylbenzylphthalate | 19.0 | ug/L | SCV | | | USEPA 1996a | |
| Caprolactam | -- | -- | -- | -- | -- | -- | |
| Carbazole | -- | -- | -- | -- | -- | -- | |
| Chrysene | -- | -- | -- | -- | -- | -- | |
| Dibenz(a,h)anthracene | -- | -- | -- | -- | -- | -- | |
| Dibenzofuran | 3.70 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Diethylphthalate | 270 | ug/L | SCV | | | USEPA 2008b | |

Table 12
Fresh Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Hardness (mg/L) | pH | Reference | Comments |
|---|---|---|---|---|---|---|---|
| Dimethyl phthalate | 330 | ug/L | | | | USEPA 2001 | USEPA Region 4 value |
| Di-n-butylphthalate | 35.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Di-n-octylphthalate | 22.0 | ug/L | | | | USEPA 2006b | TRNCC (2000; 2001) value |
| Fluoranthene | 8.10 | ug/L | FCV | | | USEPA 1996a | |
| Fluorene | 3.90 | ug/L | SCV | | | USEPA 1996a | |
| Hexachlorobenzene | 3.68 | ug/L | | | | Buchman 2008 | |
| Hexachlorobutadiene | 1.30 | ug/L | | | | Buchman 2008 | Canadian Water Quality Guideline |
| Hexachlorocyclopentadiene | 1.04 | ug/L | | | | Buchman 2008 | LOEL/5 |
| Hexachloroethane | 12.0 | ug/L | SCV | | | USEPA 1996a | |
| Indeno(1,2,3-cd)pyrene | 4.31 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Isophorone | 1,170 | ug/L | | | | Buchman 2008 | USEPA Region 4 value |
| Naphthalene | 12.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Nitrobenzene | 220 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| n-Nitroso-di-n-propylamine | -- | -- | -- | -- | -- | -- | |
| n-Nitrosodiphenylamine | 210 | ug/L | SCV | | | Suter and Tsao 1996 | |
| PAH (total) | -- | -- | -- | -- | -- | -- | |
| PAH (HMW) | -- | -- | -- | -- | -- | -- | |
| PAH (LMW) | -- | -- | -- | -- | -- | -- | |
| Pentachlorophenol | 15.0 | ug/L | AWQC | | 7.8 | USEPA 2009b | AWQC |
| Phenanthrene | 6.30 | ug/L | FCV | | | USEPA 1996a | |
| Phenol | 110 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Pyrene | 0.025 | ug/L | | | | Buchman 2008 | Canadian Water Quality Guideline |
| TPH-diesel range | -- | -- | -- | -- | -- | -- | |
| TPH-gas range | -- | -- | -- | -- | -- | -- | |
| TPH-oil range | -- | -- | -- | -- | -- | -- | |
| Volatile Organic Compounds | | | | | | | |
| 1,1,1-Trichloroethane | 11.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 1,1,2,2-Tetrachloroethane | 610 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | -- | -- | -- | -- | -- | |
| 1,1,2-Trichloroethane | 1,200 | ug/L | SCV | | | Suter and Tsao 1996 | |

Table 12
Fresh Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Hardness (mg/L) | pH | Reference | Comments |
|---|---|---|---|---|---|---|---|
| 1,1-Dichloroethane | 47.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 1,1-Dichloroethene | 25.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 1,2,3-Trichlorobenzene | 8.00 | ug/L | | | | Buchman 2008 | Canadian Water Quality Guideline |
| 1,2,4-Trichlorobenzene | 110 | ug/L | SCV | | | USEPA 1996a | |
| 1,2-Dibromo-3-chloropropane | -- | -- | -- | -- | -- | -- | |
| 1,2-Dibromoethane | -- | -- | -- | -- | -- | -- | |
| 1,2-Dichlorobenzene | 14.0 | ug/L | SCV | | | USEPA 1996a | |
| 1,2-Dichloroethane | 910 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 1,2-Dichloropropane | 525 | ug/L | | | | USEPA 2001 | USEPA Region 4 value |
| 1,3-Dichlorobenzene | 71.0 | ug/L | SCV | | | USEPA 1996a | |
| 1,4-Dichlorobenzene | 15.0 | ug/L | SCV | | | USEPA 1996a | |
| 2-Butanone | 14,000 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 2-Hexanone | 99.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| 4-Methyl-2-pentanone | 170 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Acetone | 1,500 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Benzene | 130 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Bromochloromethane | -- | -- | -- | -- | -- | -- | |
| Bromodichloromethane | -- | -- | -- | -- | -- | -- | |
| Bromoform | 320 | ug/L | SCV | | | USEPA 1996a | |
| Bromomethane | 16.0 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Carbon disulfide | 0.92 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Carbon tetrachloride | 240 | ug/L | SCV | | | USEPA 1996a | |
| Chlorobenzene | 64.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Chloroethane | -- | -- | -- | -- | -- | -- | |
| Chloroform | 28.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Chloromethane | 5,500 | ug/L | | | | USEPA 2001 | USEPA Region 4 value |
| cis-1,2-Dichloroethene | 590 | ug/L | SCV | | | Suter and Tsao 1996 | |
| cis-1,3-Dichloropropene | 0.055 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Cyclohexane | -- | -- | -- | -- | -- | -- | |
| Dibromochloromethane | -- | -- | -- | -- | -- | -- | |

Table 12
Fresh Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Hardness (mg/L) | pH | Reference | Comments |
|---|---|---|---|---|---|---|---|
| Dichlorodifluoromethane(Freon-12) | -- | -- | -- | -- | -- | -- | |
| Ethylbenzene | 7.30 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Isopropylbenzene (Cumene) | 2.60 | ug/L | | | | USEPA 2006b | NYSDEC (1993, 1999) value |
| Methyl acetate | -- | -- | -- | -- | -- | -- | |
| Methylcyclohexane | -- | -- | -- | -- | -- | -- | |
| Methylene chloride | 2,200 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Methyl-tert-butyl ether (MTBE) | 10,000 | ug/L | | | | Buchman 2008 | Canadian Water Quality Guideline |
| m- and p-Xylene | 67.0 | ug/L | SCV | | | USEPA 2008b | |
| o-Xylene | 67.0 | ug/L | SCV | | | m,p-Xylene value | |
| Styrene | 32.0 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Tetrachloroethene | 98.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Toluene | 9.80 | ug/L | SCV | | | Suter and Tsao 1996 | |
| trans-1,2-Dichloroethene | 590 | ug/L | SCV | | | Suter and Tsao 1996 | |
| trans-1,3-Dichloropropene | 0.055 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Trichloroethene | 47.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Trichlorofluoromethane(Freon-11) | -- | -- | -- | -- | -- | -- | |
| Vinyl chloride | 930 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Xylene, total | 13.0 | ug/L | SCV | | | Suter and Tsao 1996 | |
| Explosives | | | | | | | |
| 1,3,5-Trinitrobenzene | 11.0 | ug/L | SCV | | | Talmage et al. 1999 | |
| 1,3-Dinitrobenzene | 17.0 | ug/L | SCV | | | Talmage et al. 1999 | |
| 2,4,6-Trinitrotoluene | 93.0 | ug/L | SCV | | | Talmage et al. 1999 | |
| 2,4-Dinitrotoluene | 44.0 | ug/L | SCV | | | Buchman 2008 | USEPA Region 5 value |
| 2,6-Dinitrotoluene | 81.0 | ug/L | SCV | | | USEPA 2006b | Ohio EPA 2002 value |
| 2-Amino-4,6-dinitrotoluene | 19.0 | ug/L | SCV | | | Talmage et al. 1999 | |
| 2-Nitrotoluene | 3,400 | ug/L | | | | NAVFAC 2007 | Table 3-5 |
| 3,5-Dinitroaniline | 59.0 | ug/L | SCV | | | Talmage et al. 1999 | |
| 3-Nitrotoluene | 750 | ug/L | | | | USEPA 2006b | TRNCC (2000; 2001) value |
| 4-Amino-2,6-dinitrotoluene | 19.0 | ug/L | SCV | | | 2-Amino-4,6-dinitrotoluene value | |
| 4-Nitrotoluene | 1,900 | ug/L | | | | USEPA 2006b | TRNCC (2000; 2001) value |

Table 12
Fresh Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Hardness (mg/L) | pH | Reference | Comments |
|---|---|---|---|---|---|---|---|
| HMX | 330 | ug/L | SCV | | | Talmage et al. 1999 | |
| Nitrobenzene | 220 | ug/L | | | | Buchman 2008 | USEPA Region 5 value |
| Nitroglycerine | 138 | ug/L | | | | USEPA 2006b | TRNCC (2000; 2001) value |
| Nitroguanidine | 220 | ug/L | NOEC | | | NAVFAC 2007 | Table 3-5 |
| Perchlorate | 9,300 | ug/L | Chronic | | | Dean et al. 2004 | |
| PETN | 85,000 | ug/L | | | | USEPA 2006b | TRNCC (2000; 2001) value |
| RDX | 186 | ug/L | SCV | | | Talmage et al. 1999 | |
| Tetryl | -- | -- | -- | -- | -- | -- | |

1 - AWQC: Ambient Water Quality Criterion; FCV: Final Chronic Value; FRV: Final Residue Value; NOEC: No Observed Effect Concentration; SCV: Secondary Chronic Value; WQS: Water Quality Standard (Aquatic Life)

Table 13
Marine Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Inorganics | | | | | |
| Aluminum | -- | -- | -- | -- | |
| Antimony | 4,300 | ug/L | WQS | PREQB 2003 | |
| Arsenic (total), 3+ (applied to total As) | 1.40 | ug/L | WQS | PREQB 2003 | |
| Arsenic (dissolved), 3+ (applied to total As) | 36.0 | ug/L | AWQC | USEPA 2009b | |
| Barium | 200 | ug/L | | Buchman 2008 | British Columbia value |
| Beryllium | 100 | ug/L | | Buchman 2008 | British Columbia value |
| Cadmium (total) | 8.85 | ug/L | AWQC | USEPA 2009b | |
| Cadmium (dissolved) | 8.80 | ug/L | AWQC | USEPA 2009b | |
| Chromium (total), hexavalent | 50.4 | ug/L | AWQC | USEPA 2009b | |
| Chromium (dissolved), hexavalent | 50.0 | ug/L | AWQC | USEPA 2009b | |
| Cobalt | -- | -- | -- | -- | |
| Copper (total) | 3.73 | ug/L | AWQC | USEPA 2009b | |
| Copper (dissolved) | 3.10 | ug/L | AWQC; WQS | USEPA 2009b; PREQB 2003 | |
| Cyanide, free | 1.00 | ug/L | AWQC; WQS | USEPA 2009b; PREQB 2003 | Free cyanide |
| Iron | 50.0 | ug/L | | Buchman 2008 | British Columbia value |
| Lead (total) | 8.52 | ug/L | AWQC | USEPA 2009b | |
| Lead (dissolved) | 8.10 | ug/L | AWQC; WQS | USEPA 2009b; PREQB 2003 | |
| Manganese | 100 | ug/L | | Buchman 2008 | British Columbia value |
| Mercury (total), non-methyl forms | 0.051 | ug/L | WQS | PREQB 2003 | |
| Mercury (dissolved), non-methyl forms | 0.94 | ug/L | AWQC | USEPA 2009b | |
| Nickel (total) | 8.28 | ug/L | AWQC | USEPA 2009b | |
| Nickel (dissolved) | 8.20 | ug/L | AWQC; WQS | USEPA 2009b; PREQB 2003 | |
| Selenium (total) | 71.1 | ug/L | AWQC | USEPA 2009b | |
| Selenium (dissolved) | 71.0 | ug/L | AWQC; WQS | USEPA 2009b; PREQB 2003 | |
| Silver | 2.00 | ug/L | WQS | PREQB 2003 | |
| Thallium | 21.3 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Vanadium | 50.0 | ug/L | | Buchman 2008 | British Columbia value |
| Zinc (total) | 85.6 | ug/L | AWQC | USEPA 2009b | |
| Zinc (dissolved) | 81.0 | ug/L | AWQC; WQS | USEPA 2009b; PREQB 2003 | |

Table 13
Marine Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Pesticides | | | | | |
| 4,4'-DDD | 0.001 | ug/L | AWQC; WQS FRV | USEPA 2009b; PREQB 2003 | |
| 4,4'-DDE | 0.001 | ug/L | AWQC; WQS FRV | USEPA 2009b; PREQB 2003 | |
| 4,4'-DDT | 0.001 | ug/L | AWQC; WQS FRV | USEPA 2009b; PREQB 2003 | |
| Aldrin | 0.13 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| alpha-BHC | 25.0 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| alpha-Chlordane | 0.004 | ug/L | AWQC; WQS FRV | USEPA 2009b; PREQB 2003 | |
| beta-BHC | 25.0 | ug/L | | alpha-BHC value | |
| delta-BHC | 25.0 | ug/L | | alpha-BHC value | |
| Dieldrin | 0.11 | ug/L | FCV | USEPA 1996a | |
| Endosulfan I | 0.087 | ug/L | WQS | PREQB 2003 | |
| Endosulfan II | 0.087 | ug/L | WQS | PREQB 2003 | |
| Endosulfan sulfate | 0.087 | ug/L | WQS | PREQB 2003 | |
| Endrin | 0.01 | ug/L | FCV | USEPA 1996a | |
| Endrin aldehyde | 0.01 | ug/L | FCV | Endrin value | |
| Endrin ketone | 0.01 | ug/L | FCV | Endrin value | |
| gamma-BHC (Lindane) | 0.16 | ug/L | WQS | PREQB 2003 | |
| gamma-Chlordane | 0.004 | ug/L | AWQC; WQS FRV | USEPA 2009b; PREQB 2003 | |
| Heptachlor | 0.0036 | ug/L | AWQC FRV | USEPA 2009b | |
| Heptachlor epoxide | 0.0036 | ug/L | AWQC FRV | USEPA 2009b | |
| Methoxychlor | 0.03 | ug/L | AWQC; WQS | USEPA 2009b; PREQB 2003 | |
| Toxaphene | 0.21 | ug/L | FCV | USEPA 1996a | |
| Polychlorinated Biphenyls | | | | | |
| Aroclor-1016 | 0.03 | ug/L | AWQC FRV | USEPA 2009b | |
| Aroclor-1221 | 0.03 | ug/L | AWQC FRV | USEPA 2009b | |
| Aroclor-1232 | 0.03 | ug/L | AWQC FRV | USEPA 2009b | |
| Aroclor-1242 | 0.03 | ug/L | AWQC FRV | USEPA 2009b | |
| Aroclor-1248 | 0.03 | ug/L | AWQC FRV | USEPA 2009b | |
| Aroclor-1254 | 0.03 | ug/L | AWQC FRV | USEPA 2009b | |
| Aroclor-1260 | 0.03 | ug/L | AWQC FRV | USEPA 2009b | |
| Semivolatile Organic Compounds | | | | | |
| 1,1-Biphenyl | -- | -- | -- | -- | |

Table 13
Marine Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| 1,2,3-Trichlorobenzene | -- | -- | -- | -- | |
| 1,2,4,5-Tetrachlorobenzene | 129 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 1,2,4-Trichlorobenzene | 5.40 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| 1,2-Dichlorobenzene | 42.0 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| 1,3-Dichlorobenzene | 28.5 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 1,4-Dichlorobenzene | 19.9 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 1,4-Dioxane | -- | -- | -- | -- | |
| 2,2'-Oxybis(1-chloropropane) | -- | -- | -- | -- | |
| 2,3,4,6-Tetrachlorophenol | 44.0 | ug/L | | Buchman 2008 | |
| 2,4,5-Trichlorophenol | 11.0 | ug/L | | Buchman 2008 | Proposed AWQC |
| 2,4,6-Trichlorophenol | 61.0 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| 2,4-Dichlorophenol | -- | -- | -- | -- | |
| 2,4-Dimethylphenol | -- | -- | -- | -- | |
| 2,4-Dinitrophenol | 48.5 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 2,4-Dinitrotoluene | 480 | ug/L | NOEC | Nipper et al. 2001 | |
| 2,6-Dinitrotoluene | 1,000 | ug/L | NOEC | Nipper et al. 2001 | |
| 2-Chloronaphthalene | -- | -- | -- | -- | |
| 2-Chlorophenol | 265 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| 2-Methylnaphthalene | -- | -- | -- | -- | |
| 2-Methylphenol | 1,020 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| 2-Nitroaniline | -- | -- | -- | -- | |
| 2-Nitrophenol | 2,940 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| 3- and 4-Methylphenol | -- | -- | -- | -- | |
| 3,3'-Dichlorobenzidine | 73.0 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| 3-Nitroaniline | -- | -- | -- | -- | |
| 4,6-Dinitro-2-methylphenol | -- | -- | -- | -- | |
| 4-Bromophenyl-phenylether | -- | -- | -- | -- | |
| 4-Chloro-3-methylphenol | -- | -- | -- | -- | |
| 4-Chloroaniline | -- | -- | -- | -- | |
| 4-Chlorophenyl-phenylether | -- | -- | -- | -- | |
| 4-Methylphenol | -- | -- | -- | -- | |
| 4-Nitroaniline | -- | -- | -- | -- | |

Table 13
Marine Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| 4-Nitrophenol | 71.7 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Acenaphthene | 40.0 | ug/L | FCV | USEPA 1996a | |
| Acenaphthylene | -- | -- | -- | -- | |
| Acetophenone | -- | -- | -- | -- | |
| Anthracene | 0.18 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| Atrazine | 10.0 | ug/L | | Buchman 2008 | British Columbia value |
| Benzaldehyde | -- | -- | -- | -- | |
| Benzo(a)anthracene | -- | -- | -- | -- | |
| Benzo(a)pyrene | -- | -- | -- | -- | |
| Benzo(b)fluoranthene | -- | -- | -- | -- | |
| Benzo(g,h,i)perylene | -- | -- | -- | -- | |
| Benzo(k)fluoranthene | -- | -- | -- | -- | |
| Benzoic acid | -- | -- | -- | -- | |
| Benzyl alcohol | -- | -- | -- | -- | |
| bis(2-Chloroethoxy)methane | -- | -- | -- | -- | |
| bis(2-Chloroethyl)ether | -- | -- | -- | -- | |
| bis(2-Ethylhexyl)phthalate | 360 | ug/L | | Buchman 2008 | Proposed AWQC |
| Butylbenzylphthalate | 29.4 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Caprolactam | -- | -- | -- | -- | |
| Carbazole | -- | -- | -- | -- | |
| Chrysene | -- | -- | -- | -- | |
| Dibenz(a,h)anthracene | -- | -- | -- | -- | |
| Dibenzofuran | 65.0 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| Diethylphthalate | 75.9 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Dimethyl phthalate | 580 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Di-n-butylphthalate | 3.40 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Di-n-octylphthalate | -- | -- | -- | -- | |
| Fluoranthene | 11.0 | ug/L | FCV | USEPA 1996a | |
| Fluorene | -- | -- | -- | -- | |
| Hexachlorobenzene | -- | -- | -- | -- | |
| Hexachlorobutadiene | 0.32 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Hexachlorocyclopentadiene | 0.07 | ug/L | | USEPA 2001 | USEPA Region 4 value |

Table 13
Marine Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Hexachloroethane | 9.40 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Indeno(1,2,3-cd)pyrene | -- | -- | -- | -- | |
| Isophorone | 129 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Naphthalene | 1.40 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| Nitrobenzene | 66.8 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| n-Nitroso-di-n-propylamine | 120 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| n-Nitrosodiphenylamine | 33,000 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| PAH (total) | -- | -- | -- | -- | |
| PAH (HMW) | -- | -- | -- | -- | |
| PAH (LMW) | -- | -- | -- | -- | |
| Pentachlorophenol | 7.90 | ug/L | AWQC; WQS | USEPA 2009b; PREQB 2003 | |
| Phenanthrene | 8.30 | ug/L | FCV | USEPA 1996a | |
| Phenol | 58.0 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Pyrene | 0.24 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| TPH-diesel range | -- | -- | -- | -- | |
| TPH-gas range | -- | -- | -- | -- | |
| TPH-oil range | -- | -- | -- | -- | |
| Volatile Organic Compounds | | | | | |
| 1,1,1-Trichloroethane | 312 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 1,1,2,2-Tetrachloroethane | 90.2 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | -- | -- | -- | |
| 1,1,2-Trichloroethane | 550 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| 1,1-Dichloroethane | -- | -- | -- | -- | |
| 1,1-Dichloroethene | 2,240 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 1,2,3-Trichlorobenzene | -- | -- | -- | -- | |
| 1,2,4-Trichlorobenzene | 5.40 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| 1,2-Dibromo-3-chloropropane | -- | -- | -- | -- | |
| 1,2-Dibromoethane | -- | -- | -- | -- | |
| 1,2-Dichlorobenzene | 42.0 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| 1,2-Dichloroethane | 1,130 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 1,2-Dichloropropane | 2,400 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 1,3-Dichlorobenzene | 28.5 | ug/L | | USEPA 2001 | USEPA Region 4 value |

Table 13
Marine Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| 1,4-Dichlorobenzene | 19.9 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| 2-Butanone | -- | -- | -- | -- | |
| 2-Hexanone | -- | -- | -- | -- | |
| 4-Methyl-2-pentanone | 123,000 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| Acetone | 564,000 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| Benzene | 110 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| Bromochloromethane | -- | -- | -- | -- | |
| Bromodichloromethane | -- | -- | -- | -- | |
| Bromoform | 640 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Bromomethane | 120 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Carbon disulfide | -- | -- | -- | -- | |
| Carbon tetrachloride | 1,500 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Chlorobenzene | 25.0 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| Chloroethane | -- | -- | -- | -- | |
| Chloroform | 815 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Chloromethane | 2,700 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| cis-1,2-Dichloroethene | 680 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| cis-1,3-Dichloropropene | 7.90 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Cyclohexane | -- | -- | -- | -- | |
| Dibromochloromethane | -- | -- | -- | -- | |
| Dichlorodifluoromethane(Freon-12) | -- | -- | -- | -- | |
| Ethylbenzene | 25.0 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| Isopropylbenzene (Cumene) | -- | -- | -- | -- | |
| Methyl acetate | -- | -- | -- | -- | |
| Methylcyclohexane | -- | -- | -- | -- | |
| Methylene chloride | 2,560 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Methyl-tert-butyl ether (MTBE) | 5,000 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |
| m- and p-Xylene | -- | -- | -- | -- | |
| o-Xylene | -- | -- | -- | -- | |
| Styrene | 910 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| Tetrachloroethene | 45.0 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Toluene | 215 | ug/L | | Buchman 2008 | Canadian Water Quality Guideline |

Table 13
Marine Surface Water Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| trans-1,2-Dichloroethene | 680 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| trans-1,3-Dichloropropene | 7.90 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Trichloroethene | 1,940 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| Trichlorofluoromethane(Freon-11) | -- | -- | -- | -- | |
| Vinyl chloride | -- | -- | -- | -- | |
| Xylene, total | -- | -- | -- | -- | |
| Explosives | | | | | |
| 1,3,5-Trinitrobenzene | 15.0 | ug/L | NOEC | Nipper et al. 2001 | Table 1; algae |
| 1,3-Dinitrobenzene | 180 | ug/L | NOEC | Nipper et al. 2001 | Table 1; algae |
| 2,4,6-Trinitrotoluene | 100 | ug/L | | USEPA 2006b | TRNCC (2001) value |
| 2,4-Dinitrotoluene | 480 | ug/L | NOEC | Nipper et al. 2001 | Table 1; algae |
| 2,6-Dinitrotoluene | 1,000 | ug/L | NOEC | Nipper et al. 2001 | Table 1; algae |
| 2-Amino-4,6-dinitrotoluene | -- | -- | -- | -- | |
| 2-Nitrotoluene | -- | -- | -- | -- | |
| 3,5-Dinitroaniline | -- | -- | -- | -- | |
| 3-Nitrotoluene | -- | -- | -- | -- | |
| 4-Amino-2,6-dinitrotoluene | -- | -- | -- | -- | |
| 4-Nitrotoluene | -- | -- | -- | -- | |
| HMX | -- | -- | -- | -- | |
| Nitrobenzene | 66.8 | ug/L | | USEPA 2001 | USEPA Region 4 value |
| Nitroglycerine | -- | -- | -- | -- | |
| Nitroguanidine | -- | -- | -- | -- | |
| Perchlorate | -- | -- | -- | -- | |
| PETN | -- | -- | -- | -- | |
| RDX | 5,000 | ug/L | NOEC | Nipper et al. 2001 | Table 1; algae |
| Tetryl | 8.00 | ug/L | NOEC | Nipper et al. 2001 | Table 1; polychaete |

1 - AWQC: Ambient Water Quality Criterion; FCV: Final Chronic Value; FRV: Final Residue Value; NOEC: No Observed Effect Concentration; WQS: Water Quality Standard (Aquatic Life)

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Table 14
Freshwater Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Inorganics | | | | | |
| Aluminum | 25,500 | mg/kg | ARCS TEL | Buchman 2008 | |
| Antimony | 3.00 | mg/kg | UET | Buchman 2008 | Microtox |
| Arsenic | 9.79 | mg/kg | TEC | MacDonald et al. 2000a | |
| Barium | 20.0 | mg/kg | TEC | MacDonald et al. 2003 | |
| Beryllium | -- | -- | -- | -- | |
| Cadmium | 0.99 | mg/kg | TEC | MacDonald et al. 2000a | |
| Chromium | 43.4 | mg/kg | TEC | MacDonald et al. 2000a | |
| Cobalt | 50.0 | mg/kg | TEC | MacDonald et al. 2003 | |
| Copper | 31.6 | mg/kg | TEC | MacDonald et al. 2000a | |
| Cyanide | -- | -- | -- | -- | |
| Iron | 20,000 | mg/kg | LEL | Persuad et al. 1993 | |
| Lead | 35.8 | mg/kg | TEC | MacDonald et al. 2000a | |
| Manganese | 460 | mg/kg | LEL | Persuad et al. 1993 | |
| Mercury | 0.18 | mg/kg | TEC | MacDonald et al. 2000a | |
| Nickel | 22.7 | mg/kg | TEC | MacDonald et al. 2000a | |
| Selenium | 2.00 | mg/kg | | USEPA 2006b | Lemly 2002 |
| Silver | 1.00 | mg/kg | TEC | MacDonald et al. 2003 | |
| Thallium | -- | -- | -- | -- | |
| Vanadium | -- | -- | -- | -- | |
| Zinc | 121 | mg/kg | TEC | MacDonald et al. 2000a | |
| Pesticides | | | | | |
| 4,4'-DDD | 4.88 | ug/kg | TEC | MacDonald et al. 2000a | |
| 4,4'-DDE | 3.16 | ug/kg | TEC | MacDonald et al. 2000a | |
| 4,4'-DDT | 4.16 | ug/kg | TEC | MacDonald et al. 2000a | |
| Aldrin | 2.00 | ug/kg | LEL | Persuad et al. 1993 | |
| alpha-BHC | 6.00 | ug/kg | LEL | Persuad et al. 1993 | |
| alpha-Chlordane | 3.24 | ug/kg | TEC | MacDonald et al. 2000a | |
| beta-BHC | 5.00 | ug/kg | LEL | Persuad et al. 1993 | |
| delta-BHC | 3.00 | ug/kg | LEL | Persuad et al. 1993 | HCH-technical |
| Dieldrin | 1.90 | ug/kg | TEC | MacDonald et al. 2000a | |
| Endosulfan I | -- | -- | -- | -- | |

Table 14
Freshwater Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Endosulfan II | -- | -- | -- | -- | |
| Endosulfan sulfate | -- | -- | -- | -- | |
| Endrin | 2.22 | ug/kg | TEC | MacDonald et al. 2000a | |
| Endrin aldehyde | 2.22 | ug/kg | TEC | Endrin value | |
| Endrin ketone | 2.22 | ug/kg | TEC | Endrin value | |
| gamma-BHC (Lindane) | 2.37 | ug/kg | TEC | MacDonald et al. 2000a | |
| gamma-Chlordane | 3.24 | ug/kg | TEC | MacDonald et al. 2000a | |
| Heptachlor | 10.0 | ug/kg | UET | Buchman 2008 | Infaunal community (at 1% TOC) |
| Heptachlor epoxide | 2.47 | ug/kg | TEC | MacDonald et al. 2000a | |
| Methoxychlor | -- | -- | -- | -- | |
| Toxaphene | -- | -- | -- | -- | |
| Polychlorinated Biphenyls | | | | | |
| Aroclor-1016 | 59.8 | ug/kg | TEC | MacDonald et al. 2000a | |
| Aroclor-1221 | 59.8 | ug/kg | TEC | MacDonald et al. 2000a | |
| Aroclor-1232 | 59.8 | ug/kg | TEC | MacDonald et al. 2000a | |
| Aroclor-1242 | 59.8 | ug/kg | TEC | MacDonald et al. 2000a | |
| Aroclor-1248 | 59.8 | ug/kg | TEC | MacDonald et al. 2000a | |
| Aroclor-1254 | 59.8 | ug/kg | TEC | MacDonald et al. 2000a | |
| Aroclor-1260 | 59.8 | ug/kg | TEC | MacDonald et al. 2000a | |
| Semivolatile Organic Compounds | | | | | |
| 1,1-Biphenyl | -- | -- | -- | -- | |
| 1,2,3-Trichlorobenzene | -- | -- | -- | -- | |
| 1,2,4,5-Tetrachlorobenzene | -- | -- | -- | -- | |
| 1,2,4-Trichlorobenzene | -- | -- | -- | -- | |
| 1,2-Dichlorobenzene | -- | -- | -- | -- | |
| 1,3-Dichlorobenzene | -- | -- | -- | -- | |
| 1,4-Dichlorobenzene | -- | -- | -- | -- | |
| 1,4-Dioxane | -- | -- | -- | -- | |
| 2,2'-Oxybis(1-chloropropane) | -- | -- | -- | -- | |
| 2,3,4,6-Tetrachlorophenol | -- | -- | -- | -- | |
| 2,4,5-Trichlorophenol | -- | -- | -- | -- | |

Table 14
Freshwater Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| 2,4,6-Trichlorophenol | -- | -- | -- | -- | |
| 2,4-Dichlorophenol | -- | -- | -- | -- | |
| 2,4-Dimethylphenol | -- | -- | -- | -- | |
| 2,4-Dinitrophenol | -- | -- | -- | -- | |
| 2,4-Dinitrotoluene | -- | -- | -- | -- | |
| 2,6-Dinitrotoluene | -- | -- | -- | -- | |
| 2-Chloronaphthalene | -- | -- | -- | -- | |
| 2-Chlorophenol | -- | -- | -- | -- | |
| 2-Methylnaphthalene | -- | -- | -- | -- | |
| 2-Methylphenol | -- | -- | -- | -- | |
| 2-Nitroaniline | -- | -- | -- | -- | |
| 2-Nitrophenol | -- | -- | -- | -- | |
| 3- and 4-Methylphenol | -- | -- | -- | -- | |
| 3,3'-Dichlorobenzidine | -- | -- | -- | -- | |
| 3-Nitroaniline | -- | -- | -- | -- | |
| 4,6-Dinitro-2-methylphenol | -- | -- | -- | -- | |
| 4-Bromophenyl-phenylether | -- | -- | -- | -- | |
| 4-Chloro-3-methylphenol | -- | -- | -- | -- | |
| 4-Chloroaniline | -- | -- | -- | -- | |
| 4-Chlorophenyl-phenylether | -- | -- | -- | -- | |
| 4-Methylphenol | -- | -- | -- | -- | |
| 4-Nitroaniline | -- | -- | -- | -- | |
| 4-Nitrophenol | -- | -- | -- | -- | |
| Acenaphthene | 290 | ug/kg | UET | Buchman 2008 | Microtox (at 1% TOC) |
| Acenaphthylene | 160 | ug/kg | UET | Buchman 2008 | Microtox (at 1% TOC) |
| Acetophenone | -- | -- | -- | -- | |
| Anthracene | 57.2 | ug/kg | TEC | MacDonald et al. 2000a | |
| Atrazine | 0.30 | ug/kg | TEC | MacDonald et al. 2003 | |
| Benzaldehyde | -- | -- | -- | -- | |
| Benzo(a)anthracene | 108 | ug/kg | TEC | MacDonald et al. 2000a | |
| Benzo(a)pyrene | 150 | ug/kg | TEC | MacDonald et al. 2000a | |
| Benzo(b)fluoranthene | 240 | ug/kg | | Benzo(k)fluoranthene value | |

Table 14
Freshwater Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Benzo(g,h,i)perylene | 170 | ug/kg | LEL | Persuad et al. 1993 | |
| Benzo(k)fluoranthene | 240 | ug/kg | LEL | Persuad et al. 1993 | |
| Benzoic acid | -- | -- | -- | -- | |
| Benzyl alcohol | -- | -- | -- | -- | |
| bis(2-Chloroethoxy)methane | -- | -- | -- | -- | |
| bis(2-Chloroethyl)ether | -- | -- | -- | -- | |
| bis(2-Ethylhexyl)phthalate | 750 | ug/kg | UET | Buchman 2008 | Microtox (at 1% TOC) |
| Butylbenzylphthalate | -- | -- | -- | -- | |
| Caprolactam | -- | -- | -- | -- | |
| Carbazole | -- | -- | -- | -- | |
| Chrysene | 166 | ug/kg | TEC | MacDonald et al. 2000a | |
| Dibenz(a,h)anthracene | 33.0 | ug/kg | TEC | MacDonald et al. 2000a | |
| Dibenzofuran | 5,100 | ug/kg | UET | Buchman 2008 | Hyalella (at 1% TOC) |
| Diethylphthalate | 630 | ug/kg | TEC | MacDonald et al. 2003 | |
| Dimethyl phthalate | -- | -- | -- | -- | |
| Di-n-butylphthalate | 110 | ug/kg | UET | Buchman 2008 | Hyalella (at 1% TOC) |
| Di-n-octylphthalate | -- | -- | -- | -- | |
| Fluoranthene | 423 | ug/kg | TEC | MacDonald et al. 2000a | |
| Fluorene | 77.4 | ug/kg | TEC | MacDonald et al. 2000a | |
| Hexachlorobenzene | 20.0 | ug/kg | TEC; LEL | MacDonald et al. 2003; Persuad et al. 1993 | |
| Hexachlorobutadiene | -- | -- | -- | -- | |
| Hexachlorocyclopentadiene | -- | -- | -- | -- | |
| Hexachloroethane | -- | -- | -- | -- | |
| Indeno(1,2,3-cd)pyrene | 200 | ug/kg | LEL | Persuad et al. 1993 | |
| Isophorone | -- | -- | -- | -- | |
| Naphthalene | 176 | ug/kg | TEC | MacDonald et al. 2000a | |
| Nitrobenzene | -- | -- | -- | -- | |
| n-Nitroso-di-n-propylamine | -- | -- | -- | -- | |
| n-Nitrosodiphenylamine | -- | -- | -- | -- | |
| PAH (total) | 1,610 | ug/kg | TEC | MacDonald et al. 2000a | ARCS TEC = 3,553 ug/kg (Jones et al. 1997) |
| PAH (HMW) | 193 | ug/kg | ARCS TEL | Buchman 2008 | ARCS TEC = 2,900 ug/kg (Jones et al. 1997) |

Table 14
Freshwater Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| PAH (LMW) | 76.4 | ug/kg | ARCS TEL | Buchman 2008 | ARCS TEC = 786 ug/kg (Jones et al. 1997) |
| Pentachlorophenol | -- | -- | -- | -- | |
| Phenanthrene | 204 | ug/kg | TEC | MacDonald et al. 2000a | |
| Phenol | 48.0 | ug/kg | UET | Buchman 2008 | Hyalella (at 1% TOC) |
| Pyrene | 195 | ug/kg | TEC | MacDonald et al. 2000a | |
| TPH-diesel range | -- | -- | -- | -- | |
| TPH-gas range | -- | -- | -- | -- | |
| TPH-oil range | -- | -- | -- | -- | |
| Volatile Organic Compounds | | | | | |
| 1,1,1-Trichloroethane | -- | -- | -- | -- | |
| 1,1,2,2-Tetrachloroethane | -- | -- | -- | -- | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | -- | -- | -- | |
| 1,1,2-Trichloroethane | -- | -- | -- | -- | |
| 1,1-Dichloroethane | -- | -- | -- | -- | |
| 1,1-Dichloroethene | -- | -- | -- | -- | |
| 1,2,3-Trichlorobenzene | -- | -- | -- | -- | |
| 1,2,4-Trichlorobenzene | -- | -- | -- | -- | |
| 1,2-Dibromo-3-chloropropane | -- | -- | -- | -- | |
| 1,2-Dibromoethane | -- | -- | -- | -- | |
| 1,2-Dichlorobenzene | -- | -- | -- | -- | |
| 1,2-Dichloroethane | -- | -- | -- | -- | |
| 1,2-Dichloropropane | -- | -- | -- | -- | |
| 1,3-Dichlorobenzene | -- | -- | -- | -- | |
| 1,4-Dichlorobenzene | -- | -- | -- | -- | |
| 2-Butanone | -- | -- | -- | -- | |
| 2-Hexanone | -- | -- | -- | -- | |
| 4-Methyl-2-pentanone | -- | -- | -- | -- | |
| Acetone | -- | -- | -- | -- | |
| Benzene | -- | -- | -- | -- | |
| Bromochloromethane | -- | -- | -- | -- | |
| Bromodichloromethane | -- | -- | -- | -- | |
| Bromoform | -- | -- | -- | -- | |

Table 14
Freshwater Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Bromomethane | -- | -- | -- | -- | |
| Carbon disulfide | -- | -- | -- | -- | |
| Carbon tetrachloride | -- | -- | -- | -- | |
| Chlorobenzene | -- | -- | -- | -- | |
| Chloroethane | -- | -- | -- | -- | |
| Chloroform | -- | -- | -- | -- | |
| Chloromethane | -- | -- | -- | -- | |
| cis-1,2-Dichloroethene | -- | -- | -- | -- | |
| cis-1,3-Dichloropropene | -- | -- | -- | -- | |
| Cyclohexane | -- | -- | -- | -- | |
| Dibromochloromethane | -- | -- | -- | -- | |
| Dichlorodifluoromethane(Freon-12) | -- | -- | -- | -- | |
| Ethylbenzene | -- | -- | -- | -- | |
| Isopropylbenzene (Cumene) | -- | -- | -- | -- | |
| Methyl acetate | -- | -- | -- | -- | |
| Methylcyclohexane | -- | -- | -- | -- | |
| Methylene chloride | -- | -- | -- | -- | |
| Methyl-tert-butyl ether (MTBE) | -- | -- | -- | -- | |
| m- and p-Xylene | -- | -- | -- | -- | |
| o-Xylene | -- | -- | -- | -- | |
| Styrene | -- | -- | -- | -- | |
| Tetrachloroethene | -- | -- | -- | -- | |
| Toluene | -- | -- | -- | -- | |
| trans-1,2-Dichloroethene | -- | -- | -- | -- | |
| trans-1,3-Dichloropropene | -- | -- | -- | -- | |
| Trichloroethene | -- | -- | -- | -- | |
| Trichlorofluoromethane(Freon-11) | -- | -- | -- | -- | |
| Vinyl chloride | -- | -- | -- | -- | |
| Xylene, total | -- | -- | -- | -- | |
| Explosives | | | | | |
| 1,3,5-Trinitrobenzene | -- | -- | -- | -- | |
| 1,3-Dinitrobenzene | -- | -- | -- | -- | |

Table 14
Freshwater Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| 2,4,6-Trinitrotoluene | -- | -- | -- | -- | |
| 2,4-Dinitrotoluene | -- | -- | -- | -- | |
| 2,6-Dinitrotoluene | -- | -- | -- | -- | |
| 2-Amino-4,6-dinitrotoluene | -- | -- | -- | -- | |
| 2-Nitrotoluene | -- | -- | -- | -- | |
| 3,5-Dinitroaniline | -- | -- | -- | -- | |
| 3-Nitrotoluene | -- | -- | -- | -- | |
| 4-Amino-2,6-dinitrotoluene | -- | -- | -- | -- | |
| 4-Nitrotoluene | -- | -- | -- | -- | |
| HMX | -- | -- | -- | -- | |
| Nitrobenzene | -- | -- | -- | -- | |
| Nitroglycerine | -- | -- | -- | -- | |
| Nitroguanidine | -- | -- | -- | -- | |
| Perchlorate | -- | -- | -- | -- | |
| PETN | -- | -- | -- | -- | |
| RDX | -- | -- | -- | -- | |
| Tetryl | -- | -- | -- | -- | |

1 - LEL: Lowest Effect Level; TEC: Threshold Effect Concentration; TEL: Threshold Effect Level; UET: Upper Effects Threshold

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Table 15
Marine Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Inorganics | | | | | |
| Aluminum | 18,000 | mg/kg | AET | Buchman 2008 | Neanthes |
| Antimony | 2.00 | mg/kg | ER-L | Long and Morgan 1990 | |
| Arsenic | 8.20 | mg/kg | ER-L | Long et al. 1995 | |
| Barium | 48.0 | mg/kg | AET | Buchman 2008 | Amphipod |
| Beryllium | -- | -- | -- | -- | |
| Cadmium | 1.20 | mg/kg | ER-L | Long et al. 1995 | |
| Chromium | 81.0 | mg/kg | ER-L | Long et al. 1995 | |
| Cobalt | 10.0 | mg/kg | AET | Buchman 2008 | Neanthes |
| Copper | 34.0 | mg/kg | ER-L | Long et al. 1995 | |
| Cyanide | -- | -- | -- | -- | |
| Iron | 220,000 | mg/kg | AET | Buchman 2008 | Neanthes |
| Lead | 46.7 | mg/kg | ER-L | Long et al. 1995 | |
| Manganese | 260 | mg/kg | AET | Buchman 2008 | Neanthes |
| Mercury | 0.15 | mg/kg | ER-L | Long et al. 1995 | |
| Nickel | 20.9 | mg/kg | ER-L | Long et al. 1995 | |
| Selenium | 1.00 | mg/kg | AET | Buchman 2008 | Amphipod |
| Silver | 1.00 | mg/kg | ER-L | Long et al. 1995 | |
| Thallium | -- | -- | -- | -- | |
| Vanadium | 57.0 | mg/kg | AET | Buchman 2008 | Neanthes |
| Zinc | 150 | mg/kg | ER-L | Long et al. 1995 | |
| Pesticides | | | | | |
| 4,4'-DDD | 1.22 | ug/kg | TEL | MacDonald 1994 | |
| 4,4'-DDE | 2.20 | ug/kg | ER-L | Long et al. 1995 | |
| 4,4'-DDT | 1.19 | ug/kg | TEL | MacDonald 1994 | |
| Aldrin | 9.50 | ug/kg | AET | Buchman 2008 | Amphipod/Echinoderm larvae |
| alpha-BHC | 0.32 | ug/kg | TEL | gamma-BHC value | |
| alpha-Chlordane | 2.26 | ug/kg | TEL | MacDonald 1994 | |
| beta-BHC | 0.32 | ug/kg | TEL | gamma-BHC value | |
| delta-BHC | 0.32 | ug/kg | TEL | gamma-BHC value | |

Table 15
Marine Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Dieldrin | 0.715 | ug/kg | TEL | MacDonald 1994 | |
| Endosulfan I | -- | -- | -- | -- | |
| Endosulfan II | -- | -- | -- | -- | |
| Endosulfan sulfate | -- | -- | -- | -- | |
| Endrin | 0.02 | ug/kg | ER-L | Long and Morgan 1990 | |
| Endrin aldehyde | 0.02 | ug/kg | ER-L | Endrin value | |
| Endrin ketone | 0.02 | ug/kg | ER-L | Endrin value | |
| gamma-BHC (Lindane) | 0.32 | ug/kg | TEL | MacDonald 1994 | |
| gamma-Chlordane | 2.26 | ug/kg | TEL | MacDonald 1994 | |
| Heptachlor | 0.30 | ug/kg | AET | Buchman 2008 | Bivalve |
| Heptachlor epoxide | 0.30 | ug/kg | AET | Heptachlor value | Bivalve |
| Methoxychlor | -- | -- | -- | -- | |
| Toxaphene | -- | -- | -- | -- | |
| Polychlorinated Biphenyls | | | | | |
| Aroclor-1016 | 48.0 | ug/kg | TEC | MacDonald et al. 2000b | Concensus-based value |
| Aroclor-1221 | 48.0 | ug/kg | TEC | MacDonald et al. 2000b | Concensus-based value |
| Aroclor-1232 | 48.0 | ug/kg | TEC | MacDonald et al. 2000b | Concensus-based value |
| Aroclor-1242 | 48.0 | ug/kg | TEC | MacDonald et al. 2000b | Concensus-based value |
| Aroclor-1248 | 48.0 | ug/kg | TEC | MacDonald et al. 2000b | Concensus-based value |
| Aroclor-1254 | 63.3 | ug/kg | ISQG | CCME 2002 | |
| Aroclor-1260 | 48.0 | ug/kg | TEC | MacDonald et al. 2000b | Concensus-based value |
| Semivolatile Organic Compounds | | | | | |
| 1,1-Biphenyl | 17.0 | ug/kg | T20 | Buchman 2008 | |
| 1,2,3-Trichlorobenzene | -- | -- | -- | -- | |
| 1,2,4,5-Tetrachlorobenzene | -- | -- | -- | -- | |
| 1,2,4-Trichlorobenzene | 4.80 | ug/kg | AET | Buchman 2008 | Echinoderm larvae |
| 1,2-Dichlorobenzene | 13.0 | ug/kg | AET | Buchman 2008 | Neanthes |
| 1,3-Dichlorobenzene | -- | -- | -- | -- | |
| 1,4-Dichlorobenzene | 110 | ug/kg | AET | Buchman 2008 | Infaunal community/Microtox |
| 1,4-Dioxane | -- | -- | -- | -- | |

Table 15
Marine Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| 2,2'-Oxybis(1-chloropropane) | -- | -- | -- | -- | |
| 2,3,4,6-Tetrachlorophenol | -- | -- | -- | -- | |
| 2,4,5-Trichlorophenol | 3.00 | ug/kg | AET | Buchman 2008 | Infaunal community |
| 2,4,6-Trichlorophenol | 6.00 | ug/kg | AET | Buchman 2008 | Infaunal community |
| 2,4-Dichlorophenol | -- | -- | -- | -- | |
| 2,4-Dimethylphenol | 29.0 | ug/kg | | Washington State 1995 | Sediment Management (Quality) Standards |
| 2,4-Dinitrophenol | -- | -- | -- | -- | |
| 2,4-Dinitrotoluene | -- | -- | -- | -- | |
| 2,6-Dinitrotoluene | 549 | ug/kg | NOEC | Nipper et al. 2002 | |
| 2-Chloronaphthalene | -- | -- | -- | -- | |
| 2-Chlorophenol | -- | -- | -- | -- | |
| 2-Methylnaphthalene | 70.0 | ug/kg | ER-L | Long et al. 1995 | |
| 2-Methylphenol | 63.0 | ug/kg | | Washington State 1995 | Sediment Management (Quality) Standards |
| 2-Nitroaniline | -- | -- | -- | -- | |
| 2-Nitrophenol | -- | -- | -- | -- | |
| 3- and 4-Methylphenol | 670 | ug/kg | | Washington State 1995 | Sediment Management (Quality) Standards |
| 3,3'-Dichlorobenzidine | -- | -- | -- | -- | |
| 3-Nitroaniline | -- | -- | -- | -- | |
| 4,6-Dinitro-2-methylphenol | -- | -- | -- | -- | |
| 4-Bromophenyl-phenylether | -- | -- | -- | -- | |
| 4-Chloro-3-methylphenol | -- | -- | -- | -- | |
| 4-Chloroaniline | -- | -- | -- | -- | |
| 4-Chlorophenyl-phenylether | -- | -- | -- | -- | |
| 4-Methylphenol | 670 | ug/kg | | Washington State 1995 | Sediment Management (Quality) Standards |
| 4-Nitroaniline | -- | -- | -- | -- | |
| 4-Nitrophenol | -- | -- | -- | -- | |
| Acenaphthene | 16.0 | ug/kg | ER-L | Long et al. 1995 | |
| Acenaphthylene | 44.0 | ug/kg | ER-L | Long et al. 1995 | |
| Acetophenone | -- | -- | -- | -- | |
| Anthracene | 85.3 | ug/kg | ER-L | Long et al. 1995 | |
| Atrazine | -- | -- | -- | -- | |

Table 15
Marine Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Benzaldehyde | -- | -- | -- | -- | |
| Benzo(a)anthracene | 261 | ug/kg | ER-L | Long et al. 1995 | |
| Benzo(a)pyrene | 430 | ug/kg | ER-L | Long et al. 1995 | |
| Benzo(b)fluoranthene | 1,800 | ug/kg | AET | Buchman 2008 | Echinoderm larvae/infaunal community |
| Benzo(g,h,i)perylene | 670 | ug/kg | AET | Buchman 2008 | Microtox |
| Benzo(k)fluoranthene | 1,800 | ug/kg | AET | Buchman 2008 | Echinoderm larvae/infaunal community |
| Benzoic acid | 650 | ug/kg | | Washington State 1995 | Sediment Management (Quality) Standards |
| Benzyl alcohol | 57.0 | ug/kg | | Washington State 1995 | Sediment Management (Quality) Standards |
| bis(2-Chloroethoxy)methane | -- | -- | -- | -- | |
| bis(2-Chloroethyl)ether | -- | -- | -- | -- | |
| bis(2-Ethylhexyl)phthalate | 182 | ug/kg | TEL | MacDonald 1994 | |
| Butylbenzylphthalate | 63.0 | ug/kg | AET | Buchman 2008 | Microtox |
| Caprolactam | -- | -- | -- | -- | |
| Carbazole | -- | -- | -- | -- | |
| Chrysene | 384 | ug/kg | ER-L | Long et al. 1995 | |
| Dibenz(a,h)anthracene | 63.4 | ug/kg | ER-L | Long et al. 1995 | |
| Dibenzofuran | 110 | ug/kg | AET | Buchman 2008 | Echinoderm larvae |
| Diethylphthalate | 6.00 | ug/kg | AET | Buchman 2008 | Bivalve/larval bioassay |
| Dimethyl phthalate | 6.00 | ug/kg | AET | Buchman 2008 | Bivalve |
| Di-n-butylphthalate | 58.0 | ug/kg | AET | Buchman 2008 | Bivalve/larval bioassay |
| Di-n-octylphthalate | 61.0 | ug/kg | AET | Buchman 2008 | Bivalve/larval bioassay |
| Fluoranthene | 600 | ug/kg | ER-L | Long et al. 1995 | |
| Fluorene | 19.0 | ug/kg | ER-L | Long et al. 1995 | |
| Hexachlorobenzene | 6.00 | ug/kg | AET | Buchman 2008 | Bivalve |
| Hexachlorobutadiene | 1.30 | ug/kg | AET | Buchman 2008 | Echinoderm larvae |
| Hexachlorocyclopentadiene | -- | -- | -- | -- | |
| Hexachloroethane | 73.0 | ug/kg | AET | Buchman 2008 | Bivalve/larval bioassay |
| Indeno(1,2,3-cd)pyrene | 600 | ug/kg | AET | Buchman 2008 | Microtox |
| Isophorone | -- | -- | -- | -- | |
| Naphthalene | 160 | ug/kg | ER-L | Long et al. 1995 | |
| Nitrobenzene | 21.0 | ug/kg | AET | Buchman 2008 | Neanthes |

Table 15
Marine Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| n-Nitroso-di-n-propylamine | -- | -- | -- | -- | |
| n-Nitrosodiphenylamine | 28.0 | ug/kg | AET | Buchman 2008 | Infaunal community |
| PAH (total) | 4,022 | ug/kg | ER-L | Long et al. 1995 | |
| PAH (HMW) | 1,700 | ug/kg | ER-L | Long et al. 1995 | |
| PAH (LMW) | 552 | ug/kg | ER-L | Long et al. 1995 | |
| Pentachlorophenol | 360 | ug/kg | | Washington State 1995 | Sediment Management (Quality) Standards |
| Phenanthrene | 240 | ug/kg | ER-L | Long et al. 1995 | |
| Phenol | 420 | ug/kg | | Washington State 1995 | Sediment Management (Quality) Standards |
| Pyrene | 665 | ug/kg | ER-L | Long et al. 1995 | |
| TPH-diesel range | -- | -- | -- | -- | |
| TPH-gas range | -- | -- | -- | -- | |
| TPH-oil range | -- | -- | -- | -- | |
| Volatile Organic Compounds | | | | | |
| 1,1,1-Trichloroethane | -- | -- | -- | -- | |
| 1,1,2,2-Tetrachloroethane | -- | -- | -- | -- | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | -- | -- | -- | |
| 1,1,2-Trichloroethane | -- | -- | -- | -- | |
| 1,1-Dichloroethane | -- | -- | -- | -- | |
| 1,1-Dichloroethene | -- | -- | -- | -- | |
| 1,2,3-Trichlorobenzene | -- | -- | -- | -- | |
| 1,2,4-Trichlorobenzene | 4.80 | ug/kg | AET | Buchman 2008 | Echinoderm larvae |
| 1,2-Dibromo-3-chloropropane | -- | -- | -- | -- | |
| 1,2-Dibromoethane | -- | -- | -- | -- | |
| 1,2-Dichlorobenzene | 13.0 | ug/kg | AET | Buchman 2008 | Neanthes |
| 1,2-Dichloroethane | -- | -- | -- | -- | |
| 1,2-Dichloropropane | -- | -- | -- | -- | |
| 1,3-Dichlorobenzene | -- | -- | -- | -- | |
| 1,4-Dichlorobenzene | 110 | ug/kg | AET | Buchman 2008 | Infaunal community/Microtox |
| 2-Butanone | -- | -- | -- | -- | |
| 2-Hexanone | -- | -- | -- | -- | |
| 4-Methyl-2-pentanone | -- | -- | -- | -- | |

Table 15
Marine Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Acetone | -- | -- | -- | -- | |
| Benzene | -- | -- | -- | -- | |
| Bromochloromethane | -- | -- | -- | -- | |
| Bromodichloromethane | -- | -- | -- | -- | |
| Bromoform | -- | -- | -- | -- | |
| Bromomethane | -- | -- | -- | -- | |
| Carbon disulfide | -- | -- | -- | -- | |
| Carbon tetrachloride | -- | -- | -- | -- | |
| Chlorobenzene | -- | -- | -- | -- | |
| Chloroethane | -- | -- | -- | -- | |
| Chloroform | -- | -- | -- | -- | |
| Chloromethane | -- | -- | -- | -- | |
| cis-1,2-Dichloroethene | -- | -- | -- | -- | |
| cis-1,3-Dichloropropene | -- | -- | -- | -- | |
| Cyclohexane | -- | -- | -- | -- | |
| Dibromochloromethane | -- | -- | -- | -- | |
| Dichlorodifluoromethane(Freon-12) | -- | -- | -- | -- | |
| Ethylbenzene | 4.00 | ug/kg | AET | Buchman 2008 | Echinoderm larvae/bioassay |
| Isopropylbenzene (Cumene) | -- | -- | -- | -- | |
| Methyl acetate | -- | -- | -- | -- | |
| Methylcyclohexane | -- | -- | -- | -- | |
| Methylene chloride | -- | -- | -- | -- | |
| Methyl-tert-butyl ether (MTBE) | -- | -- | -- | -- | |
| m- and p-Xylene | -- | -- | -- | -- | |
| o-Xylene | -- | -- | -- | -- | |
| Styrene | -- | -- | -- | -- | |
| Tetrachloroethene | 57.0 | ug/kg | AET | Buchman 2008 | Infaunal community |
| Toluene | -- | -- | -- | -- | |
| trans-1,2-Dichloroethene | -- | -- | -- | -- | |
| trans-1,3-Dichloropropene | -- | -- | -- | -- | |
| Trichloroethene | 41.0 | ug/kg | AET | Buchman 2008 | Neanthes |

Table 15
Marine Sediment Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type[1] | Reference | Comments |
|---|---|---|---|---|---|
| Trichlorofluoromethane(Freon-11) | -- | -- | -- | -- | |
| Vinyl chloride | -- | -- | -- | -- | |
| Xylene, total | 4.00 | ug/kg | AET | Buchman 2008 | Bivalve/larval bioassay |
| Explosives | | | | | |
| 1,3,5-Trinitrobenzene | 7,000 | ug/kg | NOEC | NAVFAC 2007 | Table 3-2; amphipod |
| 1,3-Dinitrobenzene | -- | -- | -- | -- | |
| 2,4,6-Trinitrotoluene | 20,000 | ug/kg | NOEC | NAVFAC 2007 | Table 3-2; amphipod |
| 2,4-Dinitrotoluene | -- | -- | -- | -- | |
| 2,6-Dinitrotoluene | 549 | ug/kg | NOEC | Nipper et al. 2002 | Table 4; fine-grained sediment |
| 2-Amino-4,6-dinitrotoluene | -- | -- | -- | -- | |
| 2-Nitrotoluene | -- | -- | -- | -- | |
| 3,5-Dinitroaniline | -- | -- | -- | -- | |
| 3-Nitrotoluene | -- | -- | -- | -- | |
| 4-Amino-2,6-dinitrotoluene | -- | -- | -- | -- | |
| 4-Nitrotoluene | -- | -- | -- | -- | |
| HMX | 115,000 | ug/kg | NOEC | NAVFAC 2007 | Table 3-2; estuarine amphipod |
| Nitrobenzene | 21.0 | ug/kg | AET | Buchman 2008 | Neanthes |
| Nitroglycerine | -- | -- | -- | -- | |
| Nitroguanidine | -- | -- | -- | -- | |
| Perchlorate | -- | -- | -- | -- | |
| PETN | -- | -- | -- | -- | |
| RDX | 891,000 | ug/kg | NOEC | NAVFAC 2007 | Table 3-2; polychaete |
| Tetryl | 72.0 | ug/kg | NOEC | Nipper et al. 2002 | Table 4; fine-grained sediment |

1 - AET: Apparent Effect Threshold; ER-L: Effects Range-Low; ISQG: Interim Sediment Quality Guideline; NOEC: No Observed Effect Concenttration; T20: Toxicity (20%); TEC: Threshold Effect Concentration; TEL: Threshold Effect Level

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Table 16
Freshwater Sediment Values Based on Equilibrium Partitioning (EqP)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | EqP Value | Units | TOC (%) | Reference | Comments |
|---|---|---|---|---|---|
| Pesticides | | | | | |
| 4,4'-DDD | 110 | ug/kg | 1 | Jones et al. 1997 | |
| 4,4'-DDE | 340 | ug/kg | 1 | DDT value | |
| 4,4'-DDT | 340 | ug/kg | 1 | Jones et al. 1997 | |
| alpha-BHC | 120 | ug/kg | 1 | Jones et al. 1997 | |
| alpha-Chlordane | 2,800 | ug/kg | 1 | Jones et al. 1997 | |
| beta-BHC | 120 | ug/kg | 1 | Jones et al. 1997 | |
| delta-BHC | 120 | ug/kg | 1 | Jones et al. 1997 | |
| Dieldrin | 52.0 | ug/kg | 1 | USEPA 1996a | |
| Endosulfan I | 2.90 | ug/kg | 1 | USEPA 1996a | |
| Endosulfan II | 14.0 | ug/kg | 1 | USEPA 1996a | |
| Endosulfan sulfate | 5.40 | ug/kg | 1 | USEPA 1996a | "Endosulfan" value |
| Endrin | 20.0 | ug/kg | 1 | USEPA 1996a | |
| Endrin aldehyde | 20.0 | ug/kg | 1 | Endrin value | |
| Endrin ketone | 20.0 | ug/kg | 1 | Endrin value | |
| gamma-BHC (Lindane) | 3.70 | ug/kg | 1 | USEPA 1996a | |
| gamma-Chlordane | 2,800 | ug/kg | 1 | Jones et al. 1997 | |
| Heptachlor | 68.0 | ug/kg | 1 | Jones et al. 1997 | |
| Methoxychlor | 19.0 | ug/kg | 1 | USEPA 1996a | |
| Toxaphene | 28.0 | ug/kg | 1 | USEPA 1996a | |
| Polychlorinated Biphenyls | | | | | |
| Aroclor-1016 | 120 | ug/kg | 1 | Aroclor-1221 value | |
| Aroclor-1221 | 120 | ug/kg | 1 | Jones et al. 1997 | |
| Aroclor-1232 | 600 | ug/kg | 1 | Jones et al. 1997 | |
| Aroclor-1242 | 170 | ug/kg | 1 | Jones et al. 1997 | |
| Aroclor-1248 | 1,000 | ug/kg | 1 | Jones et al. 1997 | |
| Aroclor-1254 | 810 | ug/kg | 1 | Jones et al. 1997 | |
| Aroclor-1260 | 810 | ug/kg | 1 | Aroclor-1254 value | |
| Semivolatile Organic Compounds | | | | | |
| 1,1'-Biphenyl | 1,100 | ug/kg | 1 | USEPA 1996a | |
| 1,2,3-Trichlorobenzene | 858 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |

Table 16
Freshwater Sediment Values Based on Equilibrium Partitioning (EqP)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | EqP Value | Units | TOC (%) | Reference | Comments |
|---|---|---|---|---|---|
| 1,2,4,5-Tetrachlorobenzene | 1,093 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,2,4-Trichlorobenzene | 9,200 | ug/kg | 1 | USEPA 1996a | |
| 1,2-Dichlorobenzene | 340 | ug/kg | 1 | USEPA 1996a | |
| 1,3-Dichlorobenzene | 1,700 | ug/kg | 1 | USEPA 1996a | |
| 1,4-Dichlorobenzene | 350 | ug/kg | 1 | USEPA 1996a | |
| 2,3,4,6-Tetrachlorophenol | 284 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2,4,6-Trichlorophenol | 213 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2,4-Dichlorophenol | 117 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2,4-Dinitrotoluene | 41.6 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2-Chlorophenol | 31.2 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 3,3'-Dichlorobenzidine | 127 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 4-Bromophenyl-phenylether | 1,300 | ug/kg | 1 | USEPA 1996a | |
| Acenaphthene | 620 | ug/kg | 1 | USEPA 1996a | |
| Anthracene | 220 | ug/kg | 1 | Jones et al. 1997 | |
| Atrazine | 6.62 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Benzo(a)anthracene | 110 | ug/kg | 1 | Jones et al. 1997 | |
| Benzo(a)pyrene | 140 | ug/kg | 1 | Jones et al. 1997 | |
| bis(2-Ethylhexyl)phthalate | 890,000 | ug/kg | 1 | Jones et al. 1997 | |
| Butylbenzylphthalate | 11,000 | ug/kg | 1 | USEPA 1996a | |
| Dibenzofuran | 2,000 | ug/kg | 1 | USEPA 1996a | |
| Diethylphthalate | 770 | ug/kg | 1 | USEPA 2008b | Conventional model |
| Di-n-butylphthalate | 11,000 | ug/kg | 1 | USEPA 1996a | |
| Fluoranthene | 2,900 | ug/kg | 1 | USEPA 1996a | |
| Fluorene | 540 | ug/kg | 1 | USEPA 1996a | |
| Hexachlorobutadiene | 550 | ug/kg | 1 | MacDonald et al. 2003 | From NYSDEC (1999) |
| Hexachloroethane | 1,000 | ug/kg | 1 | USEPA 1996a | |
| Naphthalene | 480 | ug/kg | 1 | USEPA 1996a | |
| Nitrobenzene | 1,779 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| N-Nitrosodiphenylamine | 2,685 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Pentachlorophenol | 504 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Phenanthrene | 850 | ug/kg | 1 | USEPA 1996a | |

Table 16
Freshwater Sediment Values Based on Equilibrium Partitioning (EqP)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | EqP Value | Units | TOC (%) | Reference | Comments |
|---|---|---|---|---|---|
| Phenol | 31.0 | ug/kg | 1 | Jones et al. 1997 | |
| Volatile Organic Compounds | | | | | |
| 1,1,1-Trichloroethane | 170 | ug/kg | 1 | USEPA 1996a | |
| 1,1,2,2-Tetrachloroethane | 940 | ug/kg | 1 | USEPA 1996a | |
| 1,1,2-Trichloroethane | 1,200 | ug/kg | 1 | Jones et al. 1997 | |
| 1,1-Dichloroethane | 27.0 | ug/kg | 1 | Jones et al. 1997 | |
| 1,1-Dichloroethene | 31.0 | ug/kg | 1 | Jones et al. 1997 | |
| 1,2,3-Trichlorobenzene | 858 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,2,4-Trichlorobenzene | 9,200 | ug/kg | 1 | USEPA 1996a | |
| 1,2-Dichlorobenzene | 340 | ug/kg | 1 | USEPA 1996a | |
| 1,2-Dichloroethane | 250 | ug/kg | 1 | Jones et al. 1997 | |
| 1,3-Dichlorobenzene | 1,700 | ug/kg | 1 | USEPA 1996a | |
| 1,4-Dichlorobenzene | 350 | ug/kg | 1 | USEPA 1996a | |
| Benzene | 57.0 | ug/kg | 1 | USEPA 1996a | |
| Bromoform | 650 | ug/kg | 1 | USEPA 1996a | |
| Carbon disulfide | 0.85 | ug/kg | 1 | Jones et al. 1997 | |
| Carbon tetrachloride | 1,200 | ug/kg | 1 | USEPA 1996a | |
| Chlorobenzene | 820 | ug/kg | 1 | USEPA 1996a | |
| Chloroform | 22.0 | ug/kg | 1 | Jones et al. 1997 | |
| cis-1,2-Dichloroethene | 400 | ug/kg | 1 | Jones et al. 1997 | |
| cis-1,3-Dichloropropene | 0.051 | ug/kg | 1 | Jones et al. 1997 | |
| Ethylbenzene | 3,600 | ug/kg | 1 | USEPA 1996a | |
| Isopropylbenzene (Cumene) | 86.0 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Methylene chloride | 370 | ug/kg | 1 | Jones et al. 1997 | |
| m- and p-Xylene | 940 | ug/kg | 1 | USEPA 2008b | Conventional model |
| Styrene | 559 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Tetrachloroethene | 530 | ug/kg | 1 | USEPA 1996a | |
| Toluene | 670 | ug/kg | 1 | USEPA 1996a | |
| trans-1,2-Dichloroethene | 400 | ug/kg | 1 | Jones et al. 1997 | |
| trans-1,3-Dichloropropene | 0.051 | ug/kg | 1 | Jones et al. 1997 | |
| Trichloroethene | 1,600 | ug/kg | 1 | USEPA 1996a | |

Table 16
Freshwater Sediment Values Based on Equilibrium Partitioning (EqP)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | EqP Value | Units | TOC (%) | Reference | Comments |
|---|---|---|---|---|---|
| Xylene (total) | 160 | ug/kg | 1 | Jones et al. 1997 | |
| Explosives | | | | | |
| 1,3,5-Trinitrobenzene | 2.40 | ug/kg | 1 | Talmage et al. 1999 | |
| 1,3-Dinitrobenzene | 6.70 | ug/kg | 1 | Talmage et al. 1999 | |
| 2,4,6-Trinitrotoluene | 92.0 | ug/kg | 1 | Talmage et al. 1999 | |
| 2,4-Dinitrotoluene | 41.6 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2-Amino-4,6-dinitrotoluene | 13.2 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| 2-Nitrotoluene | 6,204 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| 3-Nitrotoluene | 1,922 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| 4-Amino-2,6-dinitrotoluene | 23.2 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| 4-Nitrotoluene | 4,060 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| HMX | 4.74 | ug/kg | 1 | Talmage et al. 1999 | |
| Nitrobenzene | 1,779 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| RDX | 12.7 | ug/kg | 1 | Talmage et al. 1999 | |

Table 17
Marine Sediment Values Based on Equilibrium Partitioning (EqP)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | EqP Value | Units | TOC (%) | Reference | Comments |
|---|---|---|---|---|---|
| Pesticides | | | | | |
| alpha-BHC | 1,360 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| beta-BHC | 1,360 | ug/kg | 1 | alpha-BHC value | |
| delta-BHC | 1,360 | ug/kg | 1 | alpha-BHC value | |
| Dieldrin | 95.0 | ug/kg | 1 | USEPA 1996a | |
| Endosulfan I | 0.51 | ug/kg | 1 | USEPA 2008b | Conventional model |
| Endosulfan II | 2.40 | ug/kg | 1 | USEPA 2008b | Conventional model |
| Endosulfan sulfate | 0.36 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Endrin | 3.50 | ug/kg | 1 | USEPA 1996a | |
| Endrin aldehyde | 3.50 | ug/kg | 1 | Endrin value | |
| Endrin ketone | 3.50 | ug/kg | 1 | Endrin value | |
| gamma-BHC (Lindane) | 1,360 | ug/kg | 1 | alpha-BHC value | |
| Methoxychlor | 29.6 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Toxaphene | 540 | ug/kg | 1 | USEPA 2008b | Conventional model |
| Polychlorinated Biphenyls | | | | | |
| Aroclor-1016 | 120 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Aroclor-1221 | 120 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Aroclor-1232 | 120 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Aroclor-1242 | 120 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Aroclor-1248 | 120 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Aroclor-1254 | 120 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Aroclor-1260 | 120 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Semivolatile Organic Compounds | | | | | |
| 1,2,4,5-Tetrachlorobenzene | 46,988 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,2,4-Trichlorobenzene | 473 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,2-Dichlorobenzene | 989 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,3-Dichlorobenzene | 842 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,4-Dichlorobenzene | 458 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2,4,5-Trichlorophenol | 819 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2,4,6-Trichlorophenol | 2,650 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2,4-Dinitrotoluene | 3,184 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| 2,6-Dinitrotoluene | 5,802 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |

Table 17
Marine Sediment Values Based on Equilibrium Partitioning (EqP)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | EqP Value | Units | TOC (%) | Reference | Comments |
|---|---|---|---|---|---|
| 2-Chlorophenol | 344 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 2-Methylnaphthalene | 380 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| 3,3'-Dichlorobenzidine | 2,060 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Acenaphthene | 1,100 | ug/kg | 1 | USEPA 1996a | |
| Acenaphthylene | 660 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Anthracene | 2,200 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Benzo(a)anthracene | 1,100 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Benzo(a)pyrene | 990 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Benzo(b)fluoranthene | 2,300 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Benzo(g,h,i)perylene | 310 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Benzo(k)fluoranthene | 2,300 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| bis(2-Ethylhexyl)phthalate | 470 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Butylbenzylphthalate | 16,840 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Chrysene | 1,100 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Dibenz(a,h)anthracene | 120 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Dibenzofuran | 7,300 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Diethylphthalate | 218 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Dimethylphthalate | 530 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Di-n-butylphthalate | 1,160 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Di-n-octylphthalate | 580 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Fluoranthene | 1,400 | ug/kg | 1 | USEPA 1996a | |
| Fluorene | 230 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Hexachlorobenzene | 3.80 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Hexachlorobutadiene | 39.0 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Hexachlorocyclopentadiene | 139 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Hexachloroethane | 804 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Indeno(1,2,3-cd)pyrene | 340 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Naphthalene | 990 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| N-Nitrosodiphenylamine | 421,770 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| PAH (total) | 2,900 | ug/kg | 1 | USEPA 2006b | Threshold Effect Concentration |
| PAH (HMW) | 9,600 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| PAH (LMW) | 3,700 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |

Table 17
Marine Sediment Values Based on Equilibrium Partitioning (EqP)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | EqP Value | Units | TOC (%) | Reference | Comments |
|---|---|---|---|---|---|
| Pentachlorophenol | 7,970 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Phenanthrene | 1,100 | ug/kg | 1 | USEPA 1996a | |
| Pyrene | 10,000 | ug/kg | 1 | Washington State 1995 | Sediment Management (Quality) Standards |
| Volatile Organic Compounds | | | | | |
| 1,1,1-Trichloroethane | 856 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,1,2,2-Tetrachloroethane | 202 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,1,2-Trichloroethane | 570 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,1-Dichloroethene | 2,780 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,2,4-Trichlorobenzene | 473 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,2-Dichlorobenzene | 989 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,3-Dichlorobenzene | 842 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| 1,4-Dichlorobenzene | 458 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Benzene | 137 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Bromoform | 1,310 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Carbon tetrachloride | 7,245 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Chlorobenzene | 162 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| cis-1,3-Dichloropropene | 7.31 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Ethylbenzene | 305 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Styrene | 7,070 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Tetrachloroethene | 190 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Toluene | 1,085 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| trans-1,3-Dichloropropene | 7.31 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Trichloroethene | 8,955 | ug/kg | 1 | USEPA 2006b | USEPA Region 3 value |
| Explosives | | | | | |
| 2,4-Dinitrotoluene | 3,184 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| 2,6-Dinitrotoluene | 5,802 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |
| Tetryl | 10.7 | ug/kg | 1 | NAVFAC 2007 | Table 3-5 |

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Table 18
Soil Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type/Receptor | Reference | Comments |
|---|---|---|---|---|---|
| Inorganics | | | | | |
| Aluminum | pH < 5.5 | -- | Eco-SSL | USEPA 2003a | |
| Antimony | 78.0 | mg/kg | Eco-SSL - Invertebrate | USEPA 2005a | |
| Arsenic | 18.0 | mg/kg | Eco-SSL - Plant | USEPA 2005b | |
| Barium | 330 | mg/kg | Eco-SSL - Invertebrate | USEPA 2005c | |
| Beryllium | 40.0 | mg/kg | Eco-SSL - Invertebrate | USEPA 2005d | |
| Cadmium | 32.0 | mg/kg | Eco-SSL - Plant | USEPA 2005e | |
| Chromium | 64.0 | mg/kg | Soil Quality Guideline | CCME 2007 | |
| Cobalt | 13.0 | mg/kg | Eco-SSL - Plant | USEPA 2005f | |
| Copper | 70.0 | mg/kg | Eco-SSL - Plant | USEPA 2007a | |
| Cyanide | 15.8 | mg/kg | | MHSPE 2000 | Geometric mean of target and intervention values (complex) |
| Iron | 5 < pH > 8 | -- | Eco-SSL | USEPA 2003b | |
| Lead | 120 | mg/kg | Eco-SSL - Plant | USEPA 2005g | |
| Manganese | 220 | mg/kg | Eco-SSL - Plant | USEPA 2007b | |
| Mercury | 0.10 | mg/kg | Invertebrate | Efroymson et al. 1997b | |
| Nickel | 38.0 | mg/kg | Eco-SSL - Plant | USEPA 2007c | |
| Selenium | 0.52 | mg/kg | Eco-SSL - Plant | USEPA 2007d | |
| Silver | 560 | mg/kg | Eco-SSL - Plant | USEPA 2006c | |
| Thallium | 1.00 | mg/kg | Plant | Efroymson et al. 1997a | |
| Vanadium | 130 | mg/kg | Soil Quality Guideline | CCME 2007 | |
| Zinc | 120 | mg/kg | Eco-SSL - Invertebrate | USEPA 2007e | |
| Pesticides | | | | | |
| 4,4'-DDD | 583 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| 4,4'-DDE | 114 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| 4,4'-DDT | 100 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| Aldrin | 3.63 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| alpha-BHC | 226 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| alpha-Chlordane | 11.0 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| beta-BHC | 342 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| delta-BHC | 226 | ug/kg | | alpha-BHC value | |
| Dieldrin | 10.5 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |

Table 18
Soil Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type/Receptor | Reference | Comments |
|---|---|---|---|---|---|
| Endosulfan I | 6.32 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| Endosulfan II | 6.32 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| Endosulfan sulfate | 6.32 | ug/kg | | Endosulfan value | |
| Endrin | 1.95 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| Endrin aldehyde | 1.95 | ug/kg | | Endrin value | |
| Endrin ketone | 1.95 | ug/kg | | Endrin value | |
| gamma-BHC (Lindane) | 7.75 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| gamma-Chlordane | 11.0 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| Heptachlor | 52.9 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| Heptachlor epoxide | 52.9 | ug/kg | | Heptachlor value | |
| Methoxychlor | 500 | ug/kg | | Beyer 1990 | B value ("moderate soil contamination") |
| Toxaphene | 500 | ug/kg | | Beyer 1990 | B value ("moderate soil contamination") |
| Polychlorinated Biphenyls | | | | | |
| Aroclor-1016 | 8,000 | ug/kg | Plant | Efroymson et al. 1997a | Lowest EC50 (40,000); UF of 5 |
| Aroclor-1221 | 8,000 | ug/kg | Plant | Efroymson et al. 1997a | Lowest EC50 (40,000); UF of 5 |
| Aroclor-1232 | 8,000 | ug/kg | Plant | Efroymson et al. 1997a | Lowest EC50 (40,000); UF of 5 |
| Aroclor-1242 | 8,000 | ug/kg | Plant | Efroymson et al. 1997a | Lowest EC50 (40,000); UF of 5 |
| Aroclor-1248 | 8,000 | ug/kg | Plant | Efroymson et al. 1997a | Lowest EC50 (40,000); UF of 5 |
| Aroclor-1254 | 8,000 | ug/kg | Plant | Efroymson et al. 1997a | Lowest EC50 (40,000); UF of 5 |
| Aroclor-1260 | 8,000 | ug/kg | Plant | Efroymson et al. 1997a | Lowest EC50 (40,000); UF of 5 |
| Semivolatile Organic Compounds | | | | | |
| 1,1-Biphenyl | 13,600 | ug/kg | Plant | Efroymson et al. 1997a | EC50 (68,000); UF of 5 |
| 1,2,3-Trichlorobenzene | 1,150 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 115,000; UF of 100 |
| 1,2,4,5-Tetrachlorobenzene | 1,000 | ug/kg | | Beyer 1990 | B value ("moderate soil contamination") |
| 1,2,4-Trichlorobenzene | 1,270 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 127,000; UF of 100 |
| 1,2-Dichlorobenzene | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 1,3-Dichlorobenzene | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 1,4-Dichlorobenzene | 1,280 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 128,000; UF of 100 |

Table 18
Soil Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type/Receptor | Reference | Comments |
|---|---|---|---|---|---|
| 1,4-Dioxane | -- | -- | -- | -- | |
| 2,2'-Oxybis(1-chloropropane) | -- | -- | -- | -- | |
| 2,3,4,6-Tetrachlorophenol | 500 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 2,4,5-Trichlorophenol | 1,350 | ug/kg | Plant | Efroymson et al. 1997a | NOEC |
| 2,4,6-Trichlorophenol | 580 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 58,000; UF of 100 |
| 2,4-Dichlorophenol | 500 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 2,4-Dimethylphenol | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 2,4-Dinitrophenol | 20,000 | ug/kg | Plant | Efroymson et al. 1997a | NOEC |
| 2,4-Dinitrotoluene | 11,000 | ug/kg | Plant/Invertebrate | NRCC 2006 | |
| 2,6-Dinitrotoluene | 8,500 | ug/kg | Plant/Invertebrate | NRCC 2006 | |
| 2-Chloronaphthalene | see PAHs | | | | |
| 2-Chlorophenol | 500 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 2-Methylnaphthalene | see PAHs | | | | |
| 2-Methylphenol | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 2-Nitroaniline | -- | -- | -- | -- | |
| 2-Nitrophenol | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 3- and 4-Methylphenol | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 3,3'-Dichlorobenzidine | -- | -- | -- | -- | |
| 3-Nitroaniline | -- | -- | -- | -- | |
| 4,6-Dinitro-2-methylphenol | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 4-Bromophenyl-phenylether | -- | -- | -- | -- | |
| 4-Chloro-3-methylphenol | 500 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |

Table 18
Soil Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type/Receptor | Reference | Comments |
|---|---|---|---|---|---|
| 4-Chloroaniline | 500 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| 4-Chlorophenyl-phenylether | -- | -- | -- | -- | |
| 4-Methylphenol | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 4-Nitroaniline | -- | -- | -- | -- | |
| 4-Nitrophenol | 380 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 38,000; UF of 100 |
| Acenaphthene | see PAHs | | | | |
| Acenaphthylene | see PAHs | | | | |
| Acetophenone | -- | -- | -- | -- | |
| Anthracene | see PAHs | | | | |
| Atrazine | 11.9 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| Benzaldehyde | -- | -- | -- | -- | |
| Benzo(a)anthracene | see PAHs | | | | |
| Benzo(a)pyrene | see PAHs | | | | |
| Benzo(b)fluoranthene | see PAHs | | | | |
| Benzo(g,h,i)perylene | see PAHs | | | | |
| Benzo(k)fluoranthene | see PAHs | | | | |
| Benzoic acid | -- | -- | -- | -- | |
| Benzyl alcohol | -- | -- | -- | -- | |
| bis(2-Chloroethoxy)methane | -- | -- | -- | -- | |
| bis(2-Chloroethyl)ether | -- | -- | -- | -- | |
| bis(2-Ethylhexyl)phthalate | 30,000 | ug/kg | Plant | CCME 2007 | Interim Remediation Criteria (IRC) for residential/parkland |
| Butylbenzylphthalate | 30,000 | ug/kg | Plant | CCME 2007 | Interim Remediation Criteria (IRC) for residential/parkland |
| Caprolactam | -- | -- | -- | -- | |
| Carbazole | -- | -- | -- | -- | |
| Chrysene | see PAHs | | | | |
| Dibenz(a,h)anthracene | see PAHs | | | | |
| Dibenzofuran | -- | -- | -- | -- | |
| Diethylphthalate | 26,800 | ug/kg | Plant | Efroymson et al. 1997a | EC50 (134,000); UF of 5 |
| Dimethyl phthalate | 10,640 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 1,064,000; UF of 100 |
| Di-n-butylphthalate | 40,000 | ug/kg | Plant | Efroymson et al. 1997a | LOEC (200,000); UF of 5 |

Table 18
Soil Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type/Receptor | Reference | Comments |
|---|---|---|---|---|---|
| Di-n-octylphthalate | 30,000 | ug/kg | Plant | CCME 2007 | Interim Remediation Criteria (IRC) for residential/parkland |
| Fluoranthene | see PAHs | | | | |
| Fluorene | see PAHs | | | | |
| Hexachlorobenzene | 1,000 | ug/kg | | Beyer 1990 | B value ("moderate soil contamination") |
| Hexachlorobutadiene | -- | -- | -- | -- | |
| Hexachlorocyclopentadiene | 2,000 | ug/kg | Plant | Efroymson et al. 1997a | LOEC (10,000); UF of 5 |
| Hexachloroethane | -- | -- | -- | -- | |
| Indeno(1,2,3-cd)pyrene | see PAHs | | | | |
| Isophorone | -- | -- | -- | -- | |
| Naphthalene | see PAHs | | | | |
| Nitrobenzene | 2,260 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 226,000; UF of 100 |
| n-Nitroso-di-n-propylamine | -- | -- | -- | -- | |
| n-Nitrosodiphenylamine | 1,090 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 109,000; UF of 100 |
| PAH (total) | -- | -- | -- | -- | |
| PAH (HMW) | 18,000 | ug/kg | Eco-SSL - Invertebrate | USEPA 2007i | |
| PAH (LMW) | 29,000 | ug/kg | Eco-SSL - Invertebrate | USEPA 2007i | |
| Pentachlorophenol | 5,000 | ug/kg | Eco-SSL - Plant | USEPA 2007h | |
| Phenanthrene | see PAHs | | | | |
| Phenol | 1,880 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 188,000; UF of 100 |
| Pyrene | see PAHs | | | | |
| TPH-diesel range | -- | -- | -- | -- | |
| TPH-gas range | -- | -- | -- | -- | |
| TPH-oil range | -- | -- | -- | -- | |
| Volatile Organic Compounds | | | | | |
| 1,1,1-Trichloroethane | 1,025 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| 1,1,2,2-Tetrachloroethane | 5,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | -- | -- | -- | -- | |
| 1,1,2-Trichloroethane | 2,000 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| 1,1-Dichloroethane | 548 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |

Table 18
Soil Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type/Receptor | Reference | Comments |
|---|---|---|---|---|---|
| 1,1-Dichloroethene | 173 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| 1,2,3-Trichlorobenzene | 1,150 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 115,000; UF of 100 |
| 1,2,4-Trichlorobenzene | 1,270 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 127,000; UF of 100 |
| 1,2-Dibromo-3-chloropropane | -- | -- | -- | -- | |
| 1,2-Dibromoethane | 300 | ug/kg | Plant | CCME 2007 | Interim Remediation Criteria (IRC) for residential/parkland |
| 1,2-Dichlorobenzene | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 1,2-Dichloroethane | 2,190 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| 1,2-Dichloropropane | 38,800 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 3,880,000; UF of 100 |
| 1,3-Dichlorobenzene | 1,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| 1,4-Dichlorobenzene | 1,280 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 128,000; UF of 100 |
| 2-Butanone | -- | -- | -- | -- | |
| 2-Hexanone | -- | -- | -- | -- | |
| 4-Methyl-2-pentanone | -- | -- | -- | -- | |
| Acetone | -- | -- | -- | -- | |
| Benzene | 6.80 | ug/kg | Soil Quality Guideline | CCME 2007 | |
| Bromochloromethane | -- | -- | -- | -- | |
| Bromodichloromethane | -- | -- | -- | -- | |
| Bromoform | 300 | ug/kg | Plant | CCME 2007 | Interim Remediation Criteria (IRC) for residential/parkland |
| Bromomethane | -- | -- | -- | -- | |
| Carbon disulfide | -- | -- | -- | -- | |
| Carbon tetrachloride | 3,400 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| Chlorobenzene | 2,400 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 240,000; UF of 100 |
| Chloroethane | 5,000 | ug/kg | | CCME 2007 | Interim Remediation Criteria (IRC) for residential/parkland |
| Chloroform | 1,844 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| Chloromethane | 5,000 | ug/kg | | CCME 2007 | Interim Remediation Criteria (IRC) for residential/parkland |
| cis-1,2-Dichloroethene | 447 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| cis-1,3-Dichloropropene | 5,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| Cyclohexane | 6,000 | ug/kg | | Beyer 1990 | B value ("moderate soil contamination") |

Table 18
Soil Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type/Receptor | Reference | Comments |
|---|---|---|---|---|---|
| Dibromochloromethane | -- | -- | -- | -- | |
| Dichlorodifluoromethane(Freon-12) | -- | -- | -- | -- | |
| Ethylbenzene | 18.0 | ug/kg | Soil Quality Guideline | CCME 2007 | |
| Isopropylbenzene (Cumene) | -- | -- | -- | -- | |
| Methyl acetate | -- | -- | -- | -- | |
| Methylcyclohexane | -- | -- | -- | -- | |
| Methylene chloride | 1,250 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| Methyl-tert-butyl ether (MTBE) | -- | -- | -- | -- | |
| m- and p-Xylene | 2,400 | ug/kg | Soil Quality Guideline | CCME 2007 | Xylenes |
| o-Xylene | 2,400 | ug/kg | Soil Quality Guideline | CCME 2007 | Xylenes |
| Styrene | 64,000 | ug/kg | Plant | Efroymson et al. 1997a | EC50 (320,000); UF of 5 |
| Tetrachloroethene | 200 | ug/kg | Soil Quality Guideline | CCME 2007 | |
| Toluene | 40,000 | ug/kg | Plant | Efroymson et al. 1997a | EC50 (200,000); UF of 5 |
| trans-1,2-Dichloroethene | 447 | ug/kg | | MHSPE 2000 | Geometric mean of target and intervention values |
| trans-1,3-Dichloropropene | 5,000 | ug/kg | | CCME 2007; Beyer 1990 | Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination") |
| Trichloroethene | 10.0 | ug/kg | Soil Quality Guideline | CCME 2007 | |
| Trichlorofluoromethane(Freon-11) | -- | -- | -- | -- | |
| Vinyl chloride | 412 | ug/kg | | MHSPE 2000; 2001 | Geometric mean of target and SRC values |
| Xylene, total | 2,400 | ug/kg | Soil Quality Guideline | CCME 2007 | |
| Explosives | | | | | |
| 1,3,5-Trinitrobenzene | -- | -- | -- | -- | |
| 1,3-Dinitrobenzene | -- | -- | -- | -- | |
| 2,4,6-Trinitrotoluene | 10,000 | ug/kg | Plant | Talmage et al. 1999 | |
| 2,4-Dinitrotoluene | 11,000 | ug/kg | Plant/Invertebrate | NRCC 2006 | |
| 2,6-Dinitrotoluene | 8,500 | ug/kg | Plant/Invertebrate | NRCC 2006 | |
| 2-Amino-4,6-dinitrotoluene | 80,000 | ug/kg | Plant | Talmage et al. 1999 | |
| 2-Nitrotoluene | -- | -- | -- | -- | |
| 3,5-Dinitroaniline | -- | -- | -- | -- | |
| 3-Nitrotoluene | -- | -- | -- | -- | |
| 4-Amino-2,6-dinitrotoluene | -- | -- | -- | -- | |

Table 18
Soil Ecological Screening Values (ESVs)
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | ESV | Units | Type/Receptor | Reference | Comments |
|---|---|---|---|---|---|
| 4-Nitrotoluene | -- | -- | -- | -- | |
| HMX | 10,000 | ug/kg | Invertebrate | Talmage et al. 1999 | |
| Nitrobenzene | 2,260 | ug/kg | Invertebrate | Efroymson et al. 1997b | LC50 of 226,000; UF of 100 |
| Nitroglycerine | -- | -- | -- | -- | |
| Nitroguanidine | -- | -- | -- | -- | |
| Perchlorate | 1,000 | ug/kg | Invertebrate | USEPA 2002 | |
| PETN | -- | -- | -- | -- | |
| RDX | 10,000 | ug/kg | Invertebrate | Talmage et al. 1999 | |
| Tetryl | 10,000 | ug/kg | Plant | Talmage et al. 1999 | |

Table 19
Eco-SSL Values for Birds and Mammals
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Bird | Mammal | Units | Reference |
|---|---|---|---|---|
| Metals | | | | |
| Antimony | -- | 0.27 | mg/kg | USEPA 2005a |
| Arsenic | 43.0 | 46.0 | mg/kg | USEPA 2005b |
| Barium | -- | 2,000 | mg/kg | USEPA 2005c |
| Beryllium | -- | 21.0 | mg/kg | USEPA 2005d |
| Cadmium | 0.77 | 0.36 | mg/kg | USEPA 2005e |
| Chromium | 26.0 | 34.0 | mg/kg | USEPA 2008a |
| Cobalt | 120 | 230 | mg/kg | USEPA 2005f |
| Copper | 28.0 | 49.0 | mg/kg | USEPA 2007a |
| Lead | 11.0 | 56.0 | mg/kg | USEPA 2005g |
| Manganese | 4,300 | 4,000 | mg/kg | USEPA 2007b |
| Nickel | 210 | 130 | mg/kg | USEPA 2007c |
| Selenium | 1.20 | 0.63 | mg/kg | USEPA 2007d |
| Silver | 4.20 | 14.0 | mg/kg | USEPA 2006c |
| Vanadium | 7.80 | 280 | mg/kg | USEPA 2005h |
| Zinc | 46.0 | 79.0 | mg/kg | USEPA 2007e |
| Organics | | | | |
| 4,4'-DDT (and metabolites) | 0.093 | 0.021 | mg/kg | USEPA 2007f |
| Dieldrin | 0.022 | 0.0049 | mg/kg | USEPA 2007g |
| Pentachlorophenol | 2.10 | 2.80 | mg/kg | USEPA 2007h |
| PAHs - LMW | -- | 100 | mg/kg | USEPA 2007i |
| PAHs - HMW | -- | 1.10 | mg/kg | USEPA 2007i |

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Table 20
Ingestion-Based Toxicity Reference Values (TRVs) for Mammals
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Chemical Form | Test Organism | Body Weight (kg) | Duration | Exposure Route | Effect/Endpoint | LOAEL (mg/kg/d) | Reference | NOAEL (mg/kg/d) | Reference | MATC (mg/kg/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Metals | | | | | | | | | | | |
| Antimony | -- | rat | -- | 31 days | oral in water | survival, growth, reproduction | 0.590 | USEPA 2005a | 0.059 | USEPA 2005a | 0.187 |
| Arsenic | Arsenite (As+3) | mouse | 0.03 | 3 generations | oral in water/food | reproduction | 1.26 | Sample et al. 1996 | 0.25 a | -- | 0.56 |
| Arsenic | -- | dog | -- | 8 weeks | oral in diet | survival, growth, reproduction | 1.66 | USEPA 2005b | 1.04 | USEPA 2005b | 1.31 |
| Barium | -- | multiple | -- | -- | oral | survival, growth, reproduction | 259 b | -- | 51.8 | USEPA 2005c | 116 |
| Beryllium | -- | rat | -- | 4 years | oral in water | survival, growth, reproduction | 2.66 b | -- | 0.53 | USEPA 2005d | 1.19 |
| Cadmium | -- | rat | -- | 2 weeks | oral in water | survival, growth, reproduction | 7.70 | USEPA 2005e | 0.77 | USEPA 2005e | 2.43 |
| Chromium | Cr+3 | multiple | -- | -- | oral | survival, growth, reproduction | 12.0 b | -- | 2.40 | USEPA 2008a | 5.37 |
| Chromium | Cr+6 | multiple | -- | -- | oral | survival, growth, reproduction | 46.2 b | -- | 9.24 | USEPA 2008a | 20.7 |
| Cobalt | -- | multiple | -- | -- | oral | survival, growth, reproduction | 36.7 b | -- | 7.33 | USEPA 2005f | 16.4 |
| Copper | -- | pig | -- | 4 weeks | oral in diet | survival, growth, reproduction | 9.34 | USEPA 2007a | 5.60 | USEPA 2007a | 7.23 |
| Copper | Copper sulfate | mink | 1.00 | 357 days | oral in diet | reproduction | 15.1 | Sample et al. 1996 | 11.7 | Sample et al. 1996 | 13.3 |
| Lead | -- | rat | -- | 7 weeks | oral in water | survival, growth, reproduction | 8.90 | USEPA 2005g | 4.70 | USEPA 2005g | 6.47 |
| Manganese | -- | multiple | -- | -- | oral | survival, growth, reproduction | 258 b | -- | 51.5 | USEPA 2007b | 115 |
| Mercury | Methyl mercury chloride | rat | 0.35 | 3 generations | oral in diet | reproduction | 0.160 | Sample et al. 1996 | 0.032 | Sample et al. 1996 | 0.072 |
| Mercury | Methyl mercury chloride | mink | 1.00 | 93 days | oral in diet | survival/weight loss | 0.25 c | Sample et al. 1996 | 0.15 c | Sample et al. 1996 | 0.19 |
| Nickel | -- | mouse | -- | 35 days | oral | survival, growth, reproduction | 3.40 | USEPA 2007c | 1.70 | USEPA 2007c | 2.40 |
| Selenium | Potassium selenate | rat | 0.35 | 1 year | oral in water | reproduction | 0.33 | Sample et al. 1996 | 0.20 | Sample et al. 1996 | 0.26 |
| Silver | -- | pig | -- | 40 days | oral in diet | survival, growth, reproduction | 60.2 | USEPA 2006c | 12.0 a | -- | 26.9 |
| Vanadium | -- | mouse | -- | 12 days | oral (gavage) | survival, growth, reproduction | 8.31 | USEPA 2005h | 4.16 | USEPA 2005h | 5.88 |
| Zinc | -- | multiple | -- | -- | oral | survival, growth, reproduction | 377 b | -- | 75.4 | USEPA 2007e | 169 |
| Pesticides | | | | | | | | | | | |
| 4,4'-DDD | -- | rat | -- | 15 days | oral (gavage) | survival, growth, reproduction | 0.735 | USEPA 2007f | 0.147 | USEPA 2007f | 0.329 |
| 4,4'-DDE | -- | rat | -- | 15 days | oral (gavage) | survival, growth, reproduction | 0.735 | USEPA 2007f | 0.147 | USEPA 2007f | 0.329 |
| 4,4'-DDT | -- | rat | -- | 15 days | oral (gavage) | survival, growth, reproduction | 0.735 | USEPA 2007f | 0.147 | USEPA 2007f | 0.329 |
| Aldrin | -- | rat | 0.35 | 3 generations | oral in diet | reproduction | 1.00 | Sample et al. 1996 | 0.20 | Sample et al. 1996 | 0.45 |
| alpha-BHC | Mixed isomers | rat | 0.35 | 4 generations | oral in diet | reproduction | 3.20 | Sample et al. 1996 | 1.60 | Sample et al. 1996 | 2.26 |
| alpha-Chlordane | Chlordane | mouse | 0.03 | 6 generations | oral in diet | reproduction | 9.16 | Sample et al. 1996 | 4.58 | Sample et al. 1996 | 6.48 |
| beta-BHC | Mixed isomers | rat | 0.35 | 4 generations | oral in diet | reproduction | 3.20 | Sample et al. 1996 | 1.60 | Sample et al. 1996 | 2.26 |
| delta-BHC | Mixed isomers | rat | 0.35 | 4 generations | oral in diet | reproduction | 3.20 | Sample et al. 1996 | 1.60 | Sample et al. 1996 | 2.26 |
| Dieldrin | -- | rat | -- | 750 days | oral in diet | survival, growth, reproduction | 0.030 | USEPA 2007g | 0.015 | USEPA 2007g | 0.021 |
| Endosulfan I | -- | rat | 0.35 | 30 days | oral (gavage) | fertility | 0.75 b | -- | 0.15 | Sample et al. 1996 | 0.34 |
| Endosulfan II | -- | rat | 0.35 | 30 days | oral (gavage) | fertility | 0.75 b | -- | 0.15 | Sample et al. 1996 | 0.34 |
| Endrin | -- | mouse | 0.03 | 120 days | oral in diet | reproduction | 0.92 | Sample et al. 1996 | 0.18 a | -- | 0.41 |
| gamma-BHC (Lindane) | -- | rat | 0.35 | 3 generations | oral in diet | reproduction | 40.0 b | -- | 8.00 | Sample et al. 1996 | 17.9 |
| gamma-Chlordane | Chlordane | mouse | 0.03 | 6 generations | oral in diet | reproduction | 9.16 | Sample et al. 1996 | 4.58 | Sample et al. 1996 | 6.48 |
| Heptachlor | -- | mink | 1.00 | 181 days | oral in diet | reproduction | 1.00 | Sample et al. 1996 | 0.20 a | -- | 0.45 |
| Heptachlor epoxide | -- | mink | 1.00 | 181 days | oral in diet | reproduction | 1.00 | Heptachlor value | 0.20 a | -- | 0.45 |
| Methoxychlor | -- | rat | 0.35 | 11 months | oral in diet | reproduction | 8.00 | Sample et al. 1996 | 4.00 | Sample et al. 1996 | 5.66 |
| Toxaphene | -- | rat | 0.35 | 3 generations | oral in diet | reproduction | 40.0 b | -- | 8.00 | Sample et al. 1996 | 17.9 |
| Polychlorinated Biphenyls | | | | | | | | | | | |
| Aroclor-1016 | -- | oldfield mouse | 0.014 | 12 months | oral in diet | reproduction | 0.68 | Aroclor-1254 value | 0.14 a | Aroclor-1254 value | 0.30 |
| Aroclor-1016 | -- | mink | 1.00 | 18 months | oral in diet | reproduction | 3.43 | Sample et al. 1996 | 1.37 | Sample et al. 1996 | 2.17 |

Table 20
Ingestion-Based Toxicity Reference Values (TRVs) for Mammals
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Chemical Form | Test Organism | Body Weight (kg) | Duration | Exposure Route | Effect/Endpoint | LOAEL (mg/kg/d) | Reference | NOAEL (mg/kg/d) | Reference | MATC (mg/kg/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aroclor-1221 | -- | oldfield mouse | 0.014 | 12 months | oral in diet | reproduction | 0.68 | Aroclor-1254 value | 0.14 a | Aroclor-1254 value | 0.30 |
| Aroclor-1221 | -- | mink | 1.00 | 7 months | oral in diet | reproduction | 0.69 | Aroclor-1242 value | 0.14 a | Aroclor-1242 value | 0.31 |
| Aroclor-1232 | -- | oldfield mouse | 0.014 | 12 months | oral in diet | reproduction | 0.68 | Aroclor-1254 value | 0.14 a | Aroclor-1254 value | 0.30 |
| Aroclor-1232 | -- | mink | 1.00 | 7 months | oral in diet | reproduction | 0.69 | Aroclor-1242 value | 0.14 a | Aroclor-1242 value | 0.31 |
| Aroclor-1242 | -- | oldfield mouse | 0.014 | 12 months | oral in diet | reproduction | 0.68 | Aroclor-1254 value | 0.14 a | Aroclor-1254 value | 0.30 |
| Aroclor-1242 | -- | mink | 1.00 | 7 months | oral in diet | reproduction | 0.69 | Sample et al. 1996 | 0.14 a | -- | 0.31 |
| Aroclor-1248 | -- | oldfield mouse | 0.014 | 12 months | oral in diet | reproduction | 0.68 | Aroclor-1254 value | 0.14 a | Aroclor-1254 value | 0.30 |
| Aroclor-1248 | -- | mink | 1.00 | 4.5 months | oral in diet | reproduction | 0.69 | Aroclor-1254 value | 0.14 | Aroclor-1254 value | 0.31 |
| Aroclor-1254 | -- | oldfield mouse | 0.014 | 12 months | oral in diet | reproduction | 0.68 | Sample et al. 1996 | 0.14 a | -- | 0.30 |
| Aroclor-1254 | -- | mink | 1.00 | 4.5 months | oral in diet | reproduction | 0.69 | Sample et al. 1996 | 0.14 | Sample et al. 1996 | 0.31 |
| Aroclor-1260 | -- | oldfield mouse | 0.014 | 12 months | oral in diet | reproduction | 0.68 | Aroclor-1254 value | 0.14 a | Aroclor-1254 value | 0.30 |
| Aroclor-1260 | -- | mink | 1.00 | 4.5 months | oral in diet | reproduction | 0.69 | Aroclor-1254 value | 0.14 | Aroclor-1254 value | 0.31 |
| Volatile and Semivolatile Organic Compounds | | | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | -- | rat | 0.35 | 78 weeks | oral (gavage) | reproduction | 380 b | -- | 76.0 | ATSDR 2008 | 170 |
| 1,2,4,5-Tetrachlorobenzene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 1,2,4-Trichlorobenzene | -- | rat | 0.35 | 3 generations | oral in water | reproduction | 106 | Coulston and Kolbye 1994 | 53.0 | Coulston and Kolbye 1994 | 75.0 |
| 1,2-Dichlorobenzene | -- | rat | 0.35 | chronic | oral | liver/kidney | 429 b | -- | 85.7 | Coulston and Kolbye 1994 | 192 |
| 1,3-Dichlorobenzene | -- | rat | 0.35 | chronic | oral | liver/kidney | 429 b | -- | 85.7 | Value for 1,2-Dichlorobenzene | 192 |
| 1,4-Dichlorobenzene | -- | rat | 0.35 | 2 generations | oral (gavage) | developmental | 90.0 | ATSDR 2006 | 30.0 | ATSDR 2006 | 52.0 |
| 4-Bromophenyl-phenylether | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 4-Chlorophenyl-phenylether | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| Acenaphthene | -- | rat | -- | 6 weeks | oral in diet | survival, growth, reproduction | 328 | USEPA 2007i | 65.6 | USEPA 2007i | 147 |
| Acenaphthylene | -- | rat | -- | 6 weeks | oral in diet | survival, growth, reproduction | 328 | USEPA 2007i | 65.6 | USEPA 2007i | 147 |
| Anthracene | -- | rat | -- | 6 weeks | oral in diet | survival, growth, reproduction | 328 | USEPA 2007i | 65.6 | USEPA 2007i | 147 |
| Benzo(a)anthracene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |
| Benzo(a)pyrene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |
| Benzo(b)fluoranthene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |
| Benzo(g,h,i)perylene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |
| Benzo(k)fluoranthene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |
| Chrysene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |
| Dibenz(a,h)anthracene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |
| Fluoranthene | -- | rat | -- | 6 weeks | oral in diet | survival, growth, reproduction | 328 | USEPA 2007i | 65.6 | USEPA 2007i | 147 |
| Fluorene | -- | rat | -- | 6 weeks | oral in diet | survival, growth, reproduction | 328 | USEPA 2007i | 65.6 | USEPA 2007i | 147 |
| Hexachlorobenzene | -- | rat | 0.35 | 4 generations | oral in diet | reproduction | 4.00 | ATSDR 2002 | 2.00 | ATSDR 2002 | 2.83 |
| Hexachlorobutadiene | -- | rat | 0.35 | GD 1-22; LD 1-21 | oral in diet | developmental | 20.0 | ATSDR 1994 | 2.00 | ATSDR 1994 | 6.32 |
| Hexachlorocyclopentadiene | -- | mouse | 0.03 | GD 6-15 | oral (gavage) | developmental | 375 b | -- | 75.0 | ATSDR 1999 | 168 |
| Hexachloroethane | -- | rat | 0.35 | GD 6-16 | oral (gavage) | reproduction | 500 | ATSDR 1997 | 100 | ATSDR 1997 | 224 |
| Indeno(1,2,3-cd)pyrene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |
| Pentachlorophenol | -- | multiple | -- | -- | oral | survival, growth, reproduction | 42.1 b | -- | 8.42 | USEPA 2007h | 18.8 |
| Phenanthrene | -- | rat | -- | 6 weeks | oral in diet | survival, growth, reproduction | 328 | USEPA 2007i | 65.6 | USEPA 2007i | 147 |
| Pyrene | -- | mouse | -- | 65 weeks | oral in diet | survival, growth, reproduction | 3.07 | USEPA 2007i | 0.62 | USEPA 2007i | 1.37 |

Table 20
Ingestion-Based Toxicity Reference Values (TRVs) for Mammals
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Chemical Form | Test Organism | Body Weight (kg) | Duration | Exposure Route | Effect/Endpoint | LOAEL (mg/kg/d) | Reference | NOAEL (mg/kg/d) | Reference | MATC (mg/kg/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Explosives | | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | -- | rat | 0.35 | 2 years | oral in diet | reproduction | 13.4 | Talmage et al. 1999 | 2.64 | Talmage et al. 1999 | 5.96 |
| 1,3-Dinitrobenzene | -- | rat | 0.35 | 90 days | oral in diet | reproduction | 1.73 | Talmage et al. 1999 | 0.35 | Talmage et al. 1999 | 0.78 |
| 2,4,6-Trinitrotoluene | -- | rat | 0.289 | 13 weeks | oral in diet | reproduction | 160 | Talmage et al. 1999 | 34.7 | Talmage et al. 1999 | 74.5 |
| 2,4-Dinitrotoluene | -- | dog | -- | 2 years | oral (capsule) | neurological | 1.50 | USACHPPM 2006 | 0.20 | USACHPPM 2006 | 0.55 |
| 2,6-Dinitrotoluene | -- | rat | -- | 52 weeks | oral in diet | growth (body weight) | 7.00 | USACHPPM 2006 | 1.40 a | USACHPPM 2006 | 3.13 |
| 2-Amino-4,6-dinitrotoluene | -- | rat | -- | -- | oral | survival | 45.0 b | -- | 9.00 d | USACHPPM 2005 | 20.1 |
| 2-Nitrotoluene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 3-Nitrotoluene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 4-Amino-2,6-dinitrotoluene | -- | rat | -- | -- | oral | survival | 45.0 b | -- | 9.00 d | USACHPPM 2005 | 20.1 |
| 4-Nitrotoluene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| HMX | -- | mouse | 0.024 | 13 weeks | oral in diet | survival | 75.0 | Talmage et al. 1999 | 30.0 | Talmage et al. 1999 | 47.4 |
| Nitrobenzene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| Perchlorate | -- | multiple | -- | chronic | oral | multiple | 32.0 | USACHPPM 2007 | 6.40 | USACHPPM 2007 | 14.3 |
| RDX | -- | mouse | 0.04 | 2 years | oral in diet | reproduction | 35.0 | Talmage et al. 1999 | 7.00 | Talmage et al. 1999 | 15.7 |
| Tetryl | -- | rat | 0.258 | 90 days | oral in diet | survival; reproduction | 62.0 | Talmage et al. 1999 | 13.0 | Talmage et al. 1999 | 28.4 |

NA - Not Available
[a] Uncertainty factor of 5 applied to LOAEL
[b] Uncertainty factor of 5 applied to NOAEL
[c] Does not include subchronic uncertainty factor of 10 applied by Sample et al (1996) since the study duration meets the criteria for a chronic study in Table 11
[d] Uncertainty factor of 100 applied to LD50

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Table 21
Ingestion-Based Toxicity Reference Values (TRVs) for Birds
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Chemical Form | Test Organism | Body Weight (kg) | Duration | Exposure Route | Effect/Endpoint | LOAEL (mg/kg/d) | Reference | NOAEL (mg/kg/d) | Reference | MATC (mg/kg/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Metals | | | | | | | | | | | |
| Antimony | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| Arsenic | -- | chicken | -- | 19 days | oral in diet | survival, growth,reproduction | 11.2 b | -- | 2.24 | USEPA 2005b | 5.01 |
| Arsenic | Sodium arsenite | mallard | 1.00 | 128 days | oral in diet | survival | 12.8 | Sample et al. 1996 | 5.14 | Sample et al. 1996 | 8.12 |
| Barium | Barium hydroxide | chicken (chicks) | 0.121 | 4 weeks | oral in diet | survival | 41.7 c | Sample et al. 1996 | 20.8 c | Sample et al. 1996 | 29.5 |
| Beryllium | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| Cadmium | -- | multiple | -- | -- | oral in diet | survival, growth,reproduction | 7.35 b | -- | 1.47 | USEPA 2005e | 3.29 |
| Chromium | Cr+3 | multiple | -- | -- | oral in diet | survival, growth,reproduction | 13.3 b | -- | 2.66 | USEPA 2008a | 5.95 |
| Cobalt | -- | multiple | -- | -- | oral in diet | survival, growth,reproduction | 38.1 b | -- | 7.61 | USEPA 2005f | 17.0 |
| Copper | -- | chicken | -- | 84 days | oral in diet | survival, growth,reproduction | 12.1 | USEPA 2007a | 4.05 | USEPA 2007a | 7.00 |
| Lead | -- | chicken | -- | 4 weeks | oral in diet | survival, growth,reproduction | 3.26 | USEPA 2005g | 1.63 | USEPA 2005g | 2.31 |
| Lead | Metallic | American kestrel | 0.13 | 7 months | oral in diet | reproduction | 19.3 b | -- | 3.85 | Sample et al. 1996 | 8.61 |
| Manganese | -- | multiple | -- | -- | oral | survival, growth,reproduction | 895 b | -- | 179 | USEPA 2007b | 400 |
| Mercury | Mercury chloride | Japanese quail | 0.15 | 1 year | oral in diet | reproduction | 0.90 | Sample et al. 1996 | 0.45 | Sample et al. 1996 | 0.64 |
| Mercury | -- | red-tailed hawk | 1.10 | 12 weeks | oral in diet | survival/neurological | 1.20 | USEPA 1995b | 0.49 | USEPA 1995b | 0.77 |
| Mercury | Methyl mercury | mallard | 1.00 | 3 generations | oral in diet | reproduction | 0.078 | USEPA 1997b | 0.026 | USEPA 1997b | 0.045 |
| Nickel | -- | multiple | -- | -- | oral in diet | survival, growth,reproduction | 33.6 b | -- | 6.71 | USEPA 2007c | 15.0 |
| Selenium | Selanomethionine | mallard | 1.00 | 100 days | oral in diet | reproduction | 0.80 | Sample et al. 1996 | 0.40 | Sample et al. 1996 | 0.57 |
| Selenium | Selanomethionine | black-crowned night-heron | 0.88 | 94 days | oral in diet | reproduction | 9.00 b | -- | 1.80 | Sample et al. 1996 | 4.02 |
| Selenium | Selanomethionine | screech owl | 0.20 | 13.7 weeks | oral in diet | reproduction | 1.50 | Sample et al. 1996 | 0.44 | Sample et al. 1996 | 0.81 |
| Selenium | -- | chicken | -- | 2 weeks | oral in diet | survival, growth,reproduction | 0.58 | USEPA 2007d | 0.29 | USEPA 2007d | 0.41 |
| Silver | -- | turkey | -- | 5 weeks | oral in diet | survival, growth | 20.2 | USEPA 2006c | 4.04 a | -- | 9.03 |
| Vanadium | Vanadyl sulfate | mallard | 1.17 | 12 weeks | oral in diet | growth/survival | 57.0 b | -- | 11.4 | Sample et al. 1996 | 25.5 |
| Vanadium | -- | chicken | -- | 5 weeks | oral in diet | survival, growth,reproduction | 0.688 | USEPA 2005h | 0.344 | USEPA 2005h | 0.486 |
| Zinc | -- | multiple | -- | -- | oral in diet | survival, growth,reproduction | 331 b | -- | 66.1 | USEPA 2007e | 148 |
| Pesticides | | | | | | | | | | | |
| 4,4'-DDD | -- | Japanese quail | 0.11 | 3 generations | oral in diet | reproduction | 5.00 | DDT value | 0.50 | DDT value | 1.58 |
| 4,4'-DDD | -- | barn owl | 0.47 | 2 years | oral in diet | reproduction | 0.40 b | DDE value | 0.08 | DDE value | 0.18 |
| 4,4'-DDD | -- | mallard | 1.00 | 2 years | oral in diet | reproduction | 0.60 | DDE value | 0.12 | DDE value | 0.27 |
| 4,4'-DDD | -- | bald eagle | -- | 112 days | oral in diet | survival | 3.00 | DDT value | 0.30 | DDT value | 0.95 |
| 4,4'-DDE | -- | Japanese quail | 0.11 | 3 generations | oral in diet | reproduction | 5.00 | DDT value | 0.50 | DDT value | 1.58 |
| 4,4'-DDE | -- | barn owl | 0.47 | 2 years | oral in diet | reproduction | 0.40 b | -- | 0.08 | Blus 1996 | 0.18 |
| 4,4'-DDE | -- | mallard | 1.00 | 2 years | oral in diet | reproduction | 0.60 | USEPA 1995b | 0.12 | USEPA 1995b | 0.27 |
| 4,4'-DDE | -- | bald eagle | -- | 112 days | oral in diet | survival | 3.00 | DDT value | 0.30 | DDT value | 0.95 |
| 4,4'-DDT | -- | Japanese quail | 0.11 | 3 generations | oral in diet | reproduction | 5.00 | USEPA 1995b | 0.50 | USEPA 1995b | 1.58 |
| 4,4'-DDT | -- | barn owl | 0.47 | 2 years | oral in diet | reproduction | 0.40 b | DDE value | 0.08 | DDE value | 0.18 |
| 4,4'-DDT | -- | mallard | 1.00 | 2 years | oral in diet | reproduction | 1.50 | USEPA 1995b | 0.60 | USEPA 1995b | 0.95 |
| 4,4'-DDT | -- | bald eagle | -- | 112 days | oral in diet | survival | 3.00 | USEPA 1995b | 0.30 | USEPA 1995b | 0.95 |
| Aldrin | -- | ring-necked pheasant | 1.14 | 5 days | oral in diet | survival | 0.351 b | -- | 0.070 e | Hill et al. 1975 | 0.157 |
| Aldrin | -- | mallard | 1.00 | 5 days | oral in diet | survival | 0.775 b | -- | 0.155 e | Hill et al. 1975 | 0.347 |
| alpha-BHC | Mixed isomers | Japanese quail | 0.15 | 90 days | oral in diet | reproduction | 2.25 | Sample et al. 1996 | 0.56 | Sample et al. 1996 | 1.13 |
| alpha-Chlordane | Chlordane | red-winged blackbird | 0.06 | 84 days | oral in diet | survival | 10.7 | Sample et al. 1996 | 2.14 | Sample et al. 1996 | 4.79 |
| alpha-Chlordane | -- | northern bobwhite | 0.19 | not specified | oral in diet | reproduction | 5.95 b | -- | 1.19 | Wiemeyer 1996 | 2.66 |
| alpha-Chlordane | -- | mallard | 1.00 | not specified | oral in diet | reproduction | 4.00 b | -- | 0.80 | Wiemeyer 1996 | 1.79 |
| beta-BHC | Mixed isomers | Japanese quail | 0.15 | 90 days | oral in diet | reproduction | 2.25 | Sample et al. 1996 | 0.56 | Sample et al. 1996 | 1.13 |
| delta-BHC | Mixed isomers | Japanese quail | 0.15 | 90 days | oral in diet | reproduction | 2.25 | Sample et al. 1996 | 0.56 | Sample et al. 1996 | 1.13 |
| Dieldrin | -- | mallard | -- | 24 days | oral in diet | survival, growth,reproduction | 3.78 | USEPA 2007g | 0.071 | USEPA 2007g | 0.52 |

Table 21
Ingestion-Based Toxicity Reference Values (TRVs) for Birds
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Chemical Form | Test Organism | Body Weight (kg) | Duration | Exposure Route | Effect/Endpoint | LOAEL (mg/kg/d) | | Reference | NOAEL (mg/kg/d) | | Reference | MATC (mg/kg/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Endosulfan I | -- | gray partridge | 0.40 | 4 weeks | oral in diet | reproduction | 50.0 | b | -- | 10.0 | | Sample et al. 1996 | 22.4 |
| Endosulfan II | -- | gray partridge | 0.40 | 4 weeks | oral in diet | reproduction | 50.0 | b | -- | 10.0 | | Sample et al. 1996 | 22.4 |
| Endrin | -- | mallard | 1.15 | >200 days | oral in diet | reproduction | 1.50 | b | -- | 0.30 | | Sample et al. 1996 | 0.67 |
| Endrin | -- | screech owl | 0.18 | >83 days | oral in diet | reproduction | 0.104 | | Sample et al. 1996 | 0.021 | a | -- | 0.046 |
| gamma-BHC (Lindane) | -- | mallard | 1.00 | 8 weeks | oral (intubation) | reproduction | 20.0 | | Sample et al. 1996 | 4.00 | a | -- | 8.94 |
| gamma-Chlordane | Chlordane | red-winged blackbird | 0.06 | 84 days | oral in diet | survival | 10.7 | | Sample et al. 1996 | 2.14 | | Sample et al. 1996 | 4.79 |
| gamma-Chlordane | -- | northern bobwhite | 0.19 | not specified | oral in diet | reproduction | 5.95 | b | -- | 1.19 | | Wiemeyer 1996 | 2.66 |
| gamma-Chlordane | -- | mallard | 1.00 | not specified | oral in diet | reproduction | 4.00 | b | -- | 0.80 | | Wiemeyer 1996 | 1.79 |
| Heptachlor | -- | ring-necked pheasant | 1.14 | 5 days | oral in diet | survival | 1.38 | b | -- | 0.28 | e | Hill et al. 1975 | 0.62 |
| Heptachlor | -- | mallard | 1.00 | 5 days | oral in diet | survival | 2.40 | b | -- | 0.48 | e | Hill et al. 1975 | 1.07 |
| Heptachlor | -- | American woodcock | 0.20 | 76 days | oral in diet | survival | 2.17 | | Stickel et al. 1965 | 0.49 | | Stickel et al. 1965 | 1.03 |
| Heptachlor epoxide | -- | ring-necked pheasant | 1.14 | 5 days | oral in diet | survival | 1.38 | b | -- | 0.28 | e | Heptachlor value | 0.62 |
| Heptachlor epoxide | -- | mallard | 1.00 | 5 days | oral in diet | survival | 2.40 | b | -- | 0.48 | e | Heptachlor value | 1.07 |
| Heptachlor epoxide | -- | American woodcock | 0.20 | 76 days | oral in diet | survival | 2.17 | | Stickel et al. 1965 | 0.49 | | Stickel et al. 1965 | 1.03 |
| Methoxychlor | -- | chicken | 1.50 | 16 weeks | oral in diet | reproduction | 1,775 | b | -- | 355 | | Wiemeyer 1996 | 794 |
| Toxaphene | -- | American black duck | 1.00 | 2 seasons | oral in diet | reproduction | 5.00 | | Wiemeyer 1996 | 1.00 | | Wiemeyer 1996 | 2.24 |
| Polychlorinated Biphenyls | | | | | | | | | | | | | |
| Aroclor-1016 | -- | ring-necked pheasant | 1.00 | 17 weeks | oral | reproduction | 1.80 | | Aroclor-1254 value | 0.36 | a | Aroclor-1254 value | 0.80 |
| Aroclor-1016 | -- | screech owl | 0.18 | 2 generations | oral in diet | reproduction | 2.05 | b | Aroclor-1242 value | 0.41 | | Aroclor-1242 value | 0.92 |
| Aroclor-1016 | -- | mallard | 1.00 | 1 month | oral in diet | reproduction | 7.50 | b | Aroclor-1254 value | 1.50 | | Aroclor-1254 value | 3.35 |
| Aroclor-1221 | -- | ring-necked pheasant | 1.00 | 17 weeks | oral | reproduction | 1.80 | | Aroclor-1254 value | 0.36 | a | Aroclor-1254 value | 0.80 |
| Aroclor-1221 | -- | screech owl | 0.18 | 2 generations | oral in diet | reproduction | 2.05 | b | Aroclor-1242 value | 0.41 | | Aroclor-1242 value | 0.92 |
| Aroclor-1221 | -- | mallard | 1.00 | 1 month | oral in diet | reproduction | 7.50 | b | Aroclor-1254 value | 1.50 | | Aroclor-1254 value | 3.35 |
| Aroclor-1232 | -- | ring-necked pheasant | 1.00 | 17 weeks | oral | reproduction | 1.80 | | Aroclor-1254 value | 0.36 | a | Aroclor-1254 value | 0.80 |
| Aroclor-1232 | -- | screech owl | 0.18 | 2 generations | oral in diet | reproduction | 2.05 | b | Aroclor-1242 value | 0.41 | | Aroclor-1242 value | 0.92 |
| Aroclor-1232 | -- | mallard | 1.00 | 1 month | oral in diet | reproduction | 7.50 | b | Aroclor-1254 value | 1.50 | | Aroclor-1254 value | 3.35 |
| Aroclor-1242 | -- | ring-necked pheasant | 1.00 | 17 weeks | oral | reproduction | 1.80 | | Aroclor-1254 value | 0.36 | a | Aroclor-1254 value | 0.80 |
| Aroclor-1242 | -- | screech owl | 0.18 | 2 generations | oral in diet | reproduction | 2.05 | b | -- | 0.41 | | Sample et al. 1996 | 0.92 |
| Aroclor-1242 | -- | mallard | 1.00 | 1 month | oral in diet | reproduction | 7.50 | b | Aroclor-1254 value | 1.50 | | Aroclor-1254 value | 3.35 |
| Aroclor-1248 | -- | ring-necked pheasant | 1.00 | 17 weeks | oral | reproduction | 1.80 | | Aroclor-1254 value | 0.36 | a | Aroclor-1254 value | 0.80 |
| Aroclor-1248 | -- | screech owl | 0.18 | 2 generations | oral in diet | reproduction | 2.05 | b | Aroclor-1242 value | 0.41 | | Aroclor-1242 value | 0.92 |
| Aroclor-1248 | -- | mallard | 1.00 | 1 month | oral in diet | reproduction | 7.50 | b | Aroclor-1254 value | 1.50 | | Aroclor-1254 value | 3.35 |
| Aroclor-1254 | -- | ring-necked pheasant | 1.00 | 17 weeks | oral | reproduction | 1.80 | | Sample et al. 1996 | 0.36 | a | -- | 0.80 |
| Aroclor-1254 | -- | screech owl | 0.18 | 2 generations | oral in diet | reproduction | 2.05 | b | Aroclor-1242 value | 0.41 | | Aroclor-1242 value | 0.92 |
| Aroclor-1254 | -- | mallard | 1.00 | 1 month | oral in diet | reproduction | 7.50 | b | -- | 1.50 | | USEPA 1995b | 3.35 |
| Aroclor-1260 | -- | ring-necked pheasant | 1.00 | 17 weeks | oral | reproduction | 1.80 | | Aroclor-1254 value | 0.36 | a | Aroclor-1254 value | 0.80 |
| Aroclor-1260 | -- | screech owl | 0.18 | 2 generations | oral in diet | reproduction | 2.05 | b | Aroclor-1242 value | 0.41 | | Aroclor-1242 value | 0.92 |
| Aroclor-1260 | -- | mallard | 1.00 | 1 month | oral in diet | reproduction | 7.50 | b | Aroclor-1254 value | 1.50 | | Aroclor-1254 value | 3.35 |
| Volatile and Semivolatile Organic Compounds | | | | | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | -- | -- | -- | -- | -- | -- | NA | | -- | NA | | -- | NA |
| 1,2,4,5-Tetrachlorobenzene | -- | -- | -- | -- | -- | -- | NA | | -- | NA | | -- | NA |
| 1,2,4-Trichlorobenzene | -- | northern bobwhite | 0.19 | 14 days | oral | survival | 161 | b | 1,4-Dichlorobenzene value | 32.2 | d | 1,4-Dichlorobenzene value | 71.9 |
| 1,2-Dichlorobenzene | -- | northern bobwhite | 0.19 | 14 days | oral | survival | 161 | b | 1,4-Dichlorobenzene value | 32.2 | d | 1,4-Dichlorobenzene value | 71.9 |
| 1,3-Dichlorobenzene | -- | northern bobwhite | 0.19 | 14 days | oral | survival | 161 | b | 1,4-Dichlorobenzene value | 32.2 | d | 1,4-Dichlorobenzene value | 71.9 |
| 1,4-Dichlorobenzene | -- | northern bobwhite | 0.19 | 14 days | oral | survival | 161 | b | -- | 32.2 | d | TERRETOX 2002 | 71.9 |
| 4-Bromophenyl-phenylether | -- | -- | -- | -- | -- | -- | NA | | -- | NA | | -- | NA |
| 4-Chlorophenyl-phenylether | -- | -- | -- | -- | -- | -- | NA | | -- | NA | | -- | NA |

Table 21
Ingestion-Based Toxicity Reference Values (TRVs) for Birds
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | Chemical Form | Test Organism | Body Weight (kg) | Duration | Exposure Route | Effect/Endpoint | LOAEL (mg/kg/d) | Reference | NOAEL (mg/kg/d) | Reference | MATC (mg/kg/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acenaphthene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Acenaphthylene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Anthracene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Benzo(a)anthracene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Benzo(a)pyrene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Rigdon and Neal 1963 | 15.9 |
| Benzo(b)fluoranthene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Benzo(g,h,i)perylene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Benzo(k)fluoranthene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Chrysene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Dibenz(a,h)anthracene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Fluoranthene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Fluorene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Hexachlorobenzene | -- | Japanese quail | 0.15 | 90 days | oral in diet | reproduction | 0.57 | Coulston and Kolbye 1994; TERRETOX 2002 | 0.11 | Coulston and Kolbye 1994; TERRETOX 2002 | 0.25 |
| Hexachlorobutadiene | -- | Japanese quail | 0.15 | 90 days | oral in diet | reproduction | 17.0 b | -- | 3.39 | Coulston and Kolbye 1994; TERRETOX 2002 | 7.58 |
| Hexachlorocyclopentadiene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| Hexachloroethane | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| Indeno(1,2,3-cd)pyrene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Pentachlorophenol | -- | chicken | -- | 1 week | oral in diet | survival, growth | 67.3 | USEPA 2007h | 6.73 | USEPA 2007h | 21.3 |
| Phenanthrene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Pyrene | -- | chicken | 1.50 | 35 days | oral in diet | reproduction | 35.5 b | -- | 7.10 c | Benzo(a)pyrene value | 15.9 |
| Explosives | | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 1,3-Dinitrobenzene | -- | red-winged blackbird | -- | -- | oral | survival | 2.11 b | -- | 0.42 e | LANL 2008 | 0.94 |
| 2,4,6-Trinitrotoluene | -- | rock dove | -- | 60 days | oral (gavage) | systemic | 7.00 c | Johnson and Salice 2009 | 2.00 c | Johnson and Salice 2009 | 3.74 |
| 2,4-Dinitrotoluene | -- | northern bobwhite | -- | 60 days | oral (gavage) | survival; growth | 0.50 c | Johnson and Salice 2009 | 0.10 c | Johnson and Salice 2009 | 0.22 |
| 2,6-Dinitrotoluene | -- | northern bobwhite | -- | 60 days | oral (gavage) | survival; growth | 0.50 c | 2,4-Dinitrotoluene value | 0.10 c | 2,4-Dinitrotoluene value | 0.22 |
| 2-Amino-4,6-dinitrotoluene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 2-Nitrotoluene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 3-Nitrotoluene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 4-Amino-2,6-dinitrotoluene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| 4-Nitrotoluene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| HMX | -- | northern bobwhite | 0.19 | 28 days | oral in diet | reproduction | 79.0 | Johnson and Salice 2009 | 7.90 | Johnson and Salice 2009 | 25.0 |
| Nitrobenzene | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |
| Perchlorate | -- | multiple | -- | chronic | oral | multiple | 26.0 | USACHPPM 2007 | 13.0 | USACHPPM 2007 | 18.4 |
| RDX | -- | northern bobwhite | 0.19 | 14 - 90 days | oral in diet | reproduction | 10.6 | Johnson and Salice 2009 | 8.70 | Johnson and Salice 2009 | 9.60 |
| Tetryl | -- | -- | -- | -- | -- | -- | NA | -- | NA | -- | NA |

NA - Not Available
[a] Uncertainty factor of 5 applied to LOAEL
[b] Uncertainty factor of 5 applied to NOAEL
[c] Subchronic to chronic uncertainty factor of 10 applied
[d] Acute to chronic uncertainty factor of 50 applied
[e] Uncertainty factor of 100 applied to LD50

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Table 22a
Soil Background Data - East Vieques Surface Soil
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | KTd | | | Kv | | | Qa | | | Tl | | | Combined Set | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL |
| Inorganics (mg/kg) | | | | | | | | | | | | | | | |
| Aluminum | 24,200 | 9,771 | 35,000 | NR | NR | 35,000 | 29,900 | 12,678 | 35,000 | NR | NR | 35,000 | 41,500 | 13,100 | 35,000 |
| Antimony[1] | 5.80 | -- | 5.80 | 5.80 | -- | 5.80 | 5.80 | -- | 5.80 | 5.80 | -- | 5.80 | 5.80 | -- | 5.80 |
| Arsenic | 0.64 | 0.64 | 1.60 | NR | NR | 1.60 | 1.10 | 0.75 | 1.60 | 9.60 | 4.10 | 9.20 | 9.60 | 1.54 | 9.20 |
| Barium | 121 | 85.1 | 147 | NR | NR | 212 | 344 | 93.0 | 212 | NR | NR | 212 | 344 | 76.6 | 212 |
| Beryllium | -- | -- | 0.27 | 0.27 | NR | 0.27 | -- | -- | 0.27 | 0.95 | 0.45 | 0.95 | 0.95 | 0.31 | 0.95 |
| Cadmium | 1.80 | 0.61 | 2.20 | NR | NR | 2.20 | 3.10 | 0.90 | 2.20 | 2.10 | 1.40 | 2.40 | 3.10 | 0.92 | 2.40 |
| Calcium | 7,740 | 3,554 | 8,840 | NR | NR | 8,840 | 11,900 | 4,976 | 11,900 | 362,000 | 162,000 | 417,000 | 362,000 | 46,143 | 417,000 |
| Chromium | 72.0 | 11.0 | 72.0 | NR | NR | 72.0 | 31.0 | 12.0 | 72.0 | 58.8 | 27.3 | 70.0 | 72.0 | 16.7 | 72.0 |
| Cobalt | 19.4 | 7.60 | 16.0 | 24.0 | 10.9 | 26.0 | 19.0 | 8.40 | 16.0 | NR | NR | 16.0 | 24.0 | 8.05 | 26.0 |
| Copper | 61.4 | 38.3 | 66.0 | NR | NR | 94.0 | 43.7 | 25.2 | 53.0 | NR | NR | 94.0 | 102 | 28.1 | 94.0 |
| Cyanide | NR | NR | 0.33 | NR | NR | 0.33 | NR | NR | 0.33 | 0.45 | 1.03 | 0.45 | 0.45 | 1.19 | 0.45 |
| Iron | 32,400 | 14,417 | 38,100 | 39,500 | 22,200 | 43,200 | 38,100 | 17,740 | 38,100 | NR | NR | 38,100 | 39,500 | 17,122 | 43,200 |
| Lead | 4.50 | 2.50 | 5.40 | NR | NR | 5.40 | 4.50 | 2.40 | 5.40 | 10.6 | 6.18 | 16.0 | 10.6 | 3.26 | 16.0 |
| Magnesium | 3,880 | 2,080 | 3,710 | NR | NR | 22,200 | 25,200 | 5,849 | 22,200 | NR | NR | 22,200 | 32,300 | 5,895 | 22,200 |
| Manganese | 1,630 | 639 | 1,630 | NR | NR | 1,630 | 738 | 392 | 1,630 | NR | NR | 1,630 | 1,630 | 533 | 1,630 |
| Mercury | 0.053 | 0.053 | 0.057 | NR | NR | 0.057 | 0.057 | 0.054 | 0.057 | 0.31 | 0.133 | 0.31 | 0.31 | 0.073 | 0.31 |
| Nickel | 31.2 | 5.10 | 22.0 | NR | NR | 41.0 | 15.4 | 5.60 | 22.0 | NR | NR | 41.0 | 40.0 | 7.06 | 41.0 |
| Potassium | 2,180 | 1,583 | 5,270 | NR | NR | 5,270 | 5,520 | 1,967 | 5,270 | 9,050 | 4,000 | 10,800 | 9,050 | 2,561 | 10,800 |
| Selenium | -- | -- | 0.51 | NR | NR | 0.51 | 0.51 | 0.49 | 0.51 | 1.30 | 1.51 | 1.30 | 1.30 | 1.79 | 1.30 |
| Silver | 0.091 | 0.091 | 0.22 | NR | NR | 0.22 | 0.14 | 0.11 | 0.22 | NR | NR | 0.22 | 0.22 | 0.51 | 0.22 |
| Sodium | 1,140 | 1,140 | 1,590 | NR | NR | 1,590 | 1,590 | 978 | 1,590 | NR | NR | 1,590 | 1,590 | 363 | 1,590 |
| Thallium | 0.061 | 0.03 | 0.13 | NR | NR | 0.13 | 0.092 | 0.043 | 0.13 | NR | NR | 0.13 | 0.13 | 0.12 | 0.13 |
| Vanadium | 142 | 49.0 | 144 | NR | NR | 144 | 114 | 60.0 | 144 | 50.3 | 24.8 | 56.0 | 142 | 49.8 | 144 |
| Zinc | 35.0 | 19.0 | 32.0 | NR | NR | 32.0 | 29.0 | 18.0 | 32.0 | NR | NR | 32.0 | 35.0 | 17.9 | 32.0 |
| Pesticides (ug/kg)[2] | | | | | | | | | | | | | | | |
| 4,4'-DDD | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 26.0 | -- | -- |
| 4,4'-DDE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1,200 | -- | -- |
| 4,4'-DDT | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 990 | -- | -- |
| Aldrin | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| alpha-BHC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| alpha-Chlordane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| beta-BHC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.90 | -- | -- |

Table 22a
Soil Background Data - East Vieques Surface Soil
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | KTd | | | Kv | | | Qa | | | Tl | | | Combined Set | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL |
| Chlordane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 14.0 | -- | -- |
| delta-BHC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.84 | -- | -- |
| Dieldrin | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.74 | -- | -- |
| Endosulfan I | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.44 | -- | -- |
| Endosulfan II | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Endosulfan sulfate | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Endrin | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.40 | -- | -- |
| Endrin aldehyde | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Endrin ketone | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.30 | -- | -- |
| gamma-BHC (Lindane) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| gamma-Chlordane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.90 | -- | -- |
| Heptachlor | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.76 | -- | -- |
| Heptachlor epoxide | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Methoxychlor | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Toxaphene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

NR - Not Reported
1 - Maximum value from USEPA split samples
2 - Maximum detected concentrations at East Vieques sites considered representative of normal pesticide application and not CERCLA releases (CH2M HILL, 2009a)

Table 22b
Soil Background Data - West Vieques Surface Soil
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | KTd | | | Qa | | | Qs | | | Combined Set | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL |
| Inorganics (mg/kg) | | | | | | | | | | | | |
| Aluminum | 18,000 | 11,346 | 18,000 | 29,000 | 13,350 | 29,000 | 11,000 | 3,875 | 11,000 | 29,000 | 9,573 | 29,000 |
| Antimony | 1.40 | 0.68 | 1.40 | 2.30 | 0.81 | 2.30 | 1.00 | 0.53 | 1.00 | 2.30 | 0.67 | 2.30 |
| Arsenic | 1.20 | 0.65 | 1.20 | 2.20 | 0.95 | 2.20 | 2.10 | 1.13 | 2.10 | 2.20 | 0.89 | 2.20 |
| Barium | 190 | 84.0 | 190 | 320 | 94.3 | 320 | 24.0 | 14.6 | 24.0 | 320 | 64.8 | 320 |
| Beryllium | 0.27 | 0.17 | 0.27 | 0.46 | 0.24 | 0.46 | 0.41 | 0.23 | 0.41 | 0.46 | 0.21 | 0.45 |
| Cadmium | -- | 0.031 | 0.036 | -- | 0.033 | 0.036 | -- | 0.036 | 0.040 | -- | 0.033 | 0.040 |
| Calcium | 9,100 | 4,838 | 9,100 | 45,000 | 11,817 | 45,000 | 210,000 | 84,000 | 210,000 | 210,000 | 29,849 | 210,000 |
| Chromium | 52.0 | 12.7 | 52.0 | 74.0 | 26.0 | 74.0 | 48.0 | 9.38 | 48.0 | 74.0 | 15.9 | 74.0 |
| Cobalt | 13.0 | 9.06 | 13.0 | 25.0 | 12.5 | 33.3 | 13.0 | 2.90 | 13.0 | 25.0 | 8.18 | 25.0 |
| Copper | 47.0 | 28.4 | 47.0 | 68.0 | 31.2 | 68.0 | 35.0 | 9.83 | 35.0 | 68.0 | 23.3 | 68.0 |
| Iron | 28,000 | 20,692 | 28,000 | 39,000 | 23,167 | 39,000 | 18,000 | 6,475 | 18,000 | 39,000 | 16,884 | 37,531 |
| Lead | 5.70 | 3.17 | 5.70 | 6.00 | 3.96 | 6.00 | 6.90 | 2.75 | 6.90 | 6.90 | 3.30 | 6.90 |
| Magnesium | 7,200 | 3,985 | 7,200 | 16,000 | 4,625 | 16,000 | 11,000 | 3,842 | 11,000 | 16,000 | 4,146 | 12,834 |
| Manganese | 1,200 | 626 | 1,200 | 1,200 | 663 | 1,200 | 360 | 132 | 360 | 1,200 | 478 | 1,167 |
| Mercury | 0.024 | 0.011 | 0.024 | 0.031 | 0.018 | 0.031 | 0.016 | 0.009 | 0.016 | 0.031 | 0.013 | 0.031 |
| Nickel | 18.0 | 5.09 | 18.0 | 40.0 | 12.8 | 40.0 | 26.0 | 3.86 | 26.0 | 40.0 | 7.18 | 40.0 |
| Potassium | 1,400 | 875 | 1,400 | 1,400 | 1,023 | 1,400 | 1,700 | 859 | 1,700 | 1,700 | 918 | 1,700 |
| Selenium | 0.73 | 0.54 | 0.73 | 2.00 | 0.85 | 2.00 | -- | 0.61 | 0.68 | 2.00 | 0.66 | 2.00 |
| Silver | -- | 0.065 | 0.076 | -- | 0.069 | 0.077 | -- | 0.075 | 0.084 | -- | 0.069 | 0.084 |
| Sodium | 310 | 116 | 310 | 1,200 | 367 | 1,200 | 6,300 | 2,803 | 6,300 | 6,300 | 1,069 | 6,300 |
| Thallium | 0.46 | 0.39 | 0.46 | 0.67 | 0.43 | 0.67 | -- | 0.45 | 0.50 | 0.67 | 0.42 | 0.67 |
| Vanadium | 80.0 | 53.2 | 80.0 | 130 | 73.1 | 130 | 63.0 | 22.2 | 63.0 | 130 | 49.6 | 130 |
| Zinc | 53.0 | 35.5 | 53.0 | 71.0 | 37.8 | 71.0 | 31.0 | 11.8 | 31.0 | 71.0 | 28.5 | 65.1 |
| Pesticides (ug/kg)[1] | | | | | | | | | | | | |
| 4,4'-DDD | -- | -- | -- | -- | -- | -- | -- | -- | -- | 40.0 | -- | -- |
| 4,4'-DDE | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3,990 | -- | -- |
| 4,4'-DDT | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2,190 | -- | -- |
| Aldrin | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.87 | -- | -- |

Table 22b
Soil Background Data - West Vieques Surface Soil
Ecological Risk Assessment Protocol
*Vieques Environmental Restoration Program*

| Chemical | KTd | | | Qa | | | Qs | | | Combined Set | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL | Maximum | Mean | UTL |
| alpha-BHC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| alpha-Chlordane | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4.60 | -- | -- |
| beta-BHC | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.40 | -- | -- |
| delta-BHC | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.59 | -- | -- |
| Dieldrin | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.90 | -- | -- |
| Endosulfan I | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.50 | -- | -- |
| Endosulfan II | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.65 | -- | -- |
| Endosulfan sulfate | -- | -- | -- | -- | -- | -- | -- | -- | -- | 90.0 | -- | -- |
| Endrin | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16.0 | -- | -- |
| Endrin aldehyde | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11.0 | -- | -- |
| Endrin ketone | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| gamma-BHC (Lindane) | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.66 | -- | -- |
| gamma-Chlordane | -- | -- | -- | -- | -- | -- | -- | -- | -- | 270 | -- | -- |
| Heptachlor | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.50 | -- | -- |
| Heptachlor epoxide | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.70 | -- | -- |
| Methoxychlor | -- | -- | -- | -- | -- | -- | -- | -- | -- | 240 | -- | -- |
| Toxaphene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

1 - Maximum detected concentrations at West Vieques sites considered representative of normal pesticide application and not CERCLA releases (CH2M HILL, 2009b)

# Baseline Human Health Risk Assessment Protocol for Vieques Environmental Restoration Program

A baseline human health risk assessment (HHRA) provides an evaluation of the potential risks associated with existing site conditions, under both current and potential future land-use conditions. The results of the HHRA will be used as the basis for making risk management decisions for a site, if necessary, including evaluating the need for future remedial actions or controls at a site. When an HHRA is conducted, realistic potential exposure scenarios will be evaluated. Future residential land use may be evaluated as a conservative exposure scenario, although it may not be realistic for land that is to remain non-residential, such as for conservation areas as indicated in the maps from the Puerto Rico Planning Board (Figure 1). Residential land use, where considered, will be evaluated to determine whether the site poses no unacceptable risks for unrestricted use of the site. Where sites cannot be released for unrestricted use (e.g., sites within lands Congressionally mandated as wilderness areas), the Navy may choose not to evaluate the residential land use or other infeasible exposure scenarios. Chemicals of potential concern (COPCs) that are detected in site media at concentrations within background levels will be retained for risk estimation, although they could reflect background conditions. Detected concentrations will not be compared with background levels to select COPCs. However, background comparisons will be made for risk management considerations in the risk characterization section of the HHRA.

The HHRAs will be conducted following U.S. Environmental Protection Agency (EPA) guidance. At the time the HHRA is prepared, the most recent version of the guidance documents and models will be used. The References Section at the end of this protocol contains a list of the current guidance documents and models planned for use.

The remainder of this protocol is structured under the assumption that the unrestricted use scenario will be included in a particular HHRA to account for the most conservative exposure scenario. However, as discussed above, site-specific circumstances may affect the actual exposure scenarios evaluated in the HHRA (as well as the sample collection procedures implemented to generate the data and the exposure factors used in the HHRA).

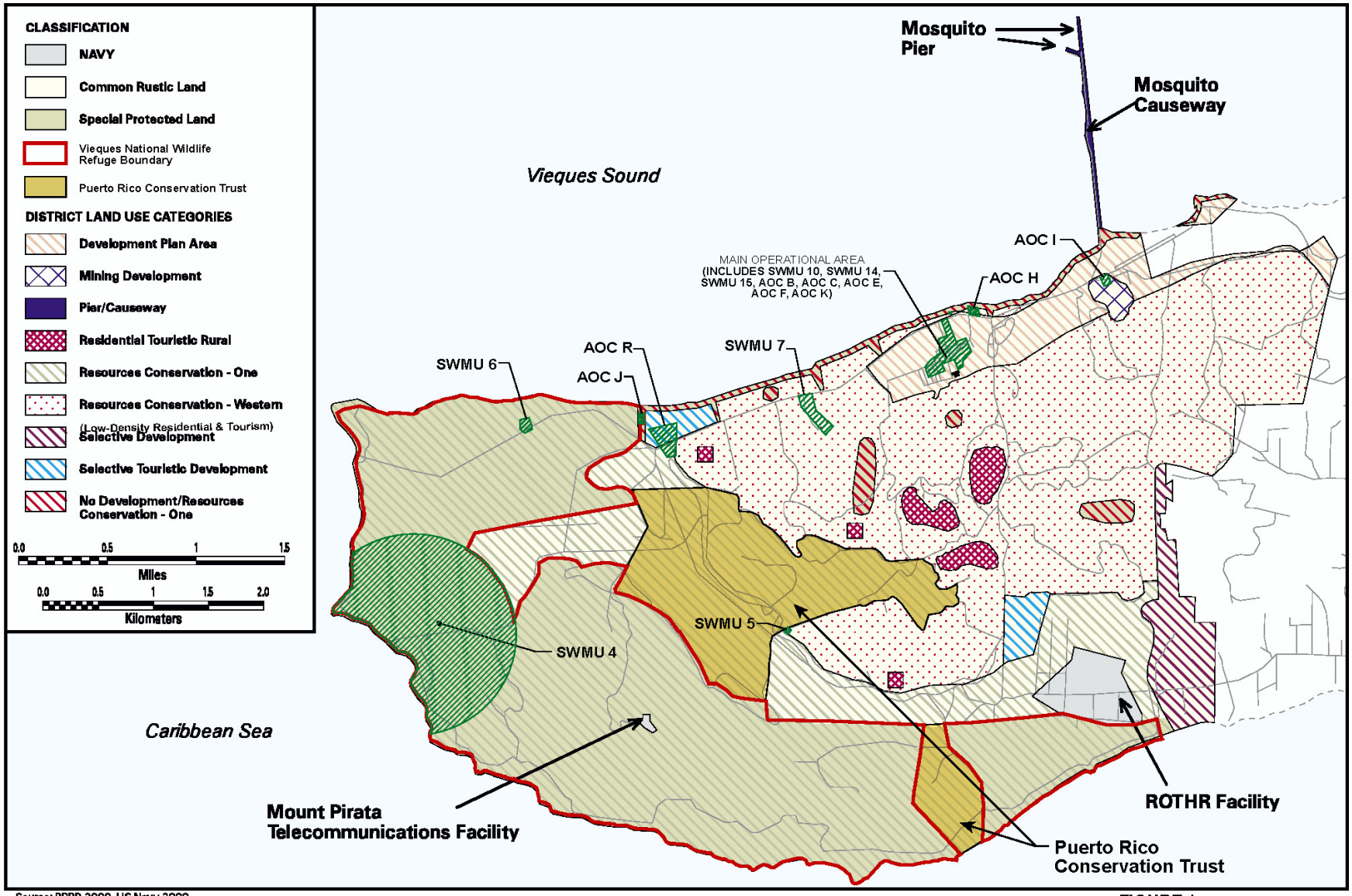
## Risk Results Format and Interim Deliverables

The HHRA tables will be presented in Risk Assessment Guidance for Superfund (RAGS) Part D format. The intent of providing RAGS Part D format is to ensure a clear and consistent approach to presenting HHRA information and results. Appendix A of EPA guidance (EPA, 2001) will be used to obtain RAGS Part D format worksheets for each site-specific HHRA.

A conceptual site model (CSM), RAGS Part D Table 1 and graphical CSM diagram showing potentially complete exposure pathways, will be developed to present an overview of site conditions and to identify potential exposure media, exposure points, receptors, and exposure routes. The conceptual site model will be developed at the work plan stage and refined, as necessary, following data collection. This will serve as the basis for the exposure pathway evaluations in the baseline HHRA.

Prior to submittal of the standard interim deliverable (i.e., RAGS Part D Tables 1-6), a "pre-interim deliverable" consisting of RAGS Part D Table 2 (COPC selection tables), Table 3 (exposure point concentration tables), ProUCL output reports, and associated figures depicting locations of screening value exceedances will be submitted for agency review. The depth of each surface soil and subsurface soil sample will be included. Subsequently, if needed, a conference call will be held with the agencies to discuss the data groupings to be used in the baseline HHRA. The agencies will provide input on the pre-interim deliverable within one week of the call.

Upon agency approval of the pre-interim deliverable, a standard interim deliverable (consisting of a graphical CSM diagram, RAGS Part D Tables 1-6, site-specific data [if available] and a brief memorandum) will be submitted for agency review and approval prior to preparation of the risk estimates and HHRA text. This step is intended to reduce the number of iterations in the risk calculations by achieving up-front concurrence on the HHRA exposure pathways, receptors, and exposure assumptions. Requests for interim toxicity data (EPA Provisional Peer-Reviewed Toxicity Values [PPRTVs]) for detected constituents will be made prior to submittal of the interim deliverable and will be incorporated into the interim deliverable.




Source: PRPB 2000, US Navy 2000

**FIGURE 1**

Proposed Land Use and Zoning Classifications by Puerto Rico Planning Board

*Former NASD, Vieques Island, Puerto Rico*

CH2MHILL

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# Risk Assessment Process

Each HHRA will include the following major components in the evaluation process:

- Data collection and evaluation, including identification of COPCs
- Exposure assessment
- Toxicity assessment
- Risk characterization

## Data Collection and Evaluation

This section will include a brief summary of information pertinent to the HHRA, such as potential sources of contamination, the specific sampling locations and depths, the sampling rationale, and the analytical methods (with reference to previous section(s) of the report to minimize repeating information already discussed), screening methods used to select COPCs, and the COPCs identified for the site.

The detected constituents at each site will be screened to select the COPCs in accordance with EPA guidelines (EPA, 1989). The COPC selection process will be conservative to ensure that potential risks are not inadvertently underestimated or discounted at an early step in the assessment. The selected COPCs will be retained for further evaluation in the HHRA. For samples with field duplicate analyses, the higher of the two concentrations will be used when both values are detects or when both values are non-detects. In cases where one result is a detection and the other a non-detect, the detected value will be used in the risks assessment. For non-detected results, the sample quantitation limit (SQL) will be used to represent the concentration and will be used in the calculation of exposure point concentrations using the most recent version of ProUCL software (currently version 4.00.04; EPA, 2009a).

The COPCs in a typical exposure medium will be identified by comparing the maximum detected constituent concentrations against the screening criteria. If the maximum detected concentration of a constituent exceeds its respective screening criterion, the constituent will be identified as a COPC and retained for quantitative evaluation in the HHRA.

Typical exposure media that may be available for a site consist of surface soils, subsurface soils, surface water, sediment, and groundwater. The following sources will be used to obtain the health-based screening criteria:

- Surface soil (to 1 or 2 feet below land surface (bls), depending on the site), subsurface soil (down to 6 feet bls), and sediment analytical results will be screened against the most recent version of the EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (current version was published in December 2009; EPA, 2009b). The non-carcinogenic RSL values will be reduced by a factor of 10 (adjusted to a Hazard Quotient [HQ]=0.1) to account for the potential presence of multiple constituents affecting the same target organ, with the exception of lead. EPA considers lead to be a special case because of the difficulty in identifying the classic "threshold" needed to develop an RfD. The residential soil RSL for lead (400 mg/kg) is

based upon the Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children and, therefore, will not be adjusted downward by a factor of 10.

When a carcinogenic-based RSL and soil saturation limit are presented in the RSL "Supporting" table for the constituent, the adjusted non-carcinogenic RSL will be compared to the carcinogenic-based RSL and soil saturation limit and the lowest of the three values will be selected as the screening criterion for that constituent. If a soil saturation limit is not available, the lower of the two values will be selected as the screening criterion for that constituent. The residential land use RSLs will be used for selecting COPCs for the recreational and residential exposure scenarios, while the industrial RSLs will be used for selecting COPCs for the maintenance worker, construction worker, and industrial worker scenarios.

- Surface and subsurface soils will also be screened against soil-to-groundwater protection criteria. This comparison will not be used to select the COPCs for the HHRA calculations, but will be used to help understand chemical transport potential. The leachability potential will be assessed by comparing site-specific concentrations to published EPA Soil Screening Levels (SSLs) based on a dilution/attenuation factor (DAF) of 1, or site-specific SSLs if site-specific data have been collected to permit their calculation. The site-specific SSL values will be calculated using the input factors from the data collected for each site. The site-specific DAF for SSL values will be calculated following the EPA guidance (EPA, 1996 and 2002a).

- Groundwater and surface water samples will be screened against the tap water screening levels from the latest update to the EPA RSL table. The non-carcinogenic RSL values will be reduced by a factor of 10 (adjusted to an HQ=0.1) to account for the potential presence of multiple constituents affecting the same target organ. When a carcinogenic-based RSL is presented in the RSL "Supporting" table, the adjusted non-carcinogenic RSL will be compared to the carcinogenic-based RSL, and the lower of the two values will be selected as the RSL for that constituent. The Table 2s in RAGS Part D format will also include EPA Maximum Contaminant Levels (MCLs), but the MCL comparison will not be used to select COPCs for the HHRA.

- Unfiltered (rather than filtered) surface water data will be presented in RAGS Part D Table 2's. Both filtered and unfiltered groundwater data will be presented in RAGS Part D Table 2, but unfiltered results will be used to select COPCs.

- For sites where consumption of fish is deemed to be a potentially complete exposure pathway, constituents detected in surface water and/or sediment will be screened using the general approach outlined below. If both surface water and sediment data are available, the selection of COPCs will be conducted in parallel using data from both media.

  ***Surface Water*** - Surface water COPCs for the fish ingestion pathway will be identified based on comparison of site surface water concentrations to National Recommended Water Quality Criteria (NRWQC; EPA, 2006a) for consumption of organisms, the constituent's log $K_{ow}$, and the constituents bioaccumulation potential. If a NRWQC value is not available for consumption of organisms, the value for the consumption of water + organisms will be used. If a NRWQC value is not available for an organic constituent, it

will be identified as a COPC (excluding polycyclic aromatic hydrocarbons [PAHs]) if its log $K_{ow}$ exceeds 3. If a NRWQC value is not available for an inorganic constituent, the constituent will be identified as a COPC if it is considered bioaccumulative according to EPA guidance (EPA, 2000a). Figure 2 provides a flow chart describing the surface water COPC selection process for the fish ingestion pathway.

***Sediment*** – Sediment COPCs for the fish ingestion pathway will be identified based on the constituent's log $K_{ow}$ and the constituent's bioaccumulation potential according to EPA guidance (EPA, 2000a). Organic constituents detected in sediment will be identified as COPCs (excluding PAHs) if their log $K_{ow}$ value exceeds 3. Figure 2 provides a flow chart describing the sediment COPC selection process for the fish ingestion pathway.

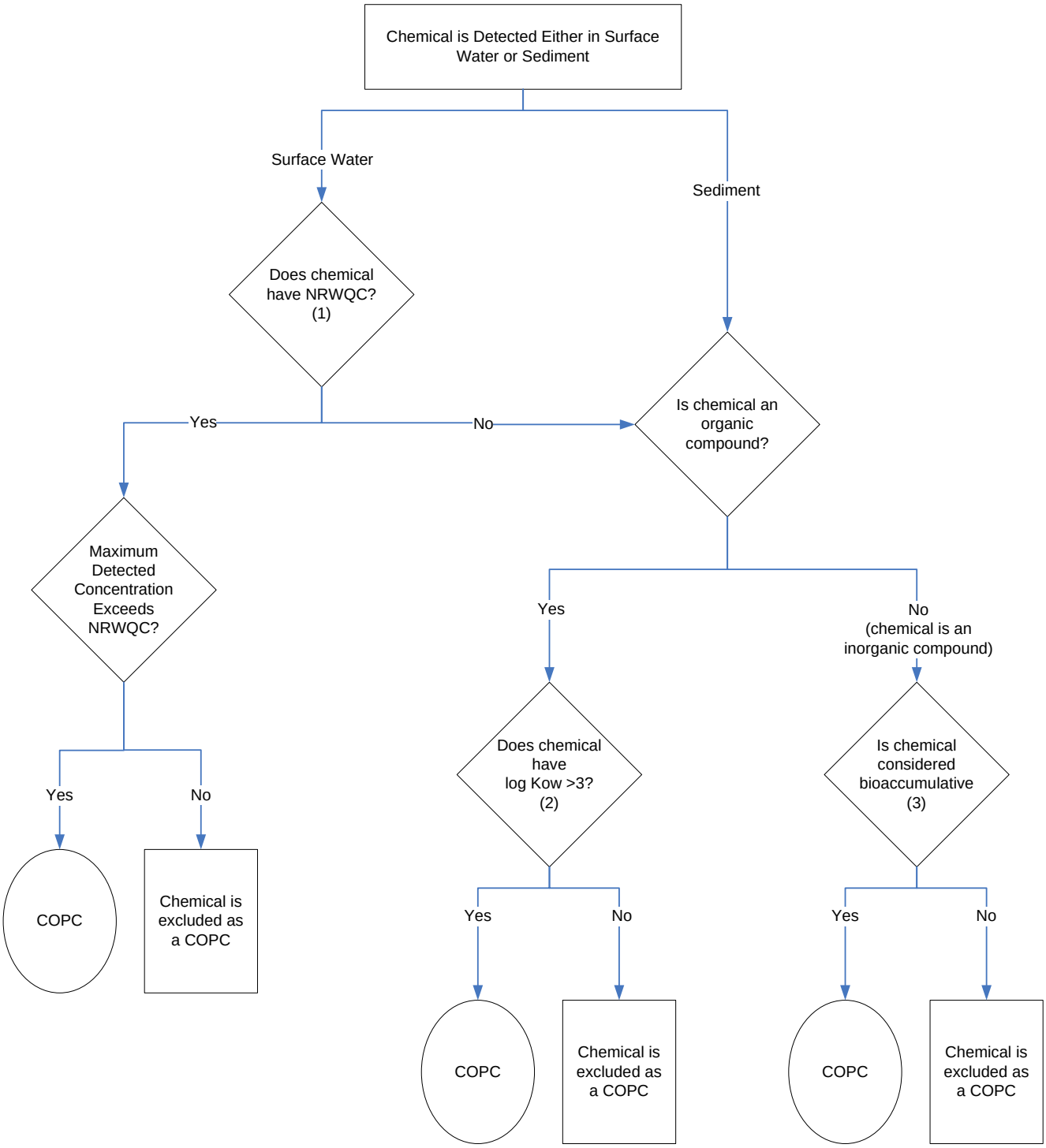
The COPCs identified in ether surface water or sediment will be identified as the final COPCs for the fish ingestion exposure pathway and appropriate biological accumulation factors will be selected to estimate concentrations in fish tissues. PAHs detected in surface water or sediment will not be identified as COPCs for the fish ingestion pathway since PAHs are readily metabolized by fish and are not expected to bioaccumulate in fish tissue or biomagnify in the food chain (ATSDR, 1995). PAH concentrations have also been found to decrease with increasing trophic level (ATSDR, 1995). Therefore, PAHs do not present a concern for the fish consumption pathway.

The RSL values will be selected from the latest update to the EPA RSL tables available at the time the HHRA is prepared. The toxicity values on which the RSLs are based will be verified in the EPA Integrated Risk Information System (IRIS) database, and if an updated value is contained in IRIS, the RSL will be recalculated prior to its use.

A detected constituent that has no screening criteria will be compared with criteria for a surrogate constituent or screening criteria will be calculated based on PPRTVs, if available, using the default RSL exposure assumptions. If neither PPRTVs nor surrogate constituents are available, the constituent will be qualitatively evaluated to determine if it should be considered a COPC. A qualitative evaluation of those chemicals without screening criteria will be included in the interim deliverable. Frequency of detection, concentration, and historical site use or release will be considered. Information available in the literature and from EPA resources will also be considered for inclusion or exclusion of constituents without screening criteria in COPC selection and subsequent HHRA steps.

Constituents that are essential nutrients (e.g., calcium, magnesium, potassium, and sodium) will not be evaluated in the quantitative HHRA, as they are toxic only at very high doses. Although iron and manganese are essential human nutrients and are toxic only at very high doses, they will be handled the same way as other detected constituents in the HHRA because human health-based screening criteria are available for both constituents. However, the iron screening criteria is based on a provisional toxicity value that increases the uncertainty associated with the quantitative risk evaluation.

When selecting COPCs in RAGS D Table 2's, chromium and mercury data will be screened using screening levels for hexavalent chromium and methylmercury as a conservative approach.




(1) National Recommended Water Quality Criteria (EPA, 2006) for consumption of organisms. If "consumption of organism" value is not available then "consumption of water + organism" value will be used.
(2) Polycyclic aromatic hydrocarbons (PAHs) will not be identified as COPCs as PAHs are not expected to bioaccumulate in fish tissues or to biomagnify. (ATSDR, 1995)
(3) Bioaccumulative chemicals will be identified according to the "Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment – Status and Needs". (EPA, 2000)

ATSDR. 1995. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons*. U.S. Department of Health and Human Services Public Health Service. August.
EPA, 2000. *Bioaccumulation testing and interpretation for the purpose of sediment quality assessment - status and needs.* EPA/823/R-00/001.
EPA. 2006. *National Recommended Water Quality Criteria*. U.S. Environmental Protection Agency, Office of Science and Technology, Office of Water, Washington, DC 20460.

FIGURE 2
Selection of COPC Process For Fish Ingestion Exposure Pathways
*Former NASD, Vieques Island, Puerto Rico*

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During the site investigation phase, soil analytical results will be used to determine if/where the collection of groundwater data is warranted. If groundwater sampling is warranted, and compounds that are sufficiently volatile and toxic (as identified in Table A-1 of the DOD Vapor Intrusion Handbook [2009]) are detected in groundwater, and it is known or reasonably anticipated that these chemicals are the result of a CERCLA-related release attributable to the Navy, and the detections are within 100 feet of an existing building (or a preferential pathway to an existing building is present), or a building may be reasonably considered to be constructed onsite in the future, a phased vapor intrusion evaluation will be performed. This approach is consistent with the DOD Vapor Intrusion Handbook (2009).

In the initial phase, a screening level assessment will be performed. This evaluation will involve comparing site groundwater data with generic risk-based screening values. The EPA residential air RSLs (EPA, 2009b) will be used with EPA's generic attenuation factors (AFs) obtained from EPA's draft vapor intrusion guidance (EPA, 2002b). The default AF is 0.001 for groundwater. The air RSL will be used with the default AF and the temperature-adjusted Henry's Law Constant to calculate the generic screening level for groundwater that is protective of indoor air vapor intrusion exposures. The residential air RSLs based on non-carcinogenic effects will be adjusted for a HQ of 0.1 to account for potential cumulative effects from the presence of multiple non-carcinogens. If maximum detected groundwater concentrations are below the generic calculated screening levels, it will be concluded that the site does not pose a vapor intrusion risk if a vadose zone source is not present. If exceedances are observed, the data will be re-evaluated in a vapor intrusion model (Phase 2). If a significant vadose zone source is present (based on site-specific data evaluation), soil gas samples will be collected above the vadose zone source area.

The next phase, if warranted based on the initial phase, will consist of using a mixture of generic default and site-specific parameters in the Johnson and Ettinger (J&E) model. The parameter values to be considered for verification or development of site-specific values will be determined based on site conditions. In some cases, the modeling results may be sufficient to determine that the site does not pose a vapor intrusion risk; in other cases, the modeling results will be one of the multiple lines of evidence used to evaluate whether there is a unacceptable vapor intrusion risk. If modeled results indicate unacceptable risks (as defined by EPA), a site-specific vapor intrusion study will be conducted.

If needed, the next phase includes multi-media sampling, and may include the collection of near-slab soil gas, sub-slab soil gas, and/or indoor air samples. A site-specific vapor intrusion work plan will be prepared prior to collection of these data. Multiple lines of evidence may be used to evaluate the magnitude and extent of vapor intrusion. Depending on the results of the investigation and a human health risk assessment, it may be determined that either no further action is necessary or that mitigation or remediation may be warranted.

## Exposure Assessment

An exposure assessment is used to evaluate potential exposure to site media by the human receptors identified for current and anticipated future land use at a site. The exposure assessment identifies human receptors, potential exposure pathways, assumed exposure factor values, and estimated exposure point concentrations (EPCs).

### Potentially Exposed Populations

Navy operations are no longer occurring on Vieques Island. Following the transfer of the former Navy property to the Commonwealth of Puerto Rico and the Department of Interior (DOI), land use planning indicates no future residential land use is likely. However, to determine whether unrestricted use of a site poses no unacceptable risk (even though residential land use is not anticipated), a residential land use scenario typically will be evaluated (unless site-specific circumstances do not warrant the consideration of unrestricted site use). Therefore, the following potentially exposed populations will be included in each quantitative HHRA:

- maintenance workers
- recreational users (adult, youth [6 to <16 years of age], and child [1 to 6 years of age])
- construction workers (including utility workers, where appropriate)
- industrial workers
- residents (adult and child)

Other site-specific populations, such as subsistence anglers/crabbers and fish/crab consumers, may also be included in the HHRA when appropriate. Other potentially exposed populations could access the site, such as trespassers and site visitors; however, their exposure potential is considerably lower than most of those listed above, and most consistent with the recreational scenario in terms of exposure potential and duration. Therefore, the above populations are adequate to evaluate potential exposure scenarios. A preliminary list of exposure factors for the receptors proposed for future HHRAs is included in Tables 1 through 10. At the time the HHRA is prepared, if default exposure factors are changed in the reference documents, the exposure factor values in Tables 1 through 10 will be modified accordingly.

The adult population will be defined as 16 and older in the HHRAs, whereas, an adult population is typically referenced as 18 and older. However, a body weight of 70 kg will be used for the 16 and older population, which is the body weight typically used for the 18 and older population group. This change in adult age definition is not anticipated to have any significant effect on the risk/hazard estimates for the sites.

### Maintenance Workers

Based on the likely occupational duties, it is typically assumed that a maintenance worker would have the potential for direct or indirect contact with surface soils at each site. The maintenance workers are not likely to be exposed to site groundwater during routine maintenance activities, as the nature of the activities assumed for a maintenance worker involves grounds maintenance, such as cutting grass, clearing brush, etc., and is assumed not to involve digging. Maintenance workers involved in occasional landscaping activities would not be exposed to soils deeper than 2 feet.

At most or all sites, groundwater occurs at depths greater than 4 feet. Therefore, direct exposure to groundwater will not be evaluated for the maintenance worker scenario unless groundwater is at a depth of less than 2 feet, in which case such exposures would be evaluated.

### Recreational Users

Some of the sites may be used for recreational purposes, such as hiking, picnicking, and other outdoor activities. Recreational receptors will be assumed to have direct contact with site surface soils, but not to site subsurface soil or groundwater. Exposure to surface water and sediments will be evaluated for these receptors if a site includes these media. Although some sites may be too small to reasonably assume that a receptor spends their entire recreational time there, such a scenario will be assumed as a conservatively protective exposure scenario. A default recreational outing time of 4 hours will be used since most sites are small (less than 1 acre) and do not include recreational water bodies suitable for swimming.

### Construction Workers

A future construction worker scenario will be evaluated for surface and subsurface soil exposures. The EPCs for a construction worker will be calculated using surface and subsurface soil up to 6 feet bls. Exposures to site groundwater are not expected for this scenario, as typical construction depths (to 6 feet bls) will not encounter groundwater at most of the sites, because at most sites, depth to groundwater is approximately 33 to 71 feet bls. However, if sites include groundwater at shallow depths (<6 feet bls) typically reached during construction activities, then direct exposure through incidental ingestion, dermal contact, and inhalation (inhalation only if VOCs are among site COPCs) to site groundwater during construction will be included.

### Industrial Workers

This scenario will be evaluated conservatively assuming a site will be converted into an industrial facility where a worker spends his/her entire workday at the site in direct contact with surface and subsurface (0-6 feet) soils. Depending on site-specific conditions, future development of some of these sites could potentially allow for light industrial /commercial use, which may bring industrial workers into contact with site media. Industrial workers are also assumed to be exposed to site groundwater as a potential potable water source. This scenario will be included to conservatively evaluate a future industrial exposure scenario, using EPA industrial worker exposure factors. If the risks for this scenario are not within acceptable limits, the unrealistic nature of this scenario and a comparison to the other, more realistic exposure scenarios will be discussed in the uncertainty section of the HHRA.

### Residents

The evaluation of a residential exposure scenario is a conservative assessment of whether site-related contamination poses an unacceptable risk for residential receptors. Residential receptors consist of children and adults and are assumed to have higher exposure to site media in comparison to other receptors (e.g., industrial/commercial workers or recreational users). For many of the sites, the residential exposure scenario will be evaluated as a hypothetical exposure to determine whether land use controls are required. If a site poses no unacceptable risk under a residential land use scenario, then the EPA does not require land use controls and the site is considered to pose no unacceptable risk for unrestricted use. Future residents will be assumed to have direct contact with surface and subsurface soils and use site groundwater as a potable source. If the estimated risks for this scenario are not within acceptable limits, the unrealistic nature of this scenario and a comparison to the other, more realistic exposure scenarios will be discussed in the uncertainty section of the HHRA. For some sites, evaluation of the residential scenario (as well as other exposure

scenarios) may not be warranted based on certain circumstances (e.g., Congressional mandate that limits site usage).

### Fish Consumers

Edible-size fish may be present at some sites with a surface water body providing an adequate fish habitat. If deemed appropriate, fish consumers (or consumers of other locally available food items [e.g., crab]) consisting of child, youth, and adult will be assumed to have indirect contact with site-related constituents through consumption of locally-harvested food items. For such scenarios, potential exposures to food items will be evaluated based on a set of conservative exposure assumptions.

## Exposure Quantitation

### Exposure Factors

A preliminary list of exposure factors is provided in Tables 1 through 10. For constituents with a mutagenic mode of action (MMOA), exposure factors for specific age groups (0-<2, 2-<16, and 16-<30) will be used when calculating carcinogenic risk estimates (EPA, 2005a). The age group-specific exposure factors are provided in Tables 1a through 4a, and the data used to calculate the age-adjusted exposure factors are presented in Table 8.

### Intake Estimates

For each receptor identified in the exposure assessment as having a potentially complete exposure pathway, chemical- and medium-specific intakes (chronic daily intakes [CDIs] for exposure durations greater than 7 years or subchronic daily intakes [SDIs] for exposure durations of less than 7 years) will be estimated for exposures via ingestion and dermal contact using appropriate exposure factors and assumptions. In accordance with RAGS Part F (EPA, 2009c), potential risks and hazards associated with inhalation exposures will be assessed on a concentration basis rather than an intake-based approach. Therefore, chemical-specific average exposure concentrations (ECs) will be estimated for inhalation exposures using appropriate exposure factors and assumptions.

Chemical intakes (CDI or SDI) via ingestion and dermal contact exposures will be expressed in terms of milligrams of constituent contacting the body per kilogram of body weight per day (mg/kg-day), while average ECs for inhalation exposures will be expressed in terms of milligrams (or micrograms) of constituent per cubic meter of air. For the exposure routes to be evaluated, the following generic equations apply:

***<u>Ingestion/dermal contact exposure routes</u>***

$$Exposure\ (mg/kg/day) = \frac{C \times IR \times ED \times EF}{BW \times AT}$$

***<u>Inhalation exposures</u>***

$$Exposure\,Concentration\,(mg/m^3 or \mu g/m^3) = \frac{C_{air} \times ED \times EF}{AT}$$

Where:

C = concentration of chemical in medium (EPC)
IR = Intake or ingestion rate
EF = Exposure frequency
ED = Exposure duration
BW = Body weight
AT = Averaging time (period over which exposure will be averaged)

Route-specific intake/exposure estimates will be included in RAGS Part D tables for each site.

### Exposure Point Concentrations

The EPC will be the reasonable upper-bound estimate of the mean concentration that may be contacted over the exposure period. The EPCs will be calculated using the most recent version of ProUCL software (currently version 4.00.04; EPA, 2009a). ProUCL first tests the data distribution to determine if the data fit a normal, lognormal, or gamma distribution, or if the data do not fit any of these distributions. ProUCL then recommends the appropriate upper confidence limit (UCL) calculation method, and calculates the EPC based on the data distribution. The recommendations outlined in the ProUCL software documentation will be followed to select the appropriate UCL for each COPC.

If sample sizes are small, the UCL will typically default to the maximum detected concentration as the EPC, and will be indicated in the ProUCL output. For each COPC identified for a receptor group where less than 8 samples are available in the dataset or the calculated UCL exceeds the maximum detected concentration, the maximum detected concentration will be used as the EPC for that data grouping.

When evaluating direct contact exposures to surface water, unfiltered (rather than filtered) analytical data will be used to calculate EPCs for surface water COPCs.

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**Table 1**
Exposure Factors for Soil/ Sediment Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs
*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Recreational | Adult | Surface Soil / Sediment | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | IR-S | Ingestion Rate of Soil/Sediment | 100/50 | mg/day | EPA, 2002 | CS x IR-S x EF x ED x CF x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 24 | years | (1) | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | Youth | Surface Soil / Sediment | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | IR-S | Ingestion Rate of Soil/Sediment | 100/50 | mg/day | EPA, 2002 | CS x IR-S x EF x ED x CF x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 10 | years | (2) | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | BW | Body Weight | 39 | kg | EPA 2004 (2) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 3,650 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | Child | Surface Soil / Sediment | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | IR-S | Ingestion Rate of Soil/Sediment | 200/50 | mg/day | EPA, 2002 | CS x IR-S x EF x ED x CF x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | BW | Body Weight | 15 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| Residential | Adult | Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | IR-S | Ingestion Rate of Soil | 100 | mg/day | EPA, 2002 | CS x IR-S x EF x ED x CF x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 24 | years | EPA, 2002 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (3) | |

**Table 1**
Exposure Factors for Soil/ Sediment Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs
*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Residential (cont.) | Child | Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | IR-S | Ingestion Rate of Soil | 200 | mg/day | EPA, 2002 | CS x IR-S x EF x ED x CF x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | BW | Body Weight | 15 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (3) | |
| | Child/Adult Aggregate | Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | IR-S-Adj | Ingestion Rate of Soil, Age-adjusted | 114.29 | mg-year/kg-day | Calculated | CS x IR-S-Adj x EF x CF1 x 1/AT |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | IR-S-Adj (mg-year/kd-day) = |
| | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | (ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A) |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| Maintenance Worker | Adult | Surface Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | Irsoil | Ingestion Rate of Soil | 100 | mg/day | EPA, 2002 | CS x Irsoil x EF x ED x CF x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 52 | days/year | (1) | |
| | | | ED | Exposure Duration | 25 | years | EPA, 2002 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| Construction Worker | Adult | Total Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | Irsoil | Ingestion Rate of Soil | 330 | mg/day | EPA, 2002 | CS x Irsoil x EF x ED x CF x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 250 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 1 | years | EPA, 2002 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 365 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| Industrial Worker | Adult | Total Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | Irsoil | Ingestion Rate of Soil | 100 | mg/day | EPA, 2002 | CS x Irsoil x EF x ED x CF x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 250 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 25 | years | EPA, 2002 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |

**Table 1**

Exposure Factors for Soil/ Sediment Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Recreational | Adult | Surface Soil / Sediment | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | Soil CDI (mg/kg-day) = |
| | | | SA | Skin Surface Area Available for Contact | 5,700 | $cm^2$ | EPA, 2004 (5) | CS x SA x SSAF x DABS x CF x EF x |
| | | | SSAF | Soil/Sediment-to-Skin Adherence Factor | 0.2/0.36 | $mg/cm^2$-day | EPA, 2004 | ED x 1/BW x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | Sediment CDI (mg/kg-day) = |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | CS x SA x SSAF x DABS x CF x EF x |
| | | | ED | Exposure Duration | 24 | years | (1) | ED x 1/BW x 1/AT |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | Youth | Surface Soil / Sediment | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | Soil CDI (mg/kg-day) = |
| | | | SA | Skin Surface Area Available for Contact | 4,100 | $cm^2$ | EPA, 2004 (5) | CS x SA x SSAF x DABS x CF x EF x |
| | | | SSAF | Soil/Sediment-to-Skin Adherence Factor | 0.2/0.36 | $mg/cm^2$-day | EPA, 2004 | ED x 1/BW x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | Sediment CDI (mg/kg-day) = |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | CS x SA x SSAF x DABS x CF x EF x |
| | | | ED | Exposure Duration | 10 | years | (2) | ED x 1/BW x 1/AT |
| | | | BW | Body Weight | 39 | kg | EPA 2004 (2) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 3,650 | days | (3) | |
| | Child | Surface Soil / Sediment | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | Soil CDI (mg/kg-day) = |
| | | | SA | Skin Surface Area Available for Contact | 2,800 | $cm^2$ | EPA, 2004 (6) | CS x SA x SSAF x DABS x CF x EF x |
| | | | SSAF | Soil/Sediment-to-Skin Adherence Factor | 0.2/0.36 | $mg/cm^2$-day | EPA, 2004 | ED x 1/BW x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | Sediment CDI (mg/kg-day) = |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | CS x SA x SSAF x DABS x CF x EF x |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | ED x 1/BW x 1/AT |
| | | | BW | Body Weight | 15 | kg | EPA, 2002 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (3) | |

**Table 1**

Exposure Factors for Soil/ Sediment Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Residential | Adult | Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | SA | Skin Surface Area Available for Contact | 5,700 | $cm^2$ | EPA, 2004 (5) | CS x SA x SSAF x DABS x CF x EF x |
| | | | SSAF | Soil to Skin Adherence Factor | 0.07 | $mg/cm^2$-day | EPA, 2004 | ED x 1/BW x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 24 | years | EPA, 2002 | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (3) | |
| | Child | Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | SA | Skin Surface Area Available for Contact | 2,800 | $cm^2$ | EPA, 2004 (6) | CS x SA x SSAF x DABS x CF x EF x |
| | | | SSAF | Soil to Skin Adherence Factor | 0.2 | $mg/cm^2$-day | EPA, 2004 | ED x 1/BW x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | |
| | | | BW | Body Weight | 15 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (3) | |
| | Child/Adult Aggregate | Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | DA-Adj | Dermal Absorption, Age-adjusted | 361 | mg-year/kg-day | Calculated | CS x DA-Adj x DABS x CF1 x EF x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2002 | DA-Adj (mg-year/kg-day) = |
| | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | (ED-C x SA-C x SSAF-C / BW-C) + (ED-A x SA-A x SSAF-A / BW-A) |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| Maintenance Worker | Adult | Surface Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | SA | Skin Surface Area Available for Contact | 3,300 | $cm^2$ | EPA, 2004 (7) | CS x SA x AF x DABS x CF x EF x |
| | | | AF | Soil to Skin Adherence Factor | 0.2 | $mg/cm^2$-day | EPA, 2004 | ED x 1/BW x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | EF | Exposure Frequency | 52 | days/year | (1) | |
| | | | ED | Exposure Duration | 25 | years | EPA, 2002 | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | (3) | |

**Table 1**

Exposure Factors for Soil/ Sediment Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Construction Worker | Adult | Total Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | SA | Skin Surface Area Available for Contact | 3,300 | $cm^2$ | EPA, 2004 (7) | CS x SA x SSAF x DABS x CF x EF x |
| | | | SSAF | Soil to Skin Adherence Factor | 0.3 | $mg/cm^2$-day | EPA, 2004 | ED x 1/BW x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | EF | Exposure Frequency | 250 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 1 | years | EPA, 2002 | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 365 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| Industrial Worker | Adult | Total Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | SA | Skin Surface Area Available for Contact | 3,300 | $cm^2$ | EPA, 2004 (7) | CS x SA x SSAF x DABS x CF x EF x |
| | | | SSAF | Soil to Skin Adherence Factor | 0.2 | $mg/cm^2$-day | EPA, 2004 | ED x 1/BW x 1/AT |
| | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | |
| | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | EF | Exposure Frequency | 250 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 25 | years | EPA, 2002 | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |

**Notes:**

(1) Based on best professional judgment.

(2) Youths from 6 to 16 years of age. Body weight is average of the mean values for boys and girls for the ages 6 through 16

(3) Calculated as the product of ED (years) x 365 days/year.

(4) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

(5) SA includes head, hands, forearms, and lower legs.

(6) SA includes head, hands, forearms, lower legs, and feet.

(7) SA includes head, hands, and forearms.

**Sources:**

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

EPA, 2004. *Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual* . Part E Supplemental Guidance for Dermal Risk Assessment) Final.

MMOA - Mutagenic mode of action

$cm^2$ = Square centimeter

kg = Kilogram

kg/mg = Kilogram per milligram

mg/kg = Milligram per kilogram

mg/kg-day = Milligram per kilogram per day

$mg/cm^2$-day = Milligram per square centimeter per day

mg/day = Milligram per day

**Table 1a**

Exposure Factors for Soil/Sediment Ingestion and Dermal Exposure Intakes - Adjusted for MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Exposure Point | Receptor Age | Receptor Age | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Recreational | Surface Soil / Sediment | Child | Child (0-<2 yrs) | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-S-Adj (0-2) | Age Adjusted Ingestion Rate of Soil/Sediment (0-<2 yrs) | 39.7 | mg-yr/day-kg | calculated | CS x IR-S-Adj (0-2) x EF x CF1 x 1/AT |
| | | | | EF | Exposure Frequency | 104 | days/year | (1) | [for child aged 0-<2 years] |
| | | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | Child (2-6 yrs) | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | IR-S-Adj (2-6) | Age Adjusted Ingestion Rate of Soil/Sediment (2-<6 yrs) | 49.8 | mg-yr/day-kg | calculated | CS x IR-S-Adj (2-6) x EF x CF1 x 1/AT |
| | | | | EF | Exposure Frequency | 104 | days/year | (1) | [for child aged 2-6 years] |
| | | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| Residential | Surface Soil | Child/Adult Aggregate | Child (0-<2 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | IR-S-Adj (0-2) | Age Adjusted Ingestion Rate of Soil (0-<2 yrs) | 39.7 | mg-yr/day-kg | calculated | CS x IR-S-Adj (0-2) x EF x CF1 x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | [for child aged 0-<2 years] |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | Child/Adolescent Aggregate (2-<16 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | IR-S-Adj (2-16) | Age Adjusted Ingestion Rate of Soil (2-<6 yrs) | 49.8 | mg-yr/day-kg | calculated | CS x IR-S-Adj (2-16) x EF x CF1 x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | [for child/adolescent aged 2-<16 years] |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | Adolescent/Adult Aggregate (16-30 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | IR-S-Adj (16-30) | Age Adjusted Ingestion Rate of Soil (16-<30 yrs) | 20.7 | mg-yr/day-kg | calculated | CS x IR-S-Adj (16-30) x EF x CF1 x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | [for adolescent/adult aged 16-30 years] |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| Recreational | Surface Soil / Sediment | Child | Child (0-<2 yrs) | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | SSAF-Adj (0-2) | Age Adjusted Soil/Sediment-to-Skin Adherence Factor (0-<2 yrs) | 103 | mg-yr/day-kg | calculated | CS x SSAF-Adj (0-2) x DABS x CF1 x EF x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | [for child aged 0-<2 years] |
| | | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | Child (2-6 yrs) | CS | Chemical Concentration in Soil/Sediment | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | SSAF-Adj (2-6) | Age Adjusted Soil/Sediment-to-Skin Adherence Factor (2-<6 yrs) | 144 | mg-yr/day-kg | calculated | CS x SSAF-Adj (2-6) x DABS x CF1 x EF x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | [for child aged 2-6 years] |
| | | | | CF | Conversion Factor | 0.000001 | kg/mg | - - | |
| | | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |

**Table 1a**

Exposure Factors for Soil/Sediment Ingestion and Dermal Exposure Intakes - Adjusted for MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Exposure Point | Receptor Age | Receptor Age | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Residential | Surface Soil | Child/Adult Aggregate | Child (0-<2 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | SSAF-Adj (0-2) | Age Adjusted Soil to Skin Adherence Factor (0-<2 yrs) | 103 | mg-yr/day-kg | calculated | CS x SSAF-Adj (0-2) x DABS x CF1 x EF x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | [for child aged 0-<2 years] |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | Child/Adolescent Aggregate (2-<16 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | SSAF-Adj (2-16) | Age Adjusted Soil to Skin Adherence Factor(2-<16 yrs) | 324 | mg-yr/day-kg | calculated | CS x SSAF-Adj (2-16) x DABS x CF1 x EF x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | [for child/adolescent aged 2-<16 years] |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | Adolescent/Adult Aggregate (16-30 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | CDI (mg/kg-day) = |
| | | | | SSAF-Adj (16-30) | Age Adjusted Soil to Skin Adherence Factor(16-<30 yrs) | 82.2 | mg-yr/day-kg | calculated | CS x SSAF-Adj (16-30) x DABS x CF1 x EF x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | -- | EPA, 2004 | [for adolescent/adult aged 16-30 years] |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |

Notes:

(1) Based on best professional judgment.

(2) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

Sources:

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

EPA, 2004: Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual. Part E Supplemental Guidance for Dermal Risk Assessment) Final.

MMOA - Mutagenic mode of action

$cm^2$ = Square centimeter

kg = Kilogram

kg/mg = Kilogram per milligram

mg/kg = Milligram per kilogram

mg/kg-day = Milligram per kilogram per day

$mg/cm^2$-day = Milligram per square centimeter per day

mg/day = Milligram per day

**Table 2**

Exposure Factors for Soil Inhalation Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Recreational | Adult | Emissions from Surface Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ET | Exposure Time | 4 | hours/day | (1) | |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 24 | years | (1) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| | Youth | Emissions from Surface Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ET | Exposure Time | 4 | hours/day | (1) | |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 10 | years | (2) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 3,650 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| | Child | Emissions from Surface Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ET | Exposure Time | 4 | hours/day | (1) | |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |

**Table 2**

Exposure Factors for Soil Inhalation Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Residential | Adult | Emissions from Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ET | Exposure Time | 24 | hours/day | EPA, 2009 | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 24 | years | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (3) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| | Child | Emissions from Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ET | Exposure Time | 24 | hours/day | EPA, 2009 | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (3) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| | Child/Adult Aggregate | Emissions from Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | Calculated | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | |
| | | | ET | Exposure Time | 24 | hours/day | EPA, 2009 | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ED | Exposure Duration | 30 | years | EPA, 2002 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |

**Table 2**

Exposure Factors for Soil Inhalation Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Maintenance Worker | Adult | Emissions from Surface Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ET | Exposure Time | 8 | hours/day | (1) | |
| | | | EF | Exposure Frequency | 52 | days/year | (1) | |
| | | | ED | Exposure Duration | 25 | years | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| Construction Worker | Adult | Emissions from Total Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 10 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ET | Exposure Time | 8 | hours/day | (1) | |
| | | | EF | Exposure Frequency | 250 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 1 | years | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 365 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| Industrial Worker | Adult | Emissions from Total Soil | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | ET | Exposure Time | 8 | hours/day | EPA, 2009 | |
| | | | EF | Exposure Frequency | 250 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 25 | years | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | (3) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (4) | |
| | | | CF | Conversion Factor | 1/24 | day/hours | -- | |

Notes:

(1) Based on best professional judgment.

(2) Youths from 6 to 16 years of age.

(3) Calculated as the product of ED (years) x 365 days/year.

(4) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

Sources:

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

EPA, 2009: Regional Screening Levels for Chemical Contaminants at Superfund Sites.

MMOA - Mutagenic mode of action

kg = Kilogram

mg/kg = Milligram per kilogram

mg/kg-day = Milligram per kilogram per day

mg/m$^3$ = Milligram per cubic meter

m$^3$/day = Cubic meter per day

m$^3$/kg = Cubic meter per kilogram

**Table 2a**

Exposure Factors for Soil Inhalation Exposure Intakes - Adjusted for MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Exposure Point | Receptor Age | | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Recreational | Emissions from Surface Soil | Child | Child (0-<2 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | | ET | Exposure Time | 4 | hours/day | (1) | |
| | | | | ED | Exposure Duration | 2 | years | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | |
| | | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| | | | Child (2-6 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | | ET | Exposure Time | 4 | hours/day | (1) | |
| | | | | ED | Exposure Duration | 4 | Years | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | |
| | | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| Residential | Emissions from Surface Soil | Child/Adult Aggregate | Child (0-<2 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | | ET | Exposure Time | 24 | hours/day | EPA, 2009 | |
| | | | | ED | Exposure Duration | 2 | years | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | | CF | Conversion Factor | 1/24 | day/hours | -- | |
| | | | Child/Adolescent Aggregate (2-<16 yrs) | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ET x EF x ED x CF x 1/AT |
| | | | | ET | Exposure Time | 24 | hours/day | EPA, 2009 | |
| | | | | ED | Exposure Duration | 14 | years | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | | CF | Conversion Factor | 1/24 | day/hours | -- | |

**Table 2a**

Exposure Factors for Soil Inhalation Exposure Intakes - Adjusted for MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Exposure Point | Receptor Age | | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Residential | Emissions from Surface Soil | Child/Adult | Adolescent/Adult | CS | Chemical Concentration in Soil | site-specific | mg/kg | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| (cont.) | | Aggregate | Aggregate | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | EPA, 2002 | CA x ED x EF x 1/AT |
| | | (cont.) | (16-30 yrs) | ET | Exposure Time | 24 | hours/day | EPA, 2009 | |
| | | | | ED | Exposure Duration | 14 | years | EPA, 2002 | CA (mg/m$^3$) = CS (1/PEF + 1/VF) |
| | | | | PEF | Particulate Emission Factor | site-specific | m$^3$/kg | see Table 9 | |
| | | | | VF | Volatilization Factor for volatile constituents | Calculated | m$^3$/kg | EPA, 2002 | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | | CF | Conversion Factor | 1/24 | day/hours | -- | |

**Notes:**

(1) Based on best professional judgment.

(2) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

**Sources:**

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

EPA, 2009: Regional Screening Levels for Chemical Contaminants at Superfund Sites.

MMOA - Mutagenic mode of action

kg = Kilogram

mg/kg = Milligram per kilogram

mg/kg-day = Milligram per kilogram per day

mg/m$^3$ = Milligram per cubic meter

m$^3$/day = Cubic meter per day

m$^3$/kg = Cubic meter per kilogram

**Table 3**
Exposure Factors for Tap Water Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs
*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Residential | Adult | Tap Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | IR-W | Ingestion Rate of Water | 2 | L/day | EPA, 2002 | CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 24 | years | EPA, 2002 | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (1) | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | Child | Tap Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | IR-W | Ingestion Rate of Water | 1 | L/day | EPA, 1997 | CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | |
| | | | BW | Body Weight | 15 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (1) | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | Child/Adult Aggregate | Tap Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | IR-W-Adj | Ingestion Rate of Water, Age-adjusted | 1.1 | liter-year/kg-day | calculated | CW x IR-W-Adj x EF x CF1 x 1/AT |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | IR-W-Adj (liter-year/kd-day) = |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | (ED-C x IR-W-C / BW-C) + (ED-A x IR-W-A / BW-A) |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| Industrial Worker | Adult | Tap Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | IR-W | Ingestion Rate of Water | 1 | L/day | EPA, 1991 | CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 250 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 25 | years | EPA, 2002 | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | (1) | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |

**Table 3**

Exposure Factors for Tap Water Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Resident | Adult | Tap Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | FA | Fraction absorbed water | chemical-specific | dimensionless | EPA, 2004 | |
| | | | Kp | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | $\tau$ | Lag Time | chemical-specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | t* | Time to Reach Steady-state | chemical-specific | hours | EPA, 2004 | |
| | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical-specific | dimensionless | EPA, 2004 | Organics : |
| | | | $t_{event}$ | Event Time | 0.58 | hr/event | EPA, 2004 | $t_{event}$<t*: DAevent ($mg/cm^2$-event) = |
| | | | SA | Skin Surface Area Available for Contact | 18,000 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) x CF1 x CF2 |
| | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 24 | years | EPA, 2002 | $t_{event}$>t*: DAevent ($mg/cm^2$-event) = |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (1) | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2 |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | Child | Tap Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | FA | Fraction absorbed water | chemical-specific | dimensionless | EPA, 2004 | |
| | | | Kp | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | $\tau$ | Lag Time | chemical-specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | t* | Time to Reach Steady-state | chemical-specific | hours | EPA, 2004 | |
| | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical-specific | dimensionless | EPA, 2004 | Organics : |
| | | | $t_{event}$ | Event Time | 1.00 | hr/event | EPA, 2004 | $t_{event}$<t*: DAevent ($mg/cm^2$-event) = |
| | | | SA | Skin Surface Area Available for Contact | 6,600 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) x CF1 x CF2 |
| | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | $t_{event}$>t*: DAevent ($mg/cm^2$-event) = |
| | | | BW | Body Weight | 15 | kg | EPA, 2002 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | AT-N | Averaging Time (Non-Cancer) | 2190 | days | (1) | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2 |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | Child/Adult Aggregate | Tap Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = DA-Adj x EF x EV x 1/AT |
| | | | DA-Adj | Dermally Absorbed Dose, Age-adjusted | Calculated | mg-year/event-kg | calculated | DA-Adj = (DAevent-A x SA-A x ED-A x 1/BW-A) |
| | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | + (Daevent-C x SA-C x ED-C x 1/BW-C) |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |

**Table 3**

Exposure Factors for Tap Water Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Industrial Worker | Adult | Tap Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | FA | Fraction absorbed water | chemical-specific | dimensionless | EPA, 2004 | |
| | | | PC | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | $\tau$ | Lag Time | chemical-specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | t* | Time to Reach Steady-state | chemical-specific | hours | EPA, 2004 | |
| | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical-specific | dimensionless | EPA, 2004 | Organics : |
| | | | $t_{event}$ | Event Time | 0.2 | hr/event | (4) | $t_{event}$<t*: DAevent ($mg/cm^2$-event) = |
| | | | SA | Skin Surface Area Available for Contact | 2,733 | $cm^2$ | EPA, 2004 (3) | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) x CF1 x CF2 |
| | | | EV | Event Frequency | 1 | events/day | EPA, 1991 | |
| | | | EF | Exposure Frequency | 250 | days/year | EPA, 2002 | |
| | | | ED | Exposure Duration | 25 | years | EPA, 2002 | $t_{event}$>t*: DAevent ($mg/cm^2$-event) = |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | FA x PC x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2 |
| | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | (1) | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

**Notes:**

(1) Calculated as the product of ED (years) x 365 days/year.

(2) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

(3) The SA for an industrial worker exposed to tap water is based on face, forearms, and hands.

(4) Based on best professional judgment (total of 12 minutes per day).

**Sources:**

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

EPA, 2004: Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual. Part E Supplemental Guidance for Dermal Risk Assessment) Final.

MMOA - Mutagenic mode of action

cm/hr = Centimeter per hour

$cm^2$ = Square centimeter

hr/day = Hour per day

hr/event = Hour per event

kg = Kilogram

$L/cm^3$ = Liter per cubic centimeter

L/day = Liter per day

$mg/cm^2$ -event = Milligram per square centimeter per event

mg/kg-day = Milligram per kilogram per day

mg/L = Milligram per liter

**Table 3a**
Exposure Factors for Tap Water Ingestion and Dermal Exposure Intakes - Adjusted for MMOA COPCs
*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Exposure Point | Receptor Age | | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Residential | Tap Water | Child/Adult Aggregate | Child (0-<2 yrs) | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-W-Adj (0-2) | Ingestion Rate of Water, Age-adjusted (0-<2 yrs) | 0.22 | liter-year/kg-day | calculated | CW x IR-W-Adj (0-2) x EF x CF1 x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | [for child aged 0-<2 years] |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (1) | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | Child/Adolescent Aggregate (2-<16 yrs) | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | | IR-W-Adj (2-16) | Ingestion Rate of Water, Age-adjusted (2-<16 yrs) | 0.84 | liter-year/kg-day | calculated | CW x IR-W-Adj (2-16) x EF x CF1 x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | [for child/adolescent aged 2-<16 years] |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (1) | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | Adolescent/Adult Aggregate (16-30 yrs) | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | | IR-W-Adj (16-30) | Ingestion Rate of Water, Age-adjusted (16-<30 yrs) | 0.41 | liter-year/kg-day | calculated | CW x IR-W-Adj (16-30) x EF x CF1 x 1/AT |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | [for adolescent/adult aged 16-30 years] |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (1) | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | Tap Water (cont.) | Child/Adult Aggregate (cont.) | Child/Adult Aggregate | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Inorganics: DAevent (mg/cm$^2$-event) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | Calculated | mg/cm$^2$-event | calculated | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | | FA | Fraction absorbed water | chemical-specific | dimensionless | EPA, 2004 | Organics : |
| | | | | Kp | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | $t_{event}$<t*: DAevent (mg/cm$^2$-event) = |
| | | | | $\tau$ | Lag Time | chemical-specific | hr/event | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) x CF1 x CF2 |
| | | | | t* | Time to Reach Steady-state | chemical-specific | hours | EPA, 2004 | |
| | | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical-specific | dimensionless | EPA, 2004 | $t_{event}$>t*: DAevent (mg/cm$^2$-event) = |
| | | | | $t_{event}$ | Event Time | see below | hr/event | EPA, 2004 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | ((1 + 3B + 3B$^2$)/(1+B)$^2$)) x CF1 x CF2 |
| | | | | CF2 | Conversion Factor 2 | 0.001 | l/cm$^3$ | - - | |

**Table 3a**

Exposure Factors for Tap Water Ingestion and Dermal Exposure Intakes - Adjusted for MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Exposure Point | Receptor Age | | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Resident (cont.) | | | Child (0-<2 yrs) | DA-Adj | Dermally Absorbed Dose per Event | Calculated | mg/cm$^2$-event | calculated | CDI (mg/kg-day) = |
| | | | | SA-Adj (0-2) | Skin Surface Area, Age-adjusted (0-<2 yrs) | 1,172 | cm$^2$-year/kg | calculated | DAevent x SA-Adj (0-2) x EV x EF x 1/AT |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | [for child aged 0-<2 years] |
| | | | | $t_{event}$ | Event Time (0-<6 yrs) | 1.0 | hr/event | EPA, 2004 | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (1) | |
| | | | Child/Adolescent Aggregate (2-6 yrs) | DA-Adj | Dermally Absorbed Dose per Event | Calculated | mg/cm$^2$-event | calculated | CDI (mg/kg-day) = |
| | | | | SA-Adj (2-6) | Skin Surface Area, Age-adjusted (2-<6 yrs) | 1,685 | cm$^2$-year/kg | calculated | DAevent x SA-Adj (2-6) x EV x EF x 1/AT |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | [for child/adolescent aged 2-6 years] |
| | | | | $t_{event}$ | Event Time (0-<6 yrs) | 1.0 | hr/event | EPA, 2004 | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (1) | |
| | | | Child/Adolescent Aggregate (6-<16 yrs) | DA-Adj | Dermally Absorbed Dose per Event | Calculated | mg/cm$^2$-event | calculated | CDI (mg/kg-day) = |
| | | | | SA-Adj (2-16) | Skin Surface Area, Age-adjusted (6-<16 yrs) | 3,234 | cm$^2$-year/kg | calculated | DAevent x SA-Adj (6-16) x EV x EF x 1/AT |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | [for child/adolescent aged 6-<16 years] |
| | | | | $t_{event}$ | Event Time (6-<30 yrs) | 0.58 | hr/event | EPA, 2004 | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (1) | |
| | | | Adolescent/Adult Aggregate (16-30 yrs) | DA-Adj | Dermally Absorbed Dose per Event | Calculated | mg/cm$^2$-event | calculated | CDI (mg/kg-day) = |
| | | | | SA-Adj (16-30) | Skin Surface Area, Age-adjusted (16-<30 yrs) | 3,687 | cm$^2$-year/kg | calculated | DAevent x SA-Adj (16-30) x EV x EF x 1/AT |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | [for adolescent/adult aged 16-30 years] |
| | | | | $t_{event}$ | Event Time (6-<30 yrs) | 0.58 | hr/event | EPA, 2004 | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (1) | |

Notes:

(1) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

Sources:

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

EPA, 2004: Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual. Part E Supplemental Guidance for Dermal Risk Assessment) Final.

MMOA - Mutagenic mode of action

cm/hr = Centimeter per hour

cm$^2$ = Square centimeter

hr/day = Hour per day

hr/event = Hour per event

kg = Kilogram

L/cm$^3$ = Liter per cubic centimeter

L/day = Liter per day

mg/cm$^2$ -event = Milligram per square centimeter per event

mg/kg-day = Milligram per kilogram per day

mg/L = Milligram per liter

**Table 4**
Exposure Factors for Groundwater Inhalation Exposure Intakes - Non-MMOA COPCs
*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Resident | Adult | Water Vapors in Bathroom | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air from Shower | calculated | mg/m$^3$ | - - | CA x ET x EF x ED x CF1 x 1/AT |
| | | | ET | Exposure Time | 0.58 | hr/day | (1) | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | CA calculated based on CW using Andelman model |
| | | | ED | Exposure Duration | 24 | years | EPA, 2002 | as modified by Schaum et al. |
| | | | CF1 | Conversion Factor | 1/24 | day/hr | -- | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (3) | |
| | Child | Water Vapors in Bathroom | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air from Shower | calculated | mg/m$^3$ | - - | CA x ET x EF x ED x CF1 x 1/AT |
| | | | ET | Exposure Time | 1 | hr/day | (1) | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | CA calculated based on CW using Andelman model |
| | | | ED | Exposure Duration | 6 | years | EPA, 2002 | as modified by Schaum et al. |
| | | | CF1 | Conversion Factor | 1/24 | day/hr | -- | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (3) | |
| | Adult/Child Aggregate | Water Vapors in Bathroom | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | Calculated | (CAc x ETc x EDc + CAa x ETa x EDa) x EF x CF1 x 1/AT |
| | | | ED | Exposure Duration | 30 | years | - - | |
| | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | CA calculated based on CW using Andelman model |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | as modified by Schaum et al. |
| | | | CF1 | Conversion Factor | 1/24 | day/hr | -- | |

Notes:

(1) EPA Region 2 and the Andelman model as modified by Schaum et. al.

(2) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

(3) Calculated as the product of ED (years) x 365 days/year.

Sources:

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

MMOA - Mutagenic mode of action

hr/day = Hour per day

kg = Kilogram

m$^3$/hour = Cubic meter per hour

mg/kg-day = Milligram per kilogram per day

mg/kg-shower = Milligram per kilogram per shower

mg/µg = Milligram per microgram

mg/m$^3$ = Milligram per cubic meter

µg/L = Microgram per liter

µg/m$^3$ = Microgram per cubic meter

**Table 4a**

Exposure Factors for Groundwater Inhalation Exposure Intakes - Adjusted for MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Exposure Point | Receptor Age | | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Resident | Water Vapors in Bathroom | Adult/Child Aggregate | Child (0-<2 yrs) | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | Calculated | CA x ED x ET x EF x CF x 1/AT |
| | | | | ED | Exposure Duration | 2 | years | EPA, 2002 | |
| | | | | ET | Exposure Time | 1 | hr/day | (1) | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | CA calculated based on CW using Andelman model |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | as modified by Schaum et al. |
| | | | | CF | Conversion Factor | 1/24 | day/hr | - - | |
| | | | Child/Adolescent Aggregate (2-6 yrs) | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | Calculated | CA x ED x ET x EF x CF x 1/AT |
| | | | | ED | Exposure Duration | 4 | years | EPA, 2002 | |
| | | | | ET | Exposure Time | 1 | hr/day | (1) | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | CA calculated based on CW using Andelman model |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | as modified by Schaum et al. |
| | | | | CF | Conversion Factor | 1/24 | day/hr | - - | |
| | | | Child/Adolescent Aggregate (6-<16 yrs) | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | Calculated | CA x ED x ET x EF x CF x 1/AT |
| | | | | ED | Exposure Duration | 10 | years | EPA, 2002 | |
| | | | | ET | Exposure Time | 0.58 | hr/day | (1) | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | CA calculated based on CW using Andelman model |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | as modified by Schaum et al. |
| | | | | CF | Conversion Factor | 1/24 | day/hr | - - | |
| | | | Adolescent/Adult Aggregate (16-30 yrs) | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Exposure Concentration (EC)(mg/m$^3$)= |
| | | | | CA | Chemical Concentration in Air | Calculated | mg/m$^3$ | Calculated | CA x ED x ET x EF x CF x 1/AT |
| | | | | ED | Exposure Duration | 14 | years | EPA, 2002 | |
| | | | | ET | Exposure Time | 0.58 | hr/day | (1) | |
| | | | | EF | Exposure Frequency | 350 | days/year | EPA, 2002 | CA calculated based on CW using Andelman model |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (2) | as modified by Schaum et al. |
| | | | | CF | Conversion Factor | 1/24 | day/hr | - - | |

**Notes:**

(1) EPA Region 2 and the Andelman model as modified by Schaum et. al.

(2) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

**Sources:**

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

MMOA - Mutagenic mode of action

hr/day = Hour per day

kg = Kilogram

m$^3$/hour = Cubic meter per hour

mg/kg-day = Milligram per kilogram per day

mg/kg-shower = Milligram per kilogram per shower

mg/µg = Milligram per microgram

mg/m$^3$ = Milligram per cubic meter

µg/L = Microgram per liter

µg/m$^3$ = Microgram per cubic meter

**Table 5**

Exposure Factors for Surface Water Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Recreational | Adult | Surface Water | CSW | Chemical Concentration in Water | site-specific | µg/l | site-specific | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | IR-SW | Ingestion Rate of Water | 0.01 / 0.05 (7) | L/hr | EPA, 1989 | CSW x IR-SW x ET x EF x ED x CF1 x |
| | | | ET | Exposure Time | 4 | hr/day | EPA, 1989 | 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 24 | years | EPA, 1991 | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (2) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (3) | |
| | Youth | Surface Water | CSW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | IR-SW | Ingestion Rate of Water | 0.01 / 0.05 (7) | L/hr | EPA, 1989 | CSW x IR-SW x ET x EF x ED x CF1 x |
| | | | ET | Exposure Time | 4 | hr/day | EPA, 1989 | 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 10 | years | EPA, 1991 | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | BW | Body Weight | 39 | kg | EPA 2004 (4) | |
| | | | AT-N | Averaging Time (Non-Cancer) | 3,650 | days | (2) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (3) | |
| | Child | Surface Water | CSW | Chemical Concentration in Surface Wat | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | IR-SW | Ingestion Rate of Surface Water | 0.01 / 0.05 (7) | L/hr | EPA, 1989 | CSW x IR-SW x ET x EF x ED x CF1 x |
| | | | ET | Exposure Time | 4 | hr/day | EPA, 1989 | 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | BW | Body Weight | 15 | kg | EPA, 2002 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (2) | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (3) | |

**Table 5**

Exposure Factors for Surface Water Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Recreational | Adult | Surface Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | Kp | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | $t_{event}$ | Event Time | 4 | hr/event | | $t_{event}$<t*: DAevent ($mg/cm^2$-event) = |
| | | | SA | Skin Surface Area Available for Contac | 18,000 | $cm^2$ | EPA, 2004 | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF1 x CF2 |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 24 | years | EPA, 1991 | $t_{event}$>t*: DAevent ($mg/cm^2$-event) = |
| | | | BW | Body Weight | 70 | kg | EPA, 2002 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | (2) | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2 |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (3) | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |
| | Youth | Surface Water | CW | Chemical Concentration in Water | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | FA | Fraction absorbed water | chemical specific | dimensionless | EPA, 2004 | |
| | | | Kp | Permeability Coefficient | chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | $\tau$ | Lag Time | chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | t* | Time to Reach Steady-state | chemical specific | hours | EPA, 2004 | |
| | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | $t_{event}$ | Event Time | 4 | hr/event | | $t_{event}$<t*: DAevent ($mg/cm^2$-event) = |
| | | | SA | Skin Surface Area Available for Contac | 12,346 | $cm^2$ | EPA, 1997, (5) | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF1 x CF2 |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 10 | years | EPA, 1991 | $t_{event}$>t*: DAevent ($mg/cm^2$-event) = |
| | | | BW | Body Weight | 39 | kg | EPA 2004 (4) | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | AT-N | Averaging Time (Non-Cancer) | 3,650 | days | (2) | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2 |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (3) | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

**Table 5**

Exposure Factors for Surface Water Ingestion and Dermal Exposure Intakes - Non-MMOA COPCs

*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Recreational | Child | Surface Water | CSW | Chemical Concentration in Surface Wat | site-specific | µg/l | site-specific | CDI (mg/kg-day) = |
| | | | DAevent | Dermally Absorbed Dose per Event | Calculated | $mg/cm^2$-event | Calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | FA | Fraction absorbed water | Chemical specific | dimensionless | EPA, 2004 | |
| | | | Kp | Permeability Coefficient | Chemical specific | cm/hr | EPA, 2004 | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | $\tau$ | Lag Time | Chemical specific | hr/event | EPA, 2004 | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | t* | Time to Reach Steady-state | Chemical specific | hours | EPA, 2004 | |
| | | | B | Ratio of Permeability of Stratum Corneum to Epidermis | Chemical specific | dimensionless | EPA, 2004 | Organics : |
| | | | $t_{event}$ | Event Time | 4 | hr/day | | $t_{event}$<t*: DAevent ($mg/cm^2$-event) = |
| | | | SA | Skin Surface Area Available for Contact | 6,686 | $cm^2$ | EPA, 1997, (6) | 2 x FA x Kp x CW x (sqrt((6 x $\tau$ x $t_{event}$)/$\pi$)) |
| | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | x CF1 x CF2 |
| | | | EF | Exposure Frequency | 104 | days/year | (1) | |
| | | | ED | Exposure Duration | 6 | years | EPA, 1991 | $t_{event}$>t*: DAevent ($mg/cm^2$-event) = |
| | | | BW | Body Weight | 15 | kg | EPA, 2002 | FA x Kp x CW x ( $t_{event}$/(1+B) + 2 x $\tau$ x |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | (2) | ((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2 |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | (3) | |
| | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

**Notes:**

(1) Based on best professional judgment.

(2) Calculated as the product of ED (years) x 365 days/year.

(3) Calculated as the product of 70 years assumed human lifetime (EPA, 1989a) x 365 days/year.

(4) Youths from 6 to 16 years of age. Body weight is average of the mean values for boys and girls for the ages 6 through 16

(5) Average total body surface area for males and females 6 to <16 years of age.

(6) Average total body surface area for males and females 1 to 6 years of age.

(7) 0.01 L/hr if water is deep enough for wading only; 0.05 L/hr if water is deep enough for swimming.

**Sources:**

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.

EPA, 2004: Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual. Part E Supplemental Guidance for Dermal Risk Assessment) Final.

µg/l = Microgram per liter

L/hr = Liter per hour

hr/day = Hour per day

mg/µg = Milligram per microgram

kg = Kilogram

$mg/cm^2$-event = Milligram per Square Centimeter per event

cm/hr = Centimeter per hour

hr/event = Hour per event

$cm^2$ = Square centimeter

$l/cm^3$ = Liters per cubic centimeter

**Table 6**
Exposure Factors for Fish Consumption Exposure Intakes
*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Fish Consumers | Adult | Fish Tissue | $C_{sw}$ | Chemical Concentration in Surface Water | site-specific | mg/L | site-specific | Chronic Daily Intake (CDI) (mg/kg-day)(1) = |
| | | | $C_{sed}$ | Chemical Concentration in Sediment | site-specific | mg/kg-sed | site-specific | $C_{fish}$ x IR-F x EF x ED x CF1 x 1/BW x 1/AT |
| | | | $C_{fish}$ | Chemical Concentration in Fish Tissue | calculated | mg/kg-fish | calculated | |
| | | | IR-F | Fish Ingestion Rate | 0.227 | kg-fish/meal | EPA, 2000 (2) | Fish Tissue Concentration ($C_{fish}$) will be determined based |
| | | | EF | Exposure Frequency | 7 | meals/week | Burger and Gochfeld, 1991 (3) | on surface water or sediment concentration using an |
| | | | ED | Exposure Duration | 24 | years | EPA, 1991 | appropriate bioaccumulation factor (BAF or BSAF [5]). |
| | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | EPA, 1989 | |
| | | | CF1 | Conversion Factor 1 | 52 | weeks/year | - - | |
| | Youth | Fish Tissue | $C_{sw}$ | Chemical Concentration in Surface Water | site-specific | mg/L | site-specific | Chronic Daily Intake (CDI) (mg/kg-day)(1) = |
| | | | $C_{sed}$ | Chemical Concentration in Sediment | site-specific | mg/kg-sed | site-specific | $C_{fish}$ x IR-F x EF x ED x CF1 x 1/BW x 1/AT |
| | | | $C_{fish}$ | Chemical Concentration in Fish Tissue | calculated | mg/kg-fish | calculated | |
| | | | IR-F | Fish Ingestion Rate | 0.227 | kg-fish/meal | EPA, 2000 (2) | Fish Tissue Concentration ($C_{fish}$) will be determined based |
| | | | EF | Exposure Frequency | 7 | meals/week | Burger and Gochfeld, 1991 (3) | on surface water or sediment concentration using an |
| | | | ED | Exposure Duration | 10 | years | EPA, 1991 | appropriate bioaccumulation factor (BAF or BSAF [5]). |
| | | | BW | Body Weight | 39 | kg | EPA, 1991 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 3,650 | days | EPA, 1989 | |
| | | | CF1 | Conversion Factor 1 | 52 | weeks/year | - - | |
| | Child | Fish Tissue | $C_{sw}$ | Chemical Concentration in Surface Water | site-specific | mg/L | site-specific | Chronic Daily Intake (CDI) (mg/kg-day)(1) = |
| | | | $C_{sed}$ | Chemical Concentration in Sediment | site-specific | mg/kg-sed | site-specific | $C_{fish}$ x IR-F x EF x ED x CF1 x 1/BW x 1/AT |
| | | | $C_{fish}$ | Chemical Concentration in Fish Tissue | calculated | mg/kg-fish | calculated | |
| | | | IR-F | Fish Ingestion Rate | 0.114 | kg-fish/day | (4) | Fish Tissue Concentration ($C_{fish}$) will be determined based |
| | | | EF | Exposure Frequency | 7 | meals/week | Burger and Gochfeld, 1991 (3) | on surface water or sediment concentration using an |
| | | | ED | Exposure Duration | 6 | years | EPA, 1991 | appropriate bioaccumulation factor (BAF or BSAF [5]). |
| | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | | CF1 | Conversion Factor 1 | 52 | weeks/year | - - | |

**Notes:**

(1) The concentration of arsenic in fish tissue is assumed to be 10% inorganic arsenic and 90% organic arsenic (EPA, 2003). Therefore, a chronic daily intake will be estimated for 10% of the arsenic concentration in surface water (for evaluaing carcinogenic exposures) and a second chronic daily intake will be estimated for 100% of the arsenic concentration in surface water (for evaluating non-carcinogenic exposures).

(2) EPA's default fish/shellfish meal size of 8 oz for the general adult population.

(3) Average fish consumption rate in Puerto Rico, adapted from the study in the city of Humacao.

(4) One half the adult fish meal size of 8 oz.

(5) Preference will be given to use of biological-sediment accumulation factor (BSAF) over surface water biological accumulation factor (BAF) because BSAF incorporates bioaccumulation from both sediment and surface water.

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2 Risk Assessment and Fish Consumption Limits Third Edition. Office of Water.

EPA, 2003. Technical Summary of Information Available on the Bioaccumulation of Arsenic in Aquatic Organisms. EPA-822-R-03-032. December 2003.

Burger and Gochfeld. 1991. Fishing a Superfund Site: Dissonance and Risk Perception of Environmental Hazards by Fishermen in Puerto Rico. Risk Analysis. 11 (2). 269-277.


mg/L = Milligram per liter
kg = Kilogram
mg/kg = Milligram per kilogram
mg/kg-day = Milligram per kilogram per day

**Table 7**
Exposure Factors for Crab Consumption Exposure Intakes
*Former NASD, Vieques, Puerto Rico*

| Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Land Crab Consumers | Adult | Land Crab Tissue | $C_{crab}$ | Chemical Concentration in Land Crab | site-specific | mg/kg-crab | site-specific | Chronic Daily Intake (CDI) (mg/kg-day)(1) = |
| | | | IR-F | Land Crab Ingestion Rate | 0.227 | kg-crab/meal | EPA, 2000 (2) | $C_{crab}$ x IR-F x EF x ED x CF1 x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 7 | meals/week | Burger and Gochfeld, 1991 (3) | |
| | | | ED | Exposure Duration | 24 | years | EPA, 1991 | |
| | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 8,760 | days | EPA, 1989 | |
| | | | CF1 | Conversion Factor 1 | 52 | weeks/year | - - | |
| | Youth | Land Crab Tissue | $C_{crab}$ | Chemical Concentration in Land Crab | site-specific | mg/kg-crab | site-specific | Chronic Daily Intake (CDI) (mg/kg-day)(1) = |
| | | | IR-F | Land Crab Ingestion Rate | 0.227 | kg-crab/meal | EPA, 2000 (2) | $C_{crab}$ x IR-F x EF x ED x CF1 x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 7 | meals/week | Burger and Gochfeld, 1991 (3) | |
| | | | ED | Exposure Duration | 10 | years | EPA, 1991 | |
| | | | BW | Body Weight | 39 | kg | EPA, 1991 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 3,650 | days | EPA, 1989 | |
| | | | CF1 | Conversion Factor 1 | 52 | weeks/year | - - | |
| | Child | Land Crab Tissue | $C_{crab}$ | Chemical Concentration in Land Crab | site-specific | mg/kg-crab | site-specific | Chronic Daily Intake (CDI) (mg/kg-day)(1) = |
| | | | IR-F | Land Crab Ingestion Rate | 0.114 | kg-crab/day | ATSDR, 2006 (4) | $C_{crab}$ x IR-F x EF x ED x CF1 x 1/BW x 1/AT |
| | | | EF | Exposure Frequency | 7 | meals/week | Burger and Gochfeld, 1991 (3) | |
| | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | | CF1 | Conversion Factor 1 | 52 | weeks/year | - - | |

**Notes:**

(1) The concentration of arsenic in crab tissue is assumed to be 10% inorganic arsenic and 90% organic arsenic (EPA, 2003). Therefore, a chronic daily intake will be estimated for 10% of the arsenic concentration in crab tissue and a second chronic daily intake will be estimated for 100% of the arsenic concentration in crab tissue.

(2) EPA's default fish/shellfish meal size of 8 oz for the general adult population.

(3) Average fish consumption rate in Puerto Rico, adapted from the study in the city of Humacao.

(4) One half the adult fish meal size of 8 oz. The value is consistent with the child land crab consumption rate used in the ATSDR's Health Consultation (2006).

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

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kg = Kilogram
mg/kg = Milligram per kilogram
mg/kg-day = Milligram per kilogram per day

**TABLE 8**
Age-Adjusted Exposure Factors
*Former NASD, Vieques, Puerto Rico*

| | | | Intake Rate | | | Dermal | | | Age-Adjusted Exposure Factors | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE (year) | ED (years) | BW [1] (kg) | WATER IR-W [2] (L/day) | SOIL IR-S [3] (mg/day) | AIR IN [4] (m3/day) | SOIL SSAF [5] (mg/cm2-event) | EXPOSED SA [6] (cm2) | TOTAL SA [7] (cm2) | AGE GROUP | IR-S-Adj (mg-yr/day-kg) | IR-W-Adj (liter-yr/day-kg) | SSAF-Adj (mg-yr/day-kg) | TOTAL SA (cm2-yr/kg) |
| 0 | 1 | 9.1 | 0.76 | 200 | 4.5 | 0.2 | 2,625 | 5,910 | 0-<2 yrs | 39.7 | 0.22 | 103 | 1,172 |
| 1 | 1 | 11.3 | 1.5 | 200 | 6.8 | 0.2 | 2,571 | 5,910 | | | | | |
| 2 | 1 | 13.3 | 1.5 | 200 | 6.8 | 0.2 | 2,434 | 5,910 | 2-<6 yrs | 49.8 | 0.37 | 144 | 1,685 |
| 3 | 1 | 15.3 | 1.5 | 200 | 8.3 | 0.2 | 2,893 | 6,565 | | | | | |
| 4 | 1 | 17.4 | 1.5 | 200 | 8.3 | 0.2 | 3,175 | 7,185 | | | | | |
| 5 | 1 | 19.7 | 1.5 | 200 | 8.3 | 0.2 | 3,255 | 7,860 | | | | | |
| 6 | 1 | 22.6 | 1.5 | 100 | 10 | 0.2 | 2,949 | 8,545 | 6-<16 yrs | 28.1 | 0.47 | 180 | 3,234 |
| 7 | 1 | 24.9 | 1.5 | 100 | 10 | 0.2 | 3,182 | 9,265 | | | | | |
| 8 | 1 | 28.1 | 1.5 | 100 | 10 | 0.2 | 3,434 | 10,000 | | | | | |
| 9 | 1 | 31.5 | 1.5 | 100 | 13.5 | 0.2 | 3,657 | 10,650 | | | | | |
| 10 | 1 | 36.3 | 1.5 | 100 | 13.5 | 0.2 | 3,819 | 11,750 | | | | | |
| 11 | 1 | 41.1 | 2 | 100 | 13.5 | 0.2 | 4,111 | 12,650 | | | | | |
| 12 | 1 | 45.3 | 2 | 100 | 13.5 | 0.2 | 4,453 | 13,700 | | | | | |
| 13 | 1 | 50.4 | 2 | 100 | 13.5 | 0.07 | 4,916 | 14,750 | | | | | |
| 14 | 1 | 56 | 2 | 100 | 13.5 | 0.07 | 5,205 | 15,800 | | | | | |
| 15 | 1 | 58.1 | 2 | 100 | 14.5 | 0.07 | 5,386 | 16,350 | | | | | |
| | | | | | | | | | 2-<16 yrs | 77.8 | 0.84 | 323.8 | 4,920 |
| 16 | 1 | 62.6 | 2 | 100 | 14.5 | 0.07 | 5,534 | 16,800 | 16-<30 yrs | 20.7 | 0.41 | 82.2 | 3,687 |
| 17 | 1 | 63.2 | 2 | 100 | 14.5 | 0.07 | 5,641 | 17,150 | | | | | |
| 18 | 1 | 65.1 | 2 | 100 | 14.5 | 0.07 | 5,700 | 18,000 | | | | | |
| 19 | 1 | 66 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 20 | 1 | 67.2 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 21 | 1 | 67.2 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 22 | 1 | 67.2 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 23 | 1 | 67.2 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 24 | 1 | 67.2 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 25 | 1 | 71.5 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 26 | 1 | 71.5 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 27 | 1 | 71.5 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 28 | 1 | 71.5 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |
| 29 | 1 | 71.5 | 2 | 100 | 13.25 | 0.07 | 5,700 | 18,000 | | | | | |

| | | | |
|---|---|---|---|
| **Equations and Definitions:** | IR-S-Adj (mg-yr/day-kg) | ∑ (ED * IR-S) / BW | ED - Exposure duration |
| | IR-W-Adj (liter-yr/day-kg) | ∑ (ED * IR-W) / BW | BW - Body weight |
| | SSAF-Adj (mg-yr/day-kg) | ∑ (ED * EV * SSAF * SA) / BW | IR-S - Ingestion rate for soil |


**References:** [1] EPA 1997. Exposure Factors Handbook. Tables 7-2 (adults) and 7-3 (children), mean. Values are mean of male and female. Source: National Center of Health Statistics (NCHS) 1987.

[2] EPA 1997. Exposure Factors Handbook. Table 3-30 - Summary of Recommended Drinking Water Intake Rates. 95th Percentile (90th Percentile was used when 95th Percentile is not listed).

[3] EPA 1991. Standard Default Exposure Factors. Default for resident child and adult.

[4] EPA 1997. Exposure Factors Handbook. Table 5-23 - Summary of Recommended Values for Inhalation. Mean of male and female.

[5] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).
Recommended default adherence factor for a child resident (0.2) and adult resident (0.07). For older children, the geometric mean weighted adherence factor for children playing in wet soil was used for children 6 - 12, as an estimate of a high-end soil contact activity (see Exhibit 3-3).

[6] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)
Calculated from Exhibit C-1 - Body Part-Specific Surface Area Calculations (Children). Data from Exposure Factors Handbook, Tables 6-6, 6-7 and 6-8.
Surface area of head, forearms, hands, lower legs and feet (for child <6 years); feet excluded from surface area calculation for >6 years.
Surface area for >18 is recommended default for adult resident (EPA 2004).

[7] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)
Exhibit C-1 - Body Part-Specific Surface Area Calculations (Children). Data from Exposure Factors Handbook, Tables 6-6 and 6-7.
Total Body Surface Area (50th percentile).

The EPCs for soil will be estimated for receptors using data collected from the depth intervals indicated below:

- Maintenance Workers – 0-1 or 0-2 feet, depending on the site-specific determination of the surface soil sampling depth;
- Recreational Users – 0-1 or 0-2 feet, depending on the site-specific determination of the surface soil sampling depth;
- Construction Workers – 0-6 feet;
- Industrial Workers – 0-6 feet;
- Residents – 2 sets of EPCs will be calculated: one based on samples collected from 0-1 or 0-2 feet, depending on the site-specific determination of the surface soil sampling depth (to address EPA's preferred approach); and the second based on samples collected from 0-6 feet. As requested by Environmental Quality Board of the Commonwealth of Puerto Rico's (PREQB), the higher of the two EPCs for each COPC will be used in the risk calculations to produce a conservative risk estimate. Uncertainties associated with this approach will be addressed in the uncertainty assessment section of the HHRA.

Initially, the groundwater EPCs will be calculated from the wells located in the apparent center of the plume (if distinguishable) per EPA guidance on calculating EPCs in Groundwater (EPA, 1991a). However, at some sites, if risk estimates based on wells located within the apparent center of the plume or with the highest contaminant concentrations indicate unacceptable risks, additional evaluations may be conducted that represent a more realistic exposure scenario (e.g., consideration of wells throughout the area of contamination, evaluation of groundwater flow directions and capture areas, etc.). If a more realistic evaluation is warranted, the approach and associated justification will be proposed to the regulatory agencies and a conference call held, if necessary, to reach resolution on the more realistic evaluation prior to the evaluation being conducted. This approach reflects the reality that groundwater extraction from a well or wells within the plume center will draw in water from a capture area around the wells that may include areas outside the plume center. Unfiltered sample results will be used to select COPCs and for the groundwater EPC estimations, unless the filtered results are shown to be a better representation of groundwater chemical conditions. The groundwater EPCs will be discussed as part of the uncertainty analysis in the Risk Characterization section of the HHRA.

The EPCs in edible fish tissue will be modeled based on surface water and sediment concentrations in samples collected from the applicable fish habitat using surface water biological accumulation factors (BAFs) and/or biota-sediment accumulation factors (BSAFs). If a constituent is identified as a COPC for the fish ingestion pathway in both sediment and surface water, the EPCs in edible fish tissue will be estimated based on sediment EPCs using an appropriate BSAF. Preference is given to the use of BSAFs because BSAFs incorporate bioaccumulation from both sediment and surface water. When a constituent is identified as a COPC in sediment or surface water (but not both), the EPC and bioaccumulation factor (i.e., BAFs for surface water COPCs and BSAF for sediment COPCs) for that medium will be used to estimate EPCs in edible fish tissue. The EPCs in sediment and surface water used to estimate COPC concentrations in edible fish tissue will be based on UCLs calculated using ProUCL if at least 8 samples are available. If development of site-

specific BAFs or BCFs is required, EPA (2000a) guidance for deriving human health NRWQC and its supporting documents (EPA, 2003a; EPA, 2009d) will be used. If mercury is detected in surface water that supports edible-size fish, the draft National BAF for methylmercury of 2,670,000 L/kg (geometric mean value for trophic level 4; EPA, 2006b) will be used.

Should the development of site-specific BAFs or identification of appropriate BCFs be infeasible, BAFs from Superfund Chemical Data Matrix (SCDM) may be applied. When mercury or lead is detected in surface water supporting edible-size fish, the concentration in fish tissue will be estimated using BAFs/BCFs for both inorganic and organic forms of the constituents.

If needed, BCFs will be obtained from EPA guidance (EPA, 2002c) and other relevant sources and used to develop site-specific BAFs in accordance with EPA (2000b) guidance for deriving human health NRWQC and its supporting documents (EPA, 2003a; EPA, 2009d). The BSAF sources that will be used in the HHRA include (but are not limited to):

- Biota-Sediment Accumulation Factor Data Set, Version 1.0 (EPA, 2008).
- United States Army Corps of Engineers (USACE) BSAF Database (USACE, 2008).
- Washington Department of Ecology (WDE) Bioaccumulation Factor Approach Analysis for Metals and Polar Organic Compounds (WDE, 1995).

BSAFs may be developed based on SCDM surface water BAFs/BCFs only when infeasible to apply HH NRWQC or national BAF methods. If multiple BSAFs are available, preference will be given to BSAFs normalized for sediment TOC and fish lipid content. The following assumptions will be applied when concentrations in fish tissue are estimated based on lipid-normalized BSAFs and site-specific information is not available:

- 1% organic carbon in sediment (EPA, 2000a)
- 5% lipid (EPA, 2000a) and 75% moisture in fish tissue (EPA, 1993)

Additionally, the form of arsenic in fish tissue is assumed to be 10% inorganic and 90% organic arsenic, to be consistent with EPA's technical document entitled "Technical Summary of Information Available on the Bioaccumulation of Arsenic in Aquatic Organisms." (EPA, 2003b). Therefore, carcinogenic risk will be estimated using 10% of the arsenic concentration whereas noncarcinogenic hazard will be evaluated using 100% of the arsenic concentration.

According to RAGS Part A (EPA, 1989), samples with unusually high non-detected analytical results will be excluded from the quantitative HHRA. For these samples, the sample quantitation limit (SQL) exceeding 10 times the maximum detected concentration for a COPC will be excluded from the EPC calculation. When SQLs are not available for non-detected inorganic results in a historical dataset, MDLs will be used as the quantitation limit. The use of MDLs may underestimate risks (because the MDL is a measure of detection limit only and does not account for sample characteristics or matrix interferences) and uncertainties associated with this substitution will be discussed in the Uncertainty section of the HHRA.

A site-specific particulate emission factor (PEF) will be calculated for estimating future average ambient air concentrations for recreational users, residents, industrial workers, and maintenance workers (Table 9). The PEF will be calculated using Equation 4-5 and Exhibit D-2 of the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (EPA, 2002a). Climate Zone 9 (based on Miami, FL) and a site-specific aerial extent of site contamination (based on the approximate area where COPCs are detected in soil) will be used in the PEF calculation.

A second site-specific PEF will be calculated for estimating future average ambient air concentrations for construction workers (Table 10). The PEF will be calculated using Equations 5-5, 5-6, and E—16 of the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (EPA, 2002a). A site-specific aerial extent of site contamination (based on the approximate area where COPCs are detected in soil) will be used in the PEF calculation.

**Table 9**

Particulate Emission Factor - Recreator/Resident/Industrial Worker/Maintenance Worker

*Former NASD, Vieques, Puerto Rico*

**PEF Equations:**

$$Q/C_{wind} = A \times \exp\left[\frac{(\ln A_{site} - B)^2}{C}\right]$$

**Exhibit D-2 (EPA, 2002)**

$$PEF = Q/C_{wind} \times \frac{3{,}600\,\text{sec/hr}}{0.036 \times (1-V) \times \left(U_m/U_t\right)^3 \times F(x)}$$

**Equation 4-5 (EPA, 2002)**

**PEF and Box Model Input Parameters**

| Parameter | Definition | Value | Units | Source |
|---|---|---|---|---|
| $Q/C_{wind}$ | inverse ratio of the geometric mean air concentration to the emission flux at the center of a square source | | m | calculated |
| A | Constant for Zone 9 (Miami, FL) | 12.1960 | unitless | Exhibit D-2 (EPA, 2002) |
| B | Constant for Zone 9 (Miami, FL) | 19.0645 | unitless | Exhibit D-2 (EPA, 2002) |
| C | Constant for Zone 9 (Miami, FL) | 215.3923 | unitless | Exhibit D-2 (EPA, 2002) |
| $A_{site}$ | Areal extent of site contamination | site-specific | acres | site-specific |
| PEF | particulate emission factor | | $m^3$/kg | calculated |
| V | fraction of vegetative cover | 0.5 | unitless | Default (Eqn. 4-5) |
| Um | mean annual windspeed | 5.19 | m/s | Daily Average Windspeed (10.1 knot) (Department of the Navy, 1979)(1) |
| Ut | equivalent threshold value of windpeed at 7 m | 11.32 | m/s | Default (Eqn. 4-5) |
| F(x) | function dependent on Um/Ut derived using Cowherd et al. (1985) | 0.194 | unitless | Default (Eqn. 4-5) |

Source:

1) The daily average windspeed from measurements at Observation Post 5 on Vieques (10.1 knots = 5.19 m/s) were used.

Department of the Navy. 1979. Draft Environmental Impact Statement:

Volume I – Continued Use of the Atlantic Fleet Weapons Training Facility Inner Range (Vieques). December.

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA

Office of Solid Waste and Emergency Response. OSWER 9355.4-24. December.

**Table 10**
Particulate Emission Factor - Construction Worker
*Former NASD, Vieques, Puerto Rico*

**PEF Equations:**

$$Q/C_{Sr} = A \times \exp\left[\frac{(\ln A_{site} - B)^2}{C}\right]$$

**Equation 5-6 (EPA, 2002)**

$$PEF_{SC} = Q/C_{Sr} \times \frac{1}{F_D} \frac{T \times A_R}{556 \times (W/3)^{0.4} \times \left(\frac{365\ d/yr - p}{365\ d/yr}\right) \times \sum VKT}$$

**Equation 5-5 (EPA, 2002)**

$$F_D = 0.1852 + \frac{5.3537}{t_c} + \frac{-9.6318}{t_c^{\ 2}}$$

**Equation E-16 (EPA, 2002)**

**PEF and Box Model Input Parameters**

| Parameter | Definition | Value | Units | Source |
|---|---|---|---|---|
| $Q/C_{Sr}$ | inverse ratio of the geometric mean air concentration to the emission flux at the center of a square source | | m | calculated |
| A | Constant | 12.9351 | unitless | default (Eqn. 5-6) |
| B | Constant | 5.7383 | unitless | default (Eqn. 5-6) |
| C | Constant | 71.7711 | unitless | default (Eqn. 5-6) |
| $A_{site}$ | Areal extent of site contamination | site-specific | acres | site-specific |
| $PEF_{SC}$ | subchronic road particulate emission factor | | $m^3$/kg | calculated |
| $F_D$ | Dispersion correction factor | | unitless | calculated |
| $t_c$ | duration of construction (250 days for 8 hr/day) | 2,000 | hr | assumed |
| T | total time over which construction occurs ($t_c$ x 3600 s/hr) | 7,200,000 | s | assumed |
| $A_R$ | surface area of contaminated road segment | 274.21 | $m^2$ | default (Eqn. 5-5) |
| W | mean weight of vehicle [(1 car @ 2 tons/car) + (2 trucks @ 20 tons/truck)] / 3 vehicles) | 14 | tons | assumed |
| p | number of days with at least 0.01 inches of precipitation (based on measured 2005 data) | 92 | days/yr | Vieques-specific measured in 2005 |
| VKT | sum of fleet vehicle kilometers traveled during the exposure duration (assumed 3 vehicles x 0.045 km/day x 250 days) | 33.8 | km | assumed |

**Source:**

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA Office of Solid Waste and Emergency Response. OSWER 9355.4-24. December.

# Toxicity Assessment

The HHRA will include a toxicity assessment section that compiles the toxicity criteria for ELCR and hazard index (HI) estimates. EPA recommends a hierarchy of toxicity value sources for HHRA (EPA, 2003c). Following EPA's recommended approach, the sources of toxicity values will be as follows:

1. ***Tier I Toxicity Criteria:*** The EPA's IRIS database, which contains up-to-date toxicity information for numerous chemicals. IRIS includes only non-carcinogenic reference doses (RfDs) and cancer slope factors (CSFs) that have been verified by EPA work groups and is the EPA's preferred source of toxicity information.
2. ***Tier II Toxicity Criteria:*** For constituents with no toxicity criteria listed in IRIS, EPA Region 2 will be contacted to obtain interim toxicity criteria from the National Center for Environmental Assessment (NCEA). These are considered the second tier of toxicity values, which are from the PPRTV database maintained by the EPA's NCEA and the Superfund Health Risk Technical Support Center (STSC).
3. ***Tier III Toxicity Criteria:*** If toxicity data are not available from either of the first two sources, toxicity values obtained from other EPA and peer-reviewed sources, as well as non-EPA sources, including the Agency for Toxic Substances and Disease Registry (ATSDR), Health Effects Assessment Summary Tables (HEAST), California Environmental Protection Agency (Cal/EPA), EPA's Office of Water, and the World Health Organization (WHO), may be used in the HHRA on a site-specific basis. The Tier III toxicity values to be used in the HHRA will be initially provided in RAGS D Tables 5 and 6 of the interim deliverable and will be approved by the agencies prior to their use in risk estimates.

In accordance with current Department of Defense policy, toxicity values presented in the Cal/EPA toxicity criteria database will be used for trichloroethylene (TCE) until toxicity values are provided in EPA's IRIS database.

The use of provisional toxicity values in an HHRA, including those from the PPRTV database, increases the uncertainty in the quantitative risk estimates. The use of PPRTVs in the HHRA will be discussed in the uncertainty section of the HHRA.

If chromium and/or mercury are identified as COPCs, the toxicity values for hexavalent chromium and/or methylmercury and the forms expected to be present in the specific environmental medium (with supporting rationale) will be provided in RAGS D Tables 5 and 6.

## Dermal Toxicity Factors

Adjustments of oral toxicity values will be made to estimate the effects of doses absorbed through the skin using the EPA RAGS Part E recommended methodology (EPA, 2004).

### Lead

When lead is identified as a COPC in soil, sediment, or fish/crab tissue, the potential risks associated with lead exposure will be evaluated using the EPA's adult lead methodology

(ALM) and Integrated Exposure Uptake Biokinetic (IEUBK) model, unless a more recent EPA-recommended lead exposure model is available. Although other draft EPA or state-specific software packages to estimate lead exposures are available (e.g., EPA's All-Ages Lead Model and Cal/EPA's LeadSpread), these additional software packages will not be used in HHRAs unless they become EPA's recommended lead exposure models. At the time a risk assessment is prepared, the most recent EPA-recommended lead exposure model will be used.

The ALM (EPA 2003d; 2009e) will be used to evaluate risks associated with non-residential adult exposures. The model focuses on estimating fetal blood lead levels (BLLs) in pregnant workers exposed to lead in soil (EPA, 2003e). When lead is identified as a COPC for indirect exposure through the food consumption (fish/crab) pathway, the most recent ALM spreadsheets provided by EPA will be modified and used to calculate BLLs.

The baseline BLL and geometric standard deviation (GSD) for U.S. women of child-bearing age from the most recent population-based survey study (e.g., NHANES) will be used. The model results are expressed as the predicted geometric mean BLL for adults and the corresponding 95th percentile fetal BLLs and the percent of the population potentially experiencing concentrations above 10 micrograms per deciliter (µg/dL).

For child receptors, the potential risks associated with lead exposures will be addressed using the most recent version of the IEUBK model (EPA, 1994; 2009f). The IEUBK model was designed to provide predictions of the probability of elevated BLLs for children. This model addresses three components of environmental risk assessments: the multi-media nature of exposures to lead, lead pharmacokinetics, and significant variability in exposure and risk, through estimation of probability distributions of BLLs for children exposed to similar environmental concentrations.

When using the IEUBK model for evaluation of risk associated with soil or sediment, the default exposure concentrations embedded in the IEUBK model will be used for other non-site-related exposure media (air and groundwater). For the evaluation of lead exposure through consumption of fish and/or crab, the "alternative dietary" option will be used initially, as a conservative approach, assuming that 100 percent of the total meat eaten by a child is fish or crab obtained from the site. The default exposure concentrations embedded in the IEUBK model will be used for other non-site-related exposure media (air and groundwater) except for soil. The arithmetic mean of the lead concentration in soil will be used to represent potential site-specific exposures to lead in soil.

### Mutagens

For chemicals with a MMOA for carcinogenesis, in the absence of chemical-specific data, the risk for exposures that occur at early life stages will be estimated by applying the default age-dependent adjustment factors (ADAFs) to the non-age-specific slope factor to address the potential for differential carcinogenic potency associated with exposure during early life (less than 16 years of age).

## Risk Characterization

Risk characterization is the process of integrating the previous elements of the HHRA into quantitative or semi-quantitative expressions of risk. The quantification of risk will be used as an integral component in risk-management and remedy decision-making.

Potential human health risks will be discussed independently for carcinogenic and non-carcinogenic constituents because of the different toxicological endpoints, relevant exposure durations, and methods used to characterize risk. The constituents that could produce both non-carcinogenic and carcinogenic effects will be evaluated in both groups. The methodology used to estimate non-carcinogenic hazards and carcinogenic risks are described in the following sections. Total risks (site-related plus background) will be calculated. The estimated risks associated with constituents within background levels will be presented so that the portion of the total calculated risk that is attributable to background concentrations can be seen and used in risk management decisions, in accordance with EPA guidance (2002d).

Subsequent to characterizing potential site-related risks, the risk estimates will be evaluated and considered by the risk managers at EPA, and risk management decisions will be made. EPA Superfund guidance generally considers an acceptable site ELCR range to be within 1 to 100 in a million ($10^{-6}$ to $10^{-4}$). Generally, remedial actions are not warranted at sites with risks below $10^{-4}$ or target organ-specific HIs less than 1.0 (EPA, 1991b). If the cumulative ELCR is less than $10^{-4}$, action generally is not required, but may be warranted if another standard (e.g., an MCL) is exceeded, or if other site-specific information suggests to risk managers that action is appropriate.

If chromium and/or mercury are identified as COPCs at the site, the risk estimates presented in RAGS Tables 7 and 9 will be based on the chemical form expected to be present in the specific environmental medium; supporting rationale will be provided.

### Non-carcinogenic Hazard Estimation Methods

For the ingestion and dermal contact exposure routes, non-carcinogenic hazards are estimated by comparing the calculated exposure intakes to RfDs, whereas, for the inhalation exposure route, the calculated average ECs are compared to inhalation reference concentrations (RfCs). The calculated intake and EC of each constituent will be divided by the RfD and RfC, respectively, as presented in the following equations. This ratio is referred to as the HQ:

$$HQ = Intake / RfD \quad \text{or} \quad HQ = EC / RfC$$

Intake and RfD are expressed in the same units (mg/kg-day) and represent the same exposure period (i.e., chronic or subchronic). Similarly, EC and RfC are expressed in the same units ($mg/m^3$) and represent the same exposure period (i.e., chronic or subchronic). An HQ that exceeds 1.0 (i.e., intake exceeds the RfD or EC exceeds the RfC) indicates that there is a potential for adverse health effects associated with exposure to that constituent for that specific exposure route.

To assess the potential for non-carcinogenic health effects posed by exposure to multiple COPCs and exposure routes, an HI approach will be used (EPA, 1989). This approach assumes that non-carcinogenic hazards associated with exposure to more than one COPC

and exposure route are additive. Synergistic or antagonistic interactions between constituents are not quantified. The HI may exceed 1.0 even if all of the individual HQs are less than 1.0. The constituents may then be separated by similar mechanisms of toxicity and toxicological effects, and separate HIs may be calculated based on each specific target organ, target system, or critical effect.

### Carcinogenic Risk Estimation

The potential for carcinogenic effects due to exposure to site media will be evaluated by estimating the excess lifetime cancer risk (ELCR). The ELCR is the incremental increase in the probability of developing cancer during one's lifetime above the background probability of developing cancer.

Potential ELCRs associated with exposure to individual carcinogens will be calculated using CSFs and the CDIs (or SDIs). For sites where ELCRs are below 0.01, the linear low-dose equation will be used to estimate the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. For the ingestion and dermal contact exposure routes, estimated ELCRs are calculated by multiplying the intake by the CSF, whereas, the calculated average ECs are compared to inhalation unit risk (IURs) to estimate ELCRs for the inhalation exposure route.

$$ELCR = Intake \times CSF \qquad \text{or} \qquad ELCR = Exposure\ Concentration * IUR$$

In instances where COPC intakes and risks are high (0.01 or higher), the one-hit equation will be used to estimate ELCRs:

$$ELCR = 1 - \exp(-CDI \times CSF) \qquad \text{or} \qquad ELCR = 1 - \exp(-EC \times IUR)$$

where:

Risk = unitless probability of an individual developing cancer

exp = the exponential

CDI = chronic daily intake averaged over 70 years

EC = chronic exposure concentration averaged over 70 years

CSF = cancer slope factor

IUR = inhalation unit risk

Consistent with the Cancer Guidelines and Supplemental Guidance (EPA, 2005a; EPA, 2005b), COPCs which act via a MMOA for carcinogenicity will be evaluated using ADAFs. For these constituents, the Supplemental Guidance identifies three specific age groups for ADAFs: < 2 years (ADAF of 10), 2 - < 16 years (ADAF of 3), and > 16 years (ADAF of 1). Both the RAGS Part D tables and text will address the COPCs with a MMOA.

<u>Recreational Child</u>:

$$ELCR = Intake_{0\text{-}2} \times CSF \times ADAF(10) + Intake_{2\text{-}6} \times CSF \times ADAF(3)$$

$$ELCR = EC_{0\text{-}2} \times IUR \times ADAF(10) + EC_{2\text{-}6} \times IUR \times ADAF(3)$$

Residential Adult/Child Aggregate (soil):

$$ELCR = Intake_{0\text{-}2} \times CSF \times ADAF(10) + Intake_{2\text{-}16} \times CSF \times ADAF(3) + Intake_{16\text{-}30} \times CSF \times ADAF(1)$$

$$ELCR = EC_{0\text{-}2} \times IUR \times ADAF(10) + EC_{2\text{-}16} \times IUR \times ADAF(3) + EC_{16\text{-}30} \times IUR \times ADAF(1)$$

Residential Ault/Child Aggregate (groundwater):

$$ELCR = Intake_{0\text{-}2} \times CSF \times ADAF(10) + Intake_{2\text{-}6} \times CSF \times ADAF(3) + Intake_{\text{-}6\text{-}16} \times CSF \times ADAF(3) + Intake_{16\text{-}30} \times CSF \times ADAF(1)$$

$$ELCR = EC_{0\text{-}2} \times IUR \times ADAF(10) + EC_{2\text{-}6} \times IUR \times ADAF(3) + EC_{\text{-}6\text{-}16} \times IUR \times ADAF(3) + EC_{16\text{-}30} \times IUR \times ADAF(1)$$

The cumulative risk from exposure to multiple COPCs within an environmental medium at a site will be estimated by summing the ELCR from individual COPCs. In addition, cumulative risks from exposure to multiple environmental media will be added, as appropriate, across applicable media for a receptor group.

### Chemicals of Concern

Chemicals of concern (COCs) will be identified where the potential ELCR or HI for a receptor group exceeded threshold values (a total ELCR greater than $1x10^{-4}$ or a target organ-specific HI greater than 1.0). When a potential ELCR of $1x10^{-4}$ is exceeded for a receptor group, the COPCs posing an individual ELCR greater than $1x10^{-6}$ in the environmental medium responsible for the unacceptable risks will be identified as COCs. When a potential target organ HI exceeds 1.0 for a receptor group, the COPCs posing a HQ greater than 0.10 for that target organ in the environmental medium responsible for the unacceptable risk will be identified as COCs.

The list of COCs may be reduced based on the following considerations:

- Metals that are wholly or primarily attributable to background levels
- Laboratory contamination
- Approved pesticide use distinct from spills, improper storage, disposal, or use.

### Uncertainty Assessment

The risk estimates provided in HHRAs are conditional estimates based on a set of assumptions about exposure and toxicity. Therefore, it is important to specify the assumptions and uncertainties inherent in the site-specific HHRA to place the risk estimates in proper perspective (EPA, 1989).

### General Uncertainty in Data Evaluation and COPC Selection

The uncertainty related to the available dataset and the selection of COPCs at each site will be addressed by using conservative screening levels, when applicable. The uncertainty in sampling and the possibility of not sampling a contaminated site location will be discussed. A comparison of site concentrations to background concentrations will not be used to select the COPCs. Therefore, the COPCs that are included but that may be attributable to background concentrations will be discussed. If chromium and/or mercury are identified as

COPCs, the use of the screening levels for hexavalent chromium and /or methylmercury will be discussed.

### Uncertainty Associated with Exposure Assessment

Uncertainty in the exposure assessment will be generally treated with conservative decision rules and assumptions. The uncertainties associated with the EPCs and exposure factors used in the intake equations will be discussed.

### Uncertainty Associated with Toxicity Assessment

Uncertainty associated with the non-carcinogenic and carcinogenic toxicity factors will be included in RAGS Part D tables. In addition, the uncertainty associated with the oral-to-dermal adjustment factors (based on chemical-specific gastrointestinal absorption) and constituents with missing toxicity values will be discussed. Also, uncertainty associated with the use of Tier III toxicity values will be discussed.

### Uncertainty in Risk Characterization

The uncertainties identified in each component of the HHRA ultimately contribute to the uncertainty in risk characterization. The addition of ELCRs and HIs across pathways and COPCs contributes to uncertainty based on the interaction of constituents such as additivity, synergism, potentiation, and susceptibility of exposed receptors. This concept will be discussed. If chromium and/or mercury are identified as COPCs, risk estimates will be presented for hexavalent chromium and/or methylmercury to provide an upper-bound estimate for the scenario where the more toxic form is present rather than the form assumed/expected.

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# Soil Sample Depth Selection Protocol

This protocol defines the soil sample selection criteria that are used to select soil sampling depths for environmental investigations on Vieques, unless otherwise deemed appropriate and specified in site-specific project plans.

Soil sampling is conducted to provide information for various purposes. In addition to general site characterization use (e.g., nature and extent of contamination), surface soil data are used in human health and ecological risk assessments. Subsurface soil data from samples collected to a depth of 6 feet are used in human health risk assessments. The presence or potential presence of basements often is associated with subsurface soil depths of 10 feet for human health risk assessment. The subsurface soil depth for human health risk assessments conducted for Vieques is limited to 6 feet because there are no basements in Puerto Rico. Soil data are also used to assess the presence of contaminants that may be continuing sources of groundwater contamination.

## Surface Soil

In order to provide analytical data from a single depth that can be used for both human health and ecological screening/risk assessments (as well as site characterization), the following are the criteria used to select the surface soil sampling depth at a given site under investigation:

- Surface soil samples will be collected from the top 24 inches of soil when the sample location is near a surface water body and land crabs or burrowing reptiles (e.g., nesting sea turtles) are potential receptors of concern at the sample location.
- Surface soil samples will be collected from the top 12 inches of soil when the sample location is not near a surface water body and land crabs or burrowing reptiles (e.g., nesting sea turtles) are not potential receptors of concern at the sample location.
- Surface soil samples will be collected from the top 6 inches of soil when collected from under debris or contaminated soil that has been removed to determine whether a release to underlying soil has occurred.

## Subsurface Soil

The following are the general criteria that are used to select subsurface soil sampling depths at environmental sites. It should be noted that subsurface soil sample selection criteria may be modified on a site-specific basis, based on factors such as the depth to groundwater, depth to bedrock, depth of contaminant source, and extent of contamination.

For the purposes of collecting data for site characterization and human health risk assessment, at each subsurface soil sampling location, continuous split-spoon (or direct-push) samples will be collected from the bottom of the surface soil interval (i.e., 1 foot or 2

feet) to 6 feet (or bedrock or water table if encountered above 6 feet). One subsurface soil sample will be collected for analysis in the 2-ft interval within the 1- or 2-to-6 ft interval (depending on the surface soil depth), based on where visual and/or instrument (e.g., OVA) screening suggests the presence of contamination, to be used for human health risk evaluation (and site characterization). In the absence of potential contamination based on visual and/or instrument screening, the subsurface soil sample will be collected for analysis at the 4-to-6 ft interval (or just above the water table or bedrock, if encountered before this depth).

For the purposes of site characterization (not for risk assessment purposes), continuous soil sampling will continue from 6 feet to bedrock or the water table, whichever is shallower. Additional soil sample(s) will be collected for analysis below the 6-foot depth (i.e., between 6 feet and the water table or bedrock, whichever is shallower) if visual or instrument screening suggests the presence of contamination, to assist in delineating the vertical extent of contamination.

# Master Waste Management Plan

## U.S. Naval Ammunition Support Detachment (NASD) & Former Vieques Naval Training Range (VNTR) Vieques Island, Puerto Rico

**Contract Task Orders 007 & 039**

**February 2010**

Prepared for

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Prepared by

CH2MHILL

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# Contents

**Section** **Page**

**Acronyms and Abbreviations** ..... **v**

**1 Introduction** ..... **1-1**

**2 Handling** ..... **2-1**
2.1 Soil ..... 2-1
2.2 Solid Debris ..... 2-1
2.3 Water ..... 2-1

**3 Management** ..... **3-1**
3.1 Time Limit ..... 3-2
3.2 Container Labels ..... 3-2
3.3 Inspection of Waste Staging Areas ..... 3-4

**4 Characterization and Profiles** ..... **4-1**

**5 Shipping and Disposal** ..... **5-1**

Tables

3-1 Waste Accumulation Requirements ..... 3-1

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# Acronyms and Abbreviations

| | |
|---|---|
| CFR | Code of Federal Regulations |
| EPA | Environmental Protection Agency |
| NASD | U.S. Naval Ammunition Support Detachment |
| NAVFAC | Naval Facility Engineering Command |
| OSR | Off-Site Rule |
| PPE | Personal Protective Equipment |
| T&D | Transportation and Disposal |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TSDF | Treatment, Storage, and Disposal Facility |
| WMP | Waste Management Plan |
| VNTR | Former Vieques Naval Training Range |

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SECTION 1

# Introduction

This Master Waste Management Plan (WMP) addresses the general management and disposal requirements for wastes generated during investigation and remedial activities conducted by CH2M HILL at the former U.S. Naval Ammunition Support Detachment (NASD) and the Former Vieques Naval Training Range (VNTR) on Vieques Island, Puerto Rico.

It is anticipated that the following wastes will be generated during these activities:

- Non-hazardous and hazardous soil from investigation and remedial activities (e.g., soil cuttings generated during drilling, residual soil from decontamination of field equipment)
- Non-hazardous and hazardous water from investigation and remedial activities (e.g., decontamination water, groundwater from purging and/or sampling, and any other accumulated water from the site [e.g., excavation water])
- Other non-soil solid debris generated in the normal course of field operations including plastic sheeting, disposable sampling materials, and personal protective equipment (PPE).

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SECTION 2

# Handling

This section describes the waste handling procedures to be followed during the field activities.

## 2.1 Soil

To minimize generation of and the need for offsite disposal of IDW, soil cuttings generated during soil boring, test pitting, or trenching will be returned to the borehole, test pit, or trench from which it they were removed, to the extent possible. Excess soil from soil boring, test pitting, or trenching will be containerized for characterization and disposal, as described in Sections 3 and 4.

At the conclusion of a field event, waste containers will be temporarily staged at a location designated by Navy personnel. The waste will then be characterized as described in Section 4.

The steps for accumulating soils are as follows:

1. Manage excess soil in drums, roll-off containers, or stockpiles as described in Section 3.
2. Begin the field transportation and disposal log as described in Section 3.
3. Stage drums or roll-offs in the area(s) designated by the Navy prior to demobilizing from the site.
4. Perform required waste characterization sampling as described in Section 4.

## 2.2 Solid Debris

Solid debris (e.g., disposable sampling equipment, personal protective equipment, etc.) may be decontaminated in accordance with the Equipment Decontamination SOP and disposed of with normal trash. Other solid debris that is associated with sampling activities where the waste is expected to be non-hazardous may also be disposed of in the normal trash. Otherwise, debris will be placed in 55-gallon steel drums, roll-offs, or other controllable mechanism and managed as described in Section 3.

## 2.3 Water

Water will be produced during monitoring well development, groundwater purging and sampling, and decontamination activities. If groundwater is extracted from a background location or from where previous investigations have confirmed that contamination does not exist at that location, the groundwater will be discharged to the ground surface at least 25 feet from the well in an area that will not affect the well being sampled or adjacent sampling locations. If purged groundwater does not meet these criteria (i.e. it is contaminated or potentially

contaminated), it, and all other water generated that doesn't meet the standards for discharging to the ground, will be contained for characterization and disposal, as described in Section 3.All other water generated will be containerized for characterization and disposal, as described in Sections 3 and 4.

At the conclusion of field activities, waste containers will be temporarily staged at a location designated by Navy personnel. The waste will then be characterized as described in Section 4.

The steps for accumulating water are as follows:

1. If the water is groundwater that has been extracted from a background location or from where previous investigations have confirmed that soil and groundwater contamination do not exist, the groundwater will be discharged to the ground surface at least 25 feet from the well in an area that will not affect the well or adjacent sampling locations. If discharging to the ground surface, that information will be included in the field notes along with the total volume being discharged. If purged groundwater does not meet these criteria (contaminated or potentially contaminated), it will be containerized for characterization and disposal as described in section 3.

2. Containerize all other water and begin the field transportation and disposal log as described in Section 3.

3. Stage drums or portable tanks in the area(s) designated by Navy personnel prior to demobilizing from the site.

4. Perform waste characterization sampling as described in Section 4.

SECTION 3

# Management

Waste will be collected and managed as described in Table 3-1. The Field Transportation and Disposal (T&D) Log will be used to track waste containers from generation to final disposition. The Field T&D Log is included as Attachment 1.

TABLE 3-1
Waste Accumulation Requirements

| Accumulating In: | Requirements |
|---|---|
| Drums/Small Containers | • Inspected upon arrival onsite for signs of contamination and/or deterioration. Any container arriving with contents or in poor condition shall be rejected.<br>• Arranged in rows<br>• Adequate aisle space between rows to allow the unobstructed movement of personnel and equipment.<br>• Each container will be provided with its own label, and labels will be visible.<br>• Drums will remain completely closed with all lids, covers, bolts, and locking mechanisms engaged except when removing or adding waste to the drum. Covers will be properly secured at the end of each workday.<br>• Drums will be disposed of with the contents. If the contents are removed from the drums for offsite transportation and treatment or disposal, the drums will be decontaminated prior to re-use or before leaving the site.<br>• Drums containing hazardous waste will be provided with secondary containment. |
| Roll-Off Boxes | • Inspected upon arrival on-site. Any roll-off container arriving with contents or in poor condition shall be rejected.<br>• Will be provided with covers and disposable liners, if necessary. Liners shall be disposed of as contaminated debris along with the soil.<br>• When not in use, securely fastened covers will be installed on all roll-off boxes such that the waste is not exposed to precipitation.<br>• Each roll-off will be labeled |
| Portable Tanks | • Inspected upon arrival onsite for signs of deterioration and contamination. Any tank arriving onsite with contents or in poor condition will be rejected.<br>• Provided with covers and secondary containment.<br>• Only non-stationary tanks (such as a cargo tank or other wheeled tank) will be used to accumulate hazardous waste.<br>• Each tank will be labeled. |

TABLE 3-1
Waste Accumulation Requirements

| Accumulating In: | Requirements |
|---|---|
| Soil Stockpiles | • Stockpiles of contaminated soil will be located near the excavation areas and within an area of existing contamination.<br>• Stockpiles will be provided with liner, cover, and perimeter berm to prevent release or infiltration of liquids.<br>– Minimum 10- and 6-mil polyethylene sheeting will be used for liners and covers, respectively.<br>– The perimeter berm will be constructed of clean materials (e.g., hay bales under the liner) and allow for collection of any free liquids draining from the stockpile.<br>– Accumulated free liquids will be pumped-out to a container or tank.<br>• Covers and perimeter berms will be secured in-place when not in use and at the end of each workday, or as necessary to prevent wind dispersion or run-off from major precipitation events.<br>• Construction materials for the stockpiles that contact contaminated soil will be disposed of as solid debris.<br>• Accumulation start dates will be recorded on a log or a sign located at the stockpile. |
| All containers will be tracked on the field T&D Log | |

Containers will be staged in an area designated by the Navy pending disposal. Appropriate emergency response equipment should be available in case of fires or spills. This equipment may include a fire extinguisher, spill response equipment, and appropriate PPE depending on the waste being staged.

Hazardous wastes will be segregated from non-hazardous wastes. Additionally, incompatible wastes (e.g., flammable and corrosive wastes) will be segregated. Wastes of the same matrix, contamination, and the same source may be aggregated to facilitate storage and disposal.

## 3.1 Time Limit

All wastes will be formally characterized for disposal as described in Section 4. For initial onsite management purposes only, generated wastes are assumed to be non-hazardous unless there is evidence otherwise. Hazardous wastes are not expected to be generated, however; any hazardous wastes will be removed from the site within 90 days from generation. Other wastes will be removed from the site as soon as possible.

## 3.2 Container Labels

Labels will include the type of waste, location from which the waste was generated, and accumulation start date. Labels must be legible and readable at all times. Faded labels will be rewritten or replaced. Each container will have one of the following labels:

- "Analysis Pending" - Temporary or handwritten label used until analytical results are received and reviewed. If handwritten, a paint pen will be used. This label will include the following:
  - Accumulation Start Date: The date that waste first entered the container
  - Type of waste (e.g., IDW soil)
  - Site (e.g., East Vieques, SWMU 1).
  - The words "CERCLA-derived, Analysis Pending"
  - Generator Name: Ms. Madeline Rivera or Mr. Pedro Ruiz, Naval Activity Puerto Rico (NAVFAC ATLANTIC field office)
- "Hazardous Waste" - Pre-printed hazardous waste labels with the following information:
  - Accumulation start date: The date that waste first entered the container
  - Generator Name: Ms. Madeline Rivera or Mr. Pedro Ruiz, Naval Activity Puerto Rico (NAVFAC ATLANTIC field office)
  - Hazardous Waste Generator Number (PRN 000204694)
  - Site (e.g., East Vieques, SWMU 1).
  - Waste codes
  - Prior to transport, the manifest number must be added (for containers of less than 110-gallon capacity)
- "Non-Hazardous Waste" - Preprinted labels (if handwritten paint pen is required) with the following information:
  - Accumulation start date: The date that waste first entered the container
  - Generator name: Ms. Madeline Rivera or Mr. Pedro Ruiz, Naval Activity Puerto Rico (NAVFAC ATLANTIC field office)
  - Site (e.g., East Vieques, SWMU 1).
  - The words "CERCLA-derived"
  - Waste-specific information (e.g., IDW soil)

Where applicable, the major hazards (e.g., flammable, oxidizer, and carcinogen) will be included on the label.

It is expected that the required labels will be the "Analysis Pending" and/or the "Non-Hazardous Waste" label.

## 3.3 Inspection of Waste Staging Areas

Waste accumulation areas will be inspected for malfunctions, deterioration, discharges, and leaks that could result in a release. The following inspection schedule will be followed:

- Periodic inspection of containers, tanks and roll-off containers (for leaks, signs of corrosion, faded labels, or signs of general deterioration).
- Periodic inspection of stockpiles (for liner and berm integrity).

Any deficiencies observed or noted during inspection will be rectified immediately. Appropriate measures may include transfer of waste from a leaking container to new container, replacement of liner or cover, or repair of containment berm.

Inspection observations will be recorded in field logs and include any deficiencies and how the issue was rectified.

SECTION 4

# Characterization and Profiles

Wastes will be characterized based on analytical results, and the characterization will be documented on a waste profile. The following analytical protocol generally will be conducted: Full Toxicity Characteristic Leaching Procedure (TCLP), Reactivity (Cyanide and Sulfide), Ignitability, and Corrosivity. Certain analyses may be eliminated or added based on site-specific conditions and site history, if known. Added or eliminated analyses will be documented in site-specific work plans and/or reports as appropriate.

The sampling approach will be determined based on site history, the composition of the waste stream, the process generating the waste stream, and the types of containers in which the waste is collected. Samples will be collected such that the results are representative of each waste stream. In general, for each waste stream, samples will be taken at the following frequency:

- One sample per 500 tons of solid media will be taken for solids collected in bulk containers,
- One sample per bulk container will be taken for liquids collected in bulk containers, and
- One sample per 10 drums is required for liquids or solids collected in drums.

Site conditions may dictate deviations from these guidelines. Such deviations will be documented in site-specific work plans and/or reports as appropriate.

Waste characterization information will be documented on a waste profile form provided by the offsite treatment and/or disposal facility as part of the waste acceptance process. The profile will be reviewed and approved by CH2M HILL prior to submission to the Navy for generator signature. CH2M HILL will provide the Navy with a waste approval package for each waste stream. This package will include a waste profile naming the U.S. Navy as the generator of the waste, analytical summary table(s) applicable to the waste, and any other applicable information necessary for the Navy to complete its review of the disposal package and provide a signature as the generator. Signed profile(s) will then be submitted to the disposal facility for approval.

The profile typically requires information including but not limited to the following:

- Generator information including name, mailing address, contact, and phone number
- Site name including street address
- Process generating waste (e.g., soil removal, well installation, etc.)
- Source of contamination
- Historical use for area
- Waste composition
- Physical state of waste
- Applicable hazardous waste codes

A facility approved copy of the waste profile or approval letter will be received prior to scheduling of offsite transportation of the waste.

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SECTION 5

# Shipping and Disposal

Transportation may be scheduled once an approved profile or approval letter is received from the disposal facility. Each load of waste material will be manifested prior to leaving the waste staging area. Hazardous wastes will be transported using Uniform Hazardous Waste Manifests. Non-hazardous wastes will be transported using Non-hazardous Waste Manifests. These forms may not be altered and must be filled out completely. Bills of Lading will not be used to transport waste.

The generator (Navy) and the transporter must sign the manifest prior to the load of waste leaving the waste staging area. CH2M HILL personnel will not sign manifests. The original signed manifest will be returned to CH2M HILL Project Manager who will keep the forms and include them in the report generated for the project.

Each transportation vehicle and load of waste will be inspected before leaving the waste staging area and documented. The quantities of waste leaving the waste staging area will be recorded in the field log.

All personnel involved in offsite disposal activities will follow safety and spill response procedures outlined in their Health and Safety Plan or the CH2M HILL Site Specific Health and Safety Plan.

Disposal facilities with proper permits that are in good standing with the state, commonwealth, and federal agencies, as applicable, will be utilized. This information will be received and approved by CH2M HILL prior to the profiling of any waste. Appropriate disposal facility requirements will be determined on a case by case basis.

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STANDARD OPERATING PROCEDURE A-1

# Soil Boring Drilling and Abandonment

## I. Purpose and Scope

The purpose of this guideline is to describe methods to obtain samples of subsurface soil using either hollow-stem auger, rotary/ sonic drilling methods, direct push methods or tripod-mounted rig and then backfill boreholes to the surface. The standardized procedure includes soil borings through surface casings installed to prevent potential contamination in shallow water-bearing units from migrating downward into deeper units. Any project required deviations from standard operating procedures (SOPs), will be provided in site specific sampling and analysis plans (SAPs).

## II. Equipment and Materials

- Truck-mounted drilling rig, skid rig, direct-push, or tripod rig
- Direct-push, hollow-stem auger, rotary, or sonic equipment
- Steel or Schedule 80 PVC casing, of appropriate inside diameter (if surface casing is required)
- Split-spoon or thin-walled tube samplers (liners for direct-push)
- Downhole compacting tool (e.g., a pipe with a flat plate attached to the bottom)
- Cement
- Bentonite
- photo-ionization detector (PID) or flame-ionization detector (FID)

## III. Procedures and Guidelines

### A. Utility and UXO clearance

Utility and UXO clearance will be accomplished by checking with the Navy representative as to the potential for utilities in the area and the likelihood of UXO on the site. If there is the potential for municipal utilities to be present, the local utility company(ies) will be contacted as well. If live utilities are anticipated in the area of work, they will be marked by a third party utility location contractor or the local utility company. If the Navy representative indicates there is the potential for UXO to be present at a site, an operational readiness evaluation call will take place among the senior CH2M HILL UXO safety specialist and CH2M HILL field personnel to go over the avoidance procedures, and the safety specialist will designate the appropriate UXO safety procedures and personnel required.

## B. Drilling

Continuous-fight hollow-stem augers (HSA) with an inside diameter (ID) of at least 3.25 inches typically are used for soil borings. The use of water or other fluid to assist in hollow-stem drilling will be avoided if possible. Rotary drilling will be with a similar minimum diameter.

The bit of the auger or drill is placed on the ground at the location to be drilled and then turned with the drilling or soil-coring rig. The drilling is advanced to a depth just above the top of the interval to be sampled. For sonic drilling, a continuous core is collected and the sample interval is selected from the length of core run.

While advancing the auger or drill to the full borehole depth, the soils removed from the boring will be screened using a PID or FID.

A tripod drilling rig is generally equipped to collect continuous samples using a hammer-driven sampler. The soil sample collection will be the same as that outlined for hollow-stem and rotary drilling.

Temporary surface casing will be installed where soil borings will penetrate a confining layer that is separating two water-bearing units. The surface casing will be installed to prevent potential contamination in shallow water-bearing units from migrating downward into deeper units.

The surface casing will be seated approximately 5 feet into the confining unit (if the thickness allows) and will be sealed in place using a bentonite slurry or bentonite pellets. This seal is intended to prevent movement of groundwater downward from the shallow water-bearing unit but will allow the casing to be removed when the soil sampling is completed.

See SOP *Soil Sampling* for details regarding soil sampling.

## C. Direct Push

Direct push methods use smaller diameter rods and Lexan sleeve lined core tubes to collect soil samples that are extruded from the core barrel while remaining in the Lexan (or similar) sleeve. Direct push rods are driven either by hydraulic push from the rig if in soft soils/sediments, or with a hammer drive if in stiffer soils.

## D. Abandonment

Unless a well is to be installed, the borehole will be abandoned by backfilling the borehole with the soil cuttings unless gross contamination is suspected in the soil cuttings (either via visual observation or instrument readings). Any annular space remaining after backfilling will be grouted to near ground surface with a bentonite-cement grout. The bentonite-cement grout will be mixed in an approximate ratio of 95 lbs Portland cement to 5 lbs bentonite powder to 7 gallons water.

### E. Decontamination and Waste Disposal

As necessary to prevent potential cross-contamination between sampling locations, equipment will be decontaminated according to the procedures identified in SOPs *Decontamination of Personnel and Equipment* and *Decontamination of Drilling Rig and Equipment.*

Any soil cuttings and decontamination fluids containerized for offsite disposal will be managed as described in the *Master Waste Management Plan*.

## IV. Key Checks and Preventative Maintenance

- Check that the drilling rig or soil-coring rig is in working order, including emergency stop devices.
- Check that the borehole is filled or grouted to the ground surface, as appropriate, at the completion of drilling and sampling.
- PID/FID calibration and checks.

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STANDARD OPERATING PROCEDURE A-2

# Soil Sampling

## I. Purpose and Scope

The purpose of this procedure is to provide standardized procedures for obtaining samples of surface and subsurface soils. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

## II. Equipment and Materials

- Personal Protection Equipment
- Stainless-steel hand auger, split spoon, or appropriate hand tool
- Thin-walled sampling tubes (such as a shelby tube)
- Direct-push rig, drilling rig, soil-coring rig, or hand auger equipment
- Stainless-steel pan or bowl
- Stainless-steel spoons or dedicated wooden spoons
- Sample bottles and equipment
- photo-ionization detector (PID) or flame-ionization detector (FID)

## III. Procedures and Guidelines

All personnel shall be wearing personal protective equipment (PPE) per health and safety plan (HASP). Decontaminate all equipment per SOP "*Decontamination of Drilling Rigs and Equipment*" and "*Decontamination of Personnel and Equipment.*" Locate and record the sample point in the logbook. If appropriate, record sample location using global positioning system (GPS) or land survey.

### A. Surface and Shallow Subsurface Sampling with Hand Auger

Remove soil to a point just above the interval to be sampled. Collect soil at the desired sampling depth. Immediately take soil for volatile organic compound (VOC) analysis directly from the end of the hand auger with an Encore sampler. Place soil for analyses other than VOCs into a stainless-steel bowl, take a PID or FID reading of the soil collected, and log the readings accordingly into the boring (or other) log. Mix the soil in the bowl according to "*Homogenization of Soil and Sediment Samples*" SOP. If this interval is to be collected for analysis, use a stainless-steel spoon or dedicated wooden spoon to transfer the sample from the bowl to the sample container(s). Try not to touch soil to be collected with bare or gloved hands. Soil samples in sample containers should be free of pebbles, roots, and other non-soil debris. Preferably, soil jars should be filled full, but if difficulties are

encountered in getting sample volume, see SAP for minimum sample volume required by lab, or have the Environmental Information Specialist (EIS) call lab for minimum volume lab will need for that/those analyses. For VOC samples in jars, fill completely to avoid headspace. For VOC samples in Encore® samplers see SOP *"Soil Sampling for VOCs using the Encore ® Sampler"*. For VOC samples in Terra core® samplers see SOP *"Soil Sampling for VOCs using the Terra core ® Sampler"*.

## B. Split-Spoon or Direct Push Sampling

Advance a boring to just above the sample depth using a drilling rig, slide hammer, or direct push technology (DPT) rig. Lower the sampler into the hole and advance it to a depth equal to the total length of the desired interval. If using a drilling rig, or slide hammer, advance the split spoon sampler using a weighted or pneumatic hammer. Record the weight, type, blow count (number of blows required to advance 6 inches), and penetrated length into the boring log. Record only the penetrated length if using DPT.

The driller will then open the sampler or extrude the lexan (or similar) sample tube and cut open the tube, leaving the cut piece of tube on the sample to minimize the possibility of soil and vapors to escape. Record the total length of sample retrieved. Using a PID or FID, take readings along several points of the sampler and record them. Also, record any visual observations of suspected contamination. If this interval is to be collected, samples for VOC analysis are to be collected immediately from the core or split spoon at the target location (based on visual observations and PID/FID readings). Samples for analyses other than VOCs should be homogenized according to *"Homogenization of Soil and Sediment Samples"* SOP. Additional sample volume may be obtained by collecting a second sample below the first sample and compositing the sample for non-volatile parameters only (if still within the desired sample depth interval). A co-located hole within approximately 2 feet from the first hole may also be used to collect additional sample volume.

## C. Thin-Walled Tube Sampling

Undisturbed samples may be collected for analysis for physical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24 to 36 inches long and 3 to 4 inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax (or comparable) and then sealed with end caps and tape. The sample designation, date and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing.

## D. Sampling Descriptions

Following sample retrieval, the soils should be visually described in the boring log using ASTM D 2488, (attached) including approximated depths, PID readings, and any other relevant observations. Use the standard CH2M HILL soil description format found on soil boring log headers:: soil name, USCS group symbol, Munsell number and color, moisture content, relative density or consistency, soil structure, mineralogy (note approximate percentages of sand, silt and clay). Use a measuring tape or folding ruler calibrated in feet

and 10ths for logging soils. Note the depths that drilling penetration is easier/faster. Note at what depth drillers switched from augering to air hammer, as applicable. Make sure to note at what depth soil becomes saturated (and if it appears to return to an unsaturated state, indicating pearched water).

# IV. Key Checks and Preventative Maintenance

- Decontamination of all non-disposable equipment between sampling locations.
- PID/FID calibration and checks.

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Designation: D 1587 – 08

# Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes[1]

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope*

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively intact soil samples suitable for laboratory tests of engineering properties, such as strength, compressibility, permeability, and density. Thin-walled tubes used in piston, plug, or rotary-type samplers should comply with Section 6.3 of this practice which describes the thin-walled tubes.

NOTE 1—This practice does not apply to liners used within the samplers.

1.2 This Practice is limited to soils that can be penetrated by the thin-walled tube. This sampling method is not recommended for sampling soils containing gravel or larger size soil particles cemented or very hard soils. Other soil samplers may be used for sampling these soil types. Such samplers include driven split barrel samplers and soil coring devices (D 1586, D 3550, and D 6151). For information on appropriate use of other soil samplers refer to D 6169.

1.3 This practice is often used in conjunction with fluid rotary drilling (D 1452, D 5783) or hollow-stem augers (D 6151). Subsurface geotechnical explorations should be reported in accordance with practice (D 5434). This practice discusses some aspects of sample preservation after the sampling event. For information on preservation and transportation process of soil samples, consult Practice D 4220. This practice does not address environmental sampling; consult D 6169 and D 6232 for information on sampling for environmental investigations.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4.1 The tubing tolerances presented in Table 1 are from sources available in North America. Use of metric equivalent is acceptable as long as thickness and proportions are similar to those required in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 1452 Practice for Soil Investigation and Sampling by Auger Borings

D 1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D 3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils

D 3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 4220 Practices for Preserving and Transporting Soil Samples

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved Oct. 1, 2008. Published October 2008. Originally approved in 1958. Last previous edition approved in 2007 as D 1587 – 00 (2007)$^{\varepsilon 1}$.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

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**TABLE 1 Dimensional Tolerances for Thin-Walled Tubes**

| | Nominal Tube Diameters from Table 2[A] Tolerances | | | | | |
|---|---|---|---|---|---|---|
| Size Outside Diameter | 2 in. | 50.8 mm | 3 in. | 76.2 mm | 5 in. | 127 mm |
| Outside diameter, $D_o$ | +0.007 -0.000 | +0.179 -0.000 | +0.010 -0.000 | +0.254 -0.000 | +0.015 -0.000 | 0.381 -0.000 |
| Inside diameter, $D_i$ | +0.000 -0.007 | +0.000 -0.179 | +0.000 -0.010 | +0.000 -0.254 | +0.000 -0.015 | +0.000 -0.381 |
| Wall thickness | ±0.007 | ±0.179 | ±0.010 | ±0.254 | ±0.015 | ±0.381 |
| Ovality | 0.015 | 0.381 | 0.020 | 0.508 | 0.030 | 0.762 |
| Straightness | 0.030/ft | 2.50/m | 0.030/ft | 2.50/m | 0.030/ft | 2.50/m |

[A] Intermediate or larger diameters should be proportional. Specify only two of the first three tolerances; that is, $D_o$ and $D_i$, or $D_o$ and Wall thickness, or $D_i$ and Wall thickness.

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

D 5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D 6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities

## 3. Terminology

3.1 *Definitions:*

3.1.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *inside clearance ratio, %, n*—the ratio of the difference in the inside diameter of the tube, $D_i$, minus the inside diameter of the cutting edge, $D_e$, to the inside diameter of the tube, $D_i$ expressed as a percentage (see Fig. 1).

3.2.2 *ovality, n*—the cross section of the tube that deviates from a perfect circle.

## 4. Summary of Practice

4.1 A relatively intact sample is obtained by pressing a thin-walled metal tube into the in-situ soil at the bottom of a boring, removing the soil-filled tube, and applying seals to the soil surfaces to prevent soil movement and moisture gain or loss.

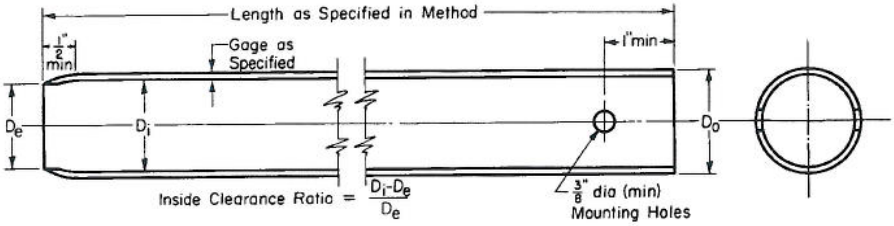
## 5. Significance and Use

5.1 This practice, or Practice D 3550 with thin wall shoe, is used when it is necessary to obtain a relatively intact specimen suitable for laboratory tests of engineering properties or other tests that might be influenced by soil disturbance.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective sampling. Users of this practice. are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

## 6. Apparatus

6.1 *Drilling Equipment*—When sampling in a boring, any drilling equipment may be used that provides a reasonably clean hole; that minimizes disturbance of the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside




NOTE 1—Minimum of two mounting holes on opposite sides for $D_o$ smaller than 4 in. (101.6 mm).

NOTE 2—Minimum of four mounting holes equally spaced for $D_o$ 4 in. (101.6 mm) and larger.

NOTE 3—Tube held with hardened screws or other suitable means.

NOTE 4—2-in (50.8 mm) outside-diameter tubes are specified with an 18-gauge wall thickness to comply with area ratio criteria accepted for "intact samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gauge tubes are generally readily available.

**Metric Equivalent Conversions**

| in. | mm |
|---|---|
| 3/8 | 9.53 |
| 1/2 | 12.7 |
| 1 | 25.4 |
| 2 | 50.8 |
| 3 | 76.2 |
| 4 | 101.6 |
| 5 | 127 |

**FIG. 1 Thin-Walled Tube for Sampling**



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**TABLE 2 Suitable Thin-Walled Steel Sample Tubes[A]**

| | | | |
|---|---|---|---|
| Outside diameter ($D_o$): | | | |
| in. | 2 | 3 | 5 |
| mm | 50.8 | 76.2 | 127 |
| Wall thickness: | | | |
| Bwg | 18 | 16 | 11 |
| in. | 0.049 | 0.065 | 0.120 |
| mm | 1.24 | 1.65 | 3.05 |
| Tube length: | | | |
| in. | 36 | 36 | 54 |
| m | 0.91 | 0.91 | 1.45 |
| Inside clearance ratio, % | <1 | <1 | <1 |

[A] The three diameters recommended in Table 2 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

6.2 *Sampler Insertion Equipment*, shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

6.3 *Thin-Walled Tubes*, should be manufactured to the dimensions as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. (50 to 130 mm) and be made of metal having adequate strength for the type of soil to be sampled. Tubes shall be clean and free of all surface irregularities including projecting weld seams. Other diameters may be used but the tube dimensions should be proportional to the tube designs presented here.

6.3.1 *Length of Tubes*—See Table 2 and 7.4.1.

6.3.2 *Tolerances*, shall be within the limits shown in Table 1.

6.3.3 *Inside Clearance Ratio*, should be not greater than 1 % unless specified otherwise for the type of soil to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled, except for sensitive soils or where local experience indicates otherwise. See 3.2.1 and Fig. 1 for definition of inside clearance ratio.

6.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating, unless the soil is to be extruded less than 3 days. The type of coating to be used may vary depending upon the material to be sampled. Plating of the tubes or alternate base metals may be specified. Galvanized tubes are often used when long term storage is required. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, zinc oxide, and others.

NOTE 3—Most coating materials are not resistant to scratching by soils that contain sands. Consideration should be given for prompt testing of the sample because chemical reactions between the metal and the soil sample con occur with time.

6.4 *Sampler Head*, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a venting area and suitable check valve with the venting area to the outside equal to or greater than the area through the check valve. In some special cases, a check valve may not be required but venting is required to avoid sample compression. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

## 7. Procedure

7.1 Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the drilling and sampling operation.

7.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted.

NOTE 4—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

7.3 Lower the sampling apparatus so that the sample tube's bottom rests on the bottom of the hole and record depth to the bottom of the sample tube to the nearest 0.1-ft (0.03 m).

7.3.1 Keep the sampling apparatus plumb during lowering, thereby preventing the cutting edge of the tube from scraping the wall of the borehole.

7.4 Advance the sampler without rotation by a continuous relatively rapid downward motion and record length of advancement to the nearest 1 in. (25 mm).

7.4.1 Determine the length of advance by the resistance and condition of the soil formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays. In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3 in. (76 mm) for sludge and end cuttings.

NOTE 5—The mass of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 2.

7.5 When the soil formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

7.6 Withdraw the sampler from the soil formation as carefully as possible in order to minimize disturbance of the sample. The tube can be slowly rotated to shear the material at the end of the tube, and to relieve water or suction pressures (or both) and improve recovery. Where the soil formation is soft, a delay before withdraw of the sampler (typically 5 to 30 minutes) may improve sample recovery.

## 8. Sample Measurement, Sealing and Labeling

8.1 Upon removal of the tube, remove the drill cuttings in the upper end of the tube and measure the length of the soil sample recovered to the nearest 0.25 in. (6 mm) in the tube. Seal the upper end of the tube. Remove at least 1 in. (25 mm)



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of material from the lower end of the tube. Use this material for soil description in accordance with Practice D 2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube.

8.1.1 Tubes sealed over the ends, as opposed to those sealed with expanding packers, should be provided with spacers or appropriate packing materials, or both prior to sealing the tube ends to provide proper confinement. Packing materials must be nonabsorbent and must maintain their properties to provide the same degree of sample support with time.

8.1.2 Depending on the requirements of the investigation, field extrusion and packaging of extruded soil samples can be performed. This allows for physical examination and classification of the sample. Samples are extruded in special hydraulic jacks equipped with properly sized platens to extrude the core in a continuous smooth speed. In some cases, further extrusion may cause sample disturbance reducing suitability for testing of engineering properties. In other cases, if damage is not significant, cores can be extruded and preserved for testing (Practice D 4220). Bent or damaged tubes should be cut off before extruding.

8.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample (see Section 9). Assure that the markings or labels are adequate to survive transportation and storage.

NOTE 6—Top end of the tube should be labeled "top."

## 9. Field Log

9.1 Record the information that may be required for preparing field logs in general accordance to Guide D 5434. This guide is used for logging explorations by drilling and sampling. Some examples of the information required include;

9.1.1 Name and location of the project,

9.1.2 Boring number,

9.1.3 Log of the soil conditions,

9.1.4 Surface elevation or reference to a datum to the nearest foot (0.5 m) or better,

9.1.5 Location of the boring,

9.1.6 Method of making the borehole,

9.1.7 Name of the drilling foreman and company, and

9.1.8 Name of the drilling inspector(s).

9.1.9 Date and time of boring-start and finish,

9.1.10 Depth to groundwater level: date and time measured,

9.2 Recording the appropriate sampling information is required as follows:

9.2.1 Depth to top of sample to the nearest 0.1 ft. (.03 m) and number of sample,

9.2.2 Description of thin-walled tube sampler: size, type of metal, type of coating,

9.2.3 Method of sampler insertion: push or drive,

9.2.4 Method of drilling, size of hole, casing, and drilling fluid used,

9.2.5 Soil description in accordance with Practice D 2488,

9.2.6 Length of sampler advance (push), and

9.2.7 Recovery: length of sample obtained.

## 10. Keywords

10.1 geologic investigations; intact; sampling; soil exploration; soil investigations; subsurface investigations

## SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D 1587 – 00 (2007)$^{\varepsilon 1}$) that may impact the use of this standard. (Approved October 1, 2008.)

(*1*) Replaced "undisturbed" with "intact" in Sections 1.1, 4.1, 5.1, 10, and Note 4 of Fig. 1.

(*2*) Editorial changes made in Sections 1.4, 7.3, 7.4.1, 7.6, 8.1, and 8.1.2.

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Designation: D 2488 – 00

# Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

## 3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
*Cobbles*—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
*Boulders*—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-µm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

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limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

*coarse*—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

*fine*—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

*coarse*—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

*medium*—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

*fine*—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

## 4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

*Dual Symbol*—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

*Borderline Symbol*—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

## 5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

## 6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula*.

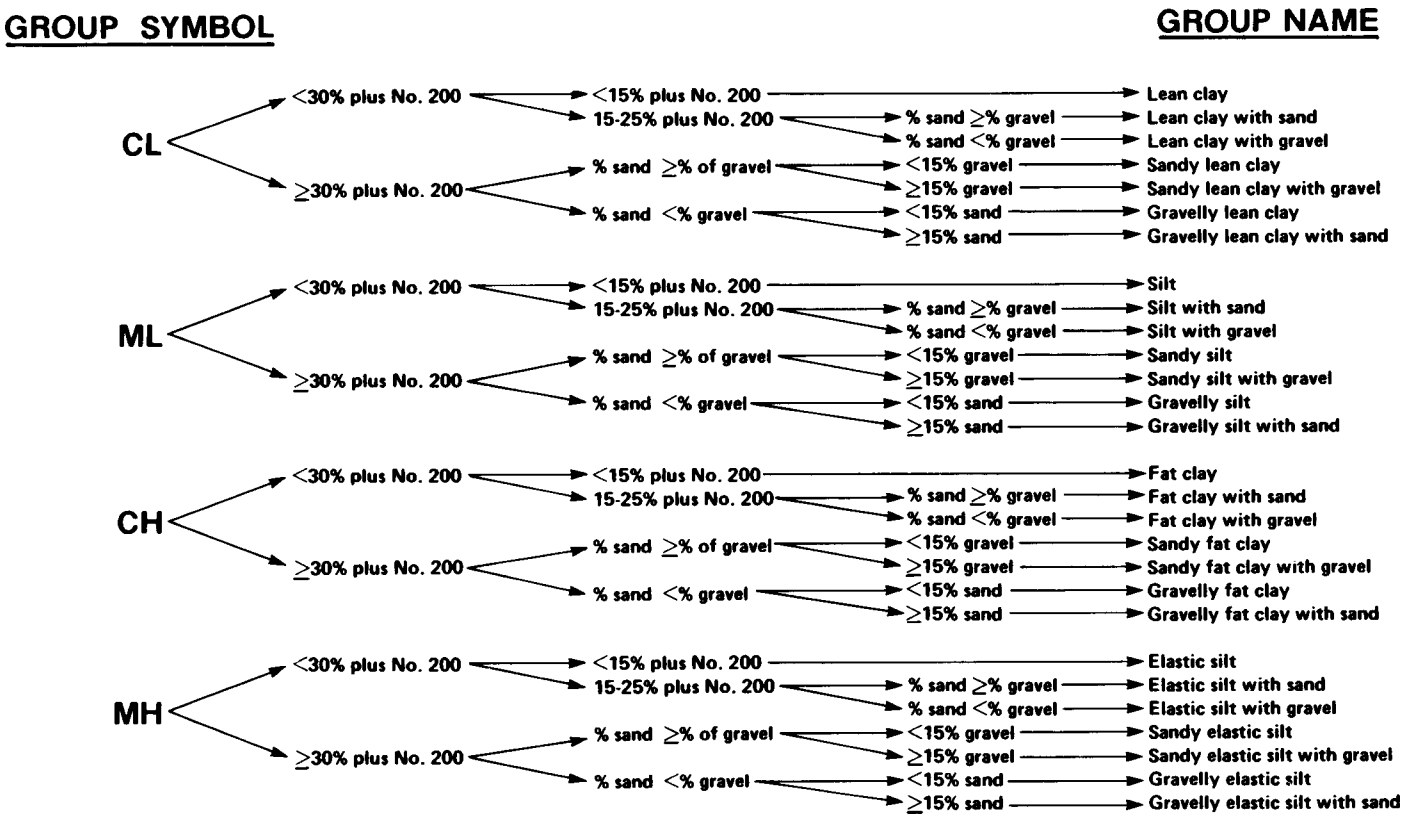
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens*.

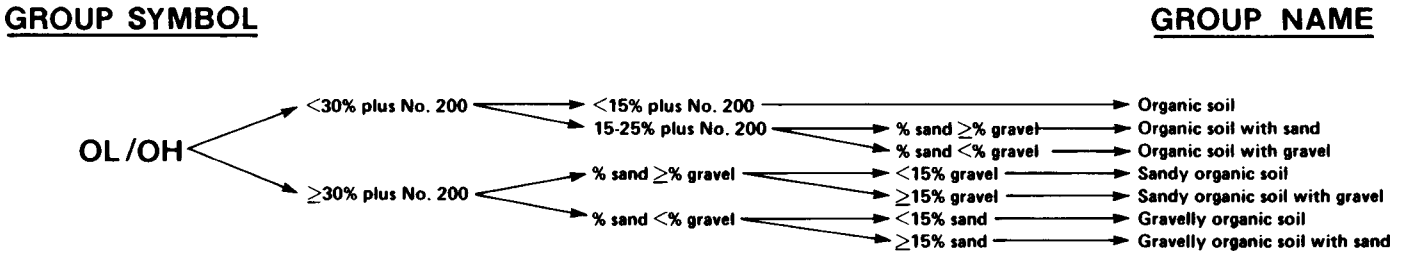
## 7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water




NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

**FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)**




NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

**FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)**

supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

## 8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

## 9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

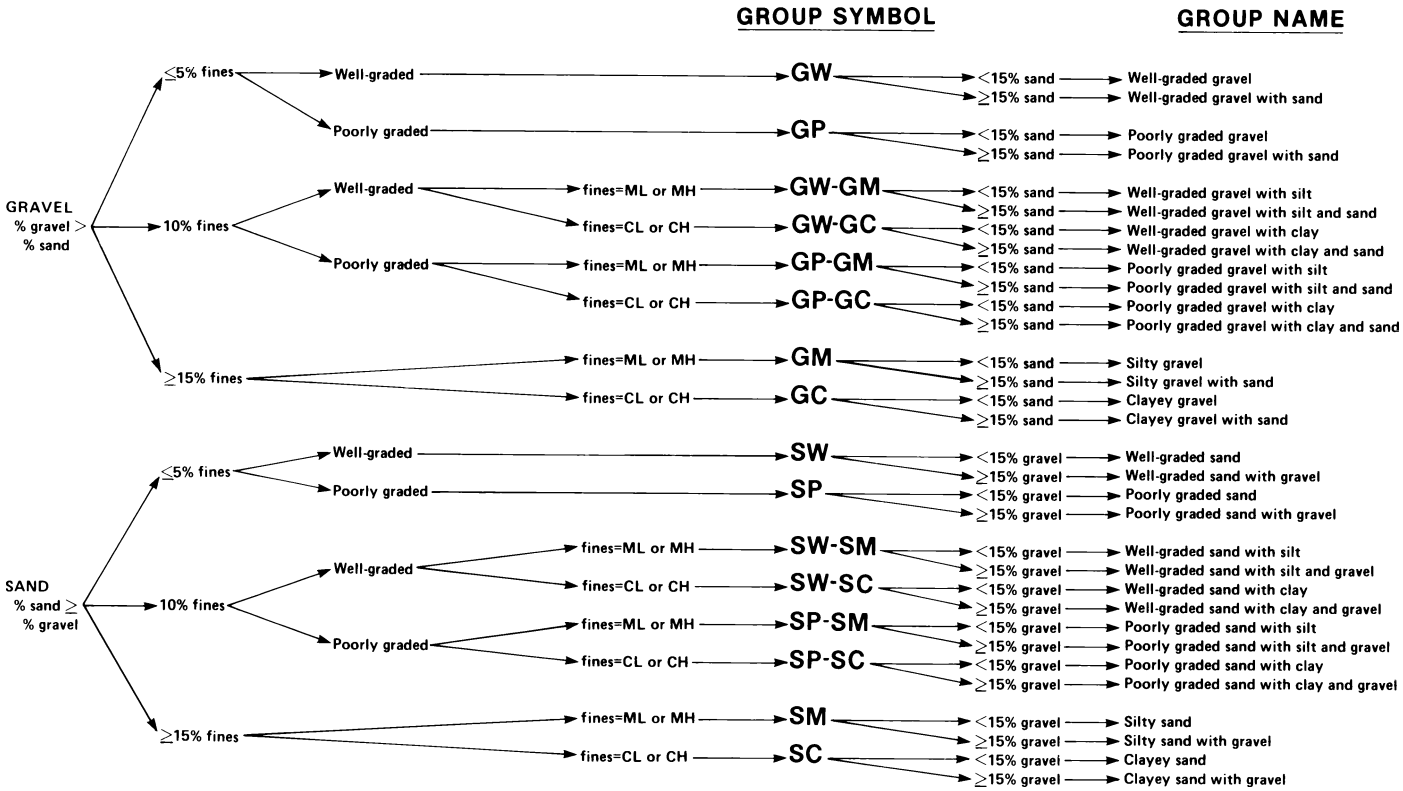
NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

| Maximum Particle Size, Sieve Opening | Minimum Specimen Size, Dry Weight |
|---|---|
| 4.75 mm (No. 4) | 100 g (0.25 lb) |
| 9.5 mm (⅜ in.) | 200 g (0.5 lb) |
| 19.0 mm (¾ in.) | 1.0 kg (2.2 lb) |
| 38.1 mm (1½ in.) | 8.0 kg (18 lb) |
| 75.0 mm (3 in.) | 60.0 kg (132 lb) |




NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

**FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)**

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

## 10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

**TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)**

| Description | Criteria |
|---|---|
| Angular | Particles have sharp edges and relatively plane sides with unpolished surfaces |
| Subangular | Particles are similar to angular description but have rounded edges |
| Subrounded | Particles have nearly plane sides but have well-rounded corners and edges |
| Rounded | Particles have smoothly curved sides and no edges |

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

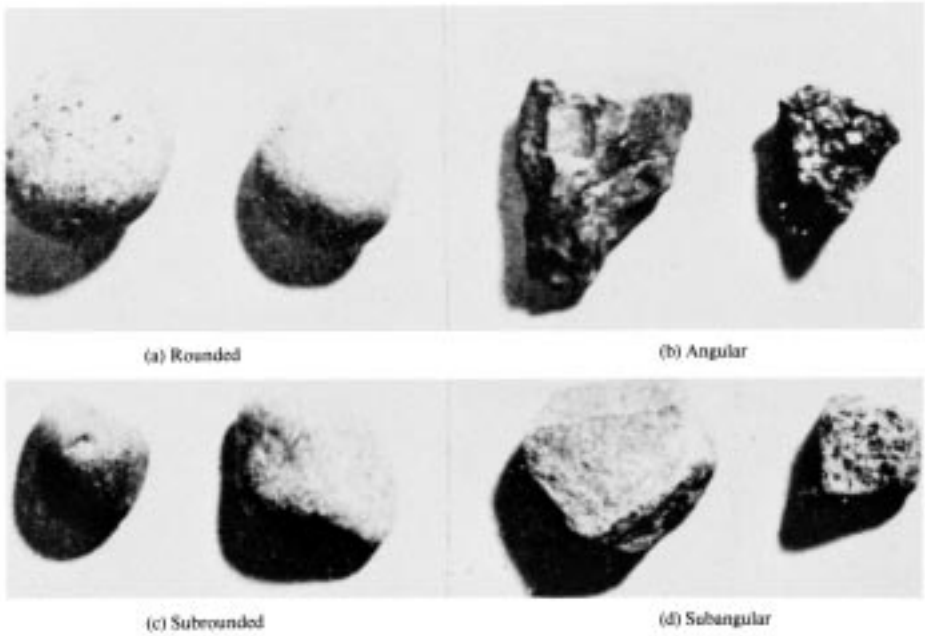



**FIG. 3 Typical Angularity of Bulky Grains**

**TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)**

| | |
|---|---|
| The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively. | |
| Flat | Particles with width/thickness > 3 |
| Elongated | Particles with length/width > 3 |
| Flat and elongated | Particles meet criteria for both flat and elongated |

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

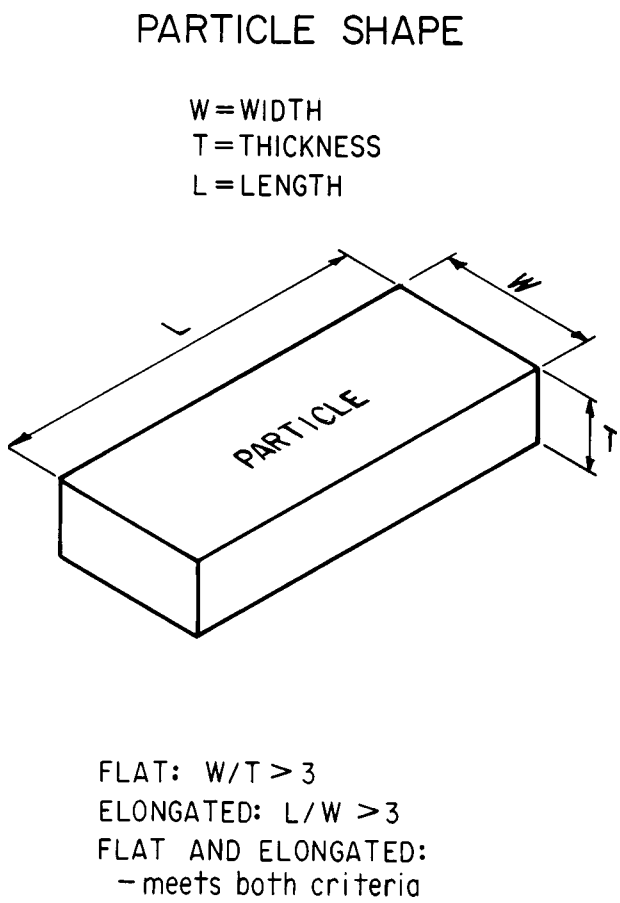



**FIG. 4 Criteria for Particle Shape**

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering

**TABLE 3 Criteria for Describing Moisture Condition**

| Description | Criteria |
|---|---|
| Dry | Absence of moisture, dusty, dry to the touch |
| Moist | Damp but no visible water |
| Wet | Visible free water, usually soil is below water table |

**TABLE 4 Criteria for Describing the Reaction With HCl**

| Description | Criteria |
|---|---|
| None | No visible reaction |
| Weak | Some reaction, with bubbles forming slowly |
| Strong | Violent reaction, with bubbles forming immediately |

**TABLE 5 Criteria for Describing Dilatancy**

| Description | Criteria |
|---|---|
| Very soft | Thumb will penetrate soil more than 1 in. (25 mm) |
| Soft | Thumb will penetrate soil about 1 in. (25 mm) |
| Firm | Thumb will indent soil about ¼in. (6 mm) |
| Hard | Thumb will not indent soil but readily indented with thumbnail |
| Very hard | Thumbnail will not indent soil |

**TABLE 6 Criteria for Describing Toughness**

| Description | Criteria |
|---|---|
| Weak | Crumbles or breaks with handling or little finger pressure |
| Moderate | Crumbles or breaks with considerable finger pressure |
| Strong | Will not crumble or break with finger pressure |

**TABLE 7 Criteria for Describing Dilatancy**

| Description | Criteria |
|---|---|
| Stratified | Alternating layers of varying material or color with layers at least 6 mm thick; note thickness |
| Laminated | Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness |
| Fissured | Breaks along definite planes of fracture with little resistance to fracturing |
| Slickensided | Fracture planes appear polished or glossy, sometimes striated |
| Blocky | Cohesive soil that can be broken down into small angular lumps which resist further breakdown |
| Lensed | Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness |
| Homogeneous | Same color and appearance throughout |

hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

## 11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

## 12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

## 13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

## 14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low,

medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

**TABLE 8 Criteria for Describing Toughness**

| Description | Criteria |
|---|---|
| None | The dry specimen crumbles into powder with mere pressure of handling |
| Low | The dry specimen crumbles into powder with some finger pressure |
| Medium | The dry specimen breaks into pieces or crumbles with considerable finger pressure |
| High | The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface |
| Very high | The dry specimen cannot be broken between the thumb and a hard surface |

**TABLE 9 Criteria for Describing Dilatancy**

| Description | Criteria |
|---|---|
| None | No visible change in the specimen |
| Slow | Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing |
| Rapid | Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing |

**TABLE 10 Criteria for Describing Toughness**

| Description | Criteria |
|---|---|
| Low | Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft |
| Medium | Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness |
| High | Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness |

**TABLE 11 Criteria for Describing Plasticity**

| Description | Criteria |
|---|---|
| Nonplastic | A ⅛-in. (3-mm) thread cannot be rolled at any water content |
| Low | The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit |
| Medium | The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit |
| High | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit |

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

**TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests**

| Soil Symbol | Dry Strength | Dilatancy | Toughness |
|---|---|---|---|
| ML | None to low | Slow to rapid | Low or thread cannot be formed |
| CL | Medium to high | None to slow | Medium |
| MH | Low to medium | None to slow | Low to medium |
| CH | High to very high | None | High |

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

## 15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

## 16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

*Trace*—Particles are present but estimated to be less than 5 %
*Few*—5 to 10 %
*Little*—15 to 25 %
*Some*—30 to 45 %
*Mostly*—50 to 100 %

**TABLE 13 Checklist for Description of Soils**

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

*For intact samples:*

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

## 17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

## 18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

# APPENDIXES

**(Nonmandatory Information)**

## X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

*In-Place Conditions*—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft$^3$; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

## X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as “Sandy Lean Clay (CL)”; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; “Poorly Graded Sand with Silt (SP-SM)”; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; “Poorly Graded Gravel with Sand (GP).”

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; “Poorly Graded Gravel (GP)”; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard,

angular sand-size particles; dry, tan; no reaction with HCl.

## X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

## X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

## X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

| *Prefix:* | Suffix: |
|---|---|

| | |
|---|---|
| s = sandy | s = with sand |
| g = gravelly | g = with gravel |
| | c = with cobbles |
| | b = with boulders |

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

| *Group Symbol and Full Name* | Abbreviated |
|---|---|
| CL, Sandy lean clay | s(CL) |
| SP-SM, Poorly graded sand with silt and gravel | (SP-SM)g |
| GP, poorly graded gravel with sand, cobbles, and boulders | (GP)scb |
| ML, gravelly silt with sand and cobbles | g(ML)sc |

## SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (1993$^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

(2) Added Note 5 under 5.7 and renumbered subsequent notes.

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STANDARD OPERATING PROCEDURE A-3

# Homogenization of Soil and Sediment Samples

## I. Purpose and Scope

This document provides standardized procedures for the homogenization of soil and sediment samples. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

## II. Equipment and Materials

- Stainless steel spoons or spatulas, disposable wooden sampling tools
- Stainless steel pans or bowls

## III. Procedures and Guidelines

Soil and sediment samples to be analyzed for non-volatile organic compound (VOC) chemical analyses will be homogenized in the field. Samples for VOCs will not be collected from homogenized soil or sediment. A stainless steel spatula, stainless spoon, or disposable wooden device will be used to remove the soil from the split spoon or other sampling device into a stainless-steel pan or bowl. Do not touch soil to be collected with bare or gloved hands.

Prior to homogenization, any rocks, twigs, leaves, or other debris should be removed from the sample to the extent practical. The soil should be placed in a decontaminated stainless steel bowl (or similar) and thoroughly mixed using a stainless steel spoon (or similar).

All stainless steel spoons, spatulas, and bowls must be decontaminated following procedures specified in SOP *Decontamination of Personnel and Equipment* prior to homogenizing the sample.

## IV. Key Checks and Items

- Take VOC samples from undisturbed soil and sediment; do not collect VOC samples from homogenized soil or sediment.
- Decontaminate all non-disposable equipment between sampling locations.
- Make sure homogenization equipment (bowls and spoons) are intact and not rusting or flaking.

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STANDARD OPERATING PROCEDURE A-4

# Soil Sampling for VOCs Using the EnCore® Sampler

## I. Purpose and Scope

This document provides standardized procedures for obtaining samples of surface and subsurface soils (and sediment depending on stiffness of sediment) for volatile organic compounds (VOCs) using the EnCore® sampler.

## II. Equipment and Materials

- The EnCore® sampler, 5g or 25g version
- Reusable T-handle

## III. Procedures and Guidelines

The sampling point and depth is located and recorded in the field logbook. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

### A. Surface and Shallow Subsurface Sampling

Collect soil core in accordance with *Soil Boring Drilling and Abandonment* and *Soil Sampling* SOPs. Collect sediment according to *Sediment Sampling* SOP. Sediment samples should be collected in jars if sediment is not sufficiently stiff to allow appropriate sampling with EnCore® sampler.

Remove EnCore® sampler from package and attach T-handle. If using a hand auger to obtain the samples, collect the 5 or 25 gram sample from the end of hand auger immediately after removing it from the hole. Using the T-handle, push the EnCore® sampler into the soil or sediment until the plunger is fully depressed, and the EnCore® sampler is completely full of sample. If split spoon or DPT is used to obtain the samples, collect the 5 or 25 gram sample immediately from the core or split spoon at the target location (based on visual observations and PID/FID readings).

Use the cap's bottom edge to scrape the bottom lip of the encore sampler so that the soil is flush with the lip. The soil in the center of the encore sampler can be very slightly mounded in the center as long as the cap fits on and locks in place tightly. Attach the cap ensuring it is on tightly and locked. Tapping the cap/EnCore® assembly is approved to ensure a proper fit. Lock the EnCore® tab to prevent inadvertent loss of the sample. Fill out a label and attach to sampler. Collect the number of EnCores® per sample required by the laboratory. Low stiffness sediments are not appropriately sampled using EnCores® (or

Terra Cores®). Low stiffness sediment VOC samples will be collected in zero headspace jars.

The EnCore® sampler has to reach the lab for preservation within 48 hours of collection. Make sure where possible to double bag encore samplers to prevent wetting during shipping.

# IV. Key Checks and Preventative Maintenance

Check that sample collection is swift to avoid loss of VOCs during sampling.

Check that the encore sampler is tightly sealed, and that it has been labeled correctly, and that all encores required have been filled.

Check the FedEx pick up time for that particular day prior to collection in order to ensure FedEx drop-off can be made with sufficient packing time.

STANDARD OPERATING PROCEDURE A-5

# Slide Hammer Soil Sampling

## I. Purpose

Collection of shallow soil samples with a direct push sampler driven by a slide hammer.

## II. Scope

Methodology, safety and use of slide hammer to drive a direct push soil sampler to collect shallow soil samples.

## III. Equipment and Materials

- Slide hammer, with appropriate weight.
- Direct push soil sampler

## IV. Procedures and Guidelines

- Follow direct push soil sampling SOP for soil collection, using slide hammer to drive soil sampler instead of direct push rig.
- Follow HSE 112 Manual Lifting, and evaluate lifting and use of slide hammer with lift evaluation form and self-assessment checklist for lifting.
- Confirm no one is using hands on area below slide hammer to stabilize driven shaft when hammer is being operated.

## V. Attachments

Lift evaluation form and self-assessment checklist for lifting.

## VI. Key Checks and Items

Use caution, get assistance carrying, watch for pinch points, follow HSE 112.

**CH2MHILL** **LIFT EVALUATION FORM**

***Form Instructions*** *: This form is to be used when employees expect to lift an object weighing more than 40 pounds (18 kilograms). To evaluate a lift please complete the first four steps and input your evaluation factors in Step 5. Based upon the evaluation factors, calculate the overall Lifting Evaluation Factor. Then determine the lift Risk Level and Evaluation Actions (Step 6).*

**Step 1: Load Weight Factor**

| Actual Load Weight | Load Weight Factor |
|---|---|
| < 10 pounds (4.5 kg.) | 1 |
| 11 to 20 pounds (5 to 9 kg.) | 2 |
| 21 to 35 pounds (9.5 to 15 kg.) | 4 |
| 36 to 50 pounds (16 to 22.5 kg.) | 7 |
| >50 pounds (22.5 kg.) | 10 |

**Step 2: Duration/Frequency Factor**

| Lifting Conditions | Lifting Condition Factor |
|---|---|
| **Good ergonomic conditions:**<br>Adequate space<br>Level and solid floor or ground<br>Adequate lighting<br>Good gripping conditions<br>Stable load | 0 |
| **Undesirable ergonomic conditions:**<br>Restricted movement<br>Restricted area height (less than 5 feet or 1.5 meters)<br>Floor uneven, soft , slippery, or sloping<br>Uneven weight distribution | 1 |

**Step 3: Posture Factors**

| Posture and Position of Lift | Posture Factor |
|---|---|
| Upper body upright, not twisted<br>Load close to body<br>Standing or walking a few steps<br>Slight inclination forward or twisting of upper body | 1 |
| Slight inclination forward or twisting of upper body<br>Load close to body<br>Standing or walking longer distances | 2 |
| Low bending or extensive inclination forward<br>Slight inclination forward with simultaneous twisting of upper body<br>Load away from body or above shoulder height<br>Sitting | 4 |
| Extensive inclination forward with simultaneous twisting of upper body<br>Load away from body<br>Restricted stability of posture when standing, squatting, or kneeling | 8 |

**Step 4: Duration/Frequency**

| Lifts per Minute | Hours per Day: <1 hr. | 1 to 2 hours | > 2 hours |
|---|---|---|---|
| < 1 lift per min. | 1 | 2 | 4 |
| 1 lift every min. | 2 | 2 | 4 |
| 2-3 lifts per min. | 2 | 4 | 6 |
| 4-5 lifts per min. | 4 | 4 | 6 |
| 6-7 lifts per min. | 4 | 6 | 8 |
| 8-9 lifts per min. | 6 | 8 | 8 |
| > 9 lifts per min. | 8 | 8 | 8 |

*The number of lifts performed per minute and the duration of the lifts will determine the Duration/Frequency Factor*

**Step 5: Lifting Evaluation**

| Load Weight Factor | + | Lifting Condition Factor | + | Posture Factor | X | Duration/Frequency Factor | = | Lifting Evaluation Factor |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

**Step 6: Risk Level and Evaluation Actions**

| Lifting Risk Factor | Risk Level and Evaluation Actions |
|---|---|
| <10 | **Low Risk** - No action needed at this time |
| 10 to 25 | **Elevated Risk** - Reduce Lifting Evaluation Factor by addressing the concerns of the Posture and Conditions Factors |
| 26 to 50 | **Increased Risk** - Reduce Lifting Evaluation Factor by reducing Load Weight Factor and/or the Frequency/Duration of the lifts. Mechanical lifting devices may be used or assistance from other workers. |
| >50 | **High Risk** - Reduce Lifting Evaluation Factor by reducing each of the contributing factors. If Lifting Evaluation Factor cannot be reduced, then mechanical lifting devices or assistance from other workers is necessary. |

HSE-112 REVISION 1 8

CH2MHILL

## HSE Self-Assessment Checklist—Lifting

This checklist shall be used **only** by CH2M HILL personnel and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: (1) CH2M HILL employees perform manual lifting activities (office or projects), and/or (2) CH2M HILL provides oversight of a subcontractor performing manual lifting activities. SC or Office Safety Coordinators/Committee members may consult with subcontractors (if applicable) when completing this checklist but shall not direct the means and methods of activities nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies, and we must carefully rely on their expertise. Conditions considered imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazardous area until corrected.
Complete the appropriate project or office information:

***Project Information***
Project Name: _____ Project No.: _____
Location: _____ PM: _____
Auditor: _____ Title: _____ Date: _____

***Office Information***
Office Location: _____
Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:
☐ Evaluate CH2M HILL employee manual lifting activities.
☐ Evaluate a CH2M HILL subcontractor's manual lifting activities.
Subcontractor Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor.
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-112.

| Planning Activities | Yes | No | N/A | N/O |
|---|---|---|---|---|
| 1. Efforts have been made to inquire about receiving equipment or supplies in containers weighting less than 50 pounds (23 kilograms). | O | O | O | O |
| 2. Equipment or supplies are being delivered as close as possible to their use point. | O | O | O | O |
| 3. Heavy equipment or supplies are being stored off the ground and no lower than knee height. | O | O | O | O |
| 4. Adequate space has been provided to access and lift equipment or supplies without reaching or twisting. | O | O | O | O |
| **Safe Work Practices (5.1)** | **Yes** | **No** | **N/A** | **N/O** |
| 5. Tasks or activities have been modified to reduce or minimize manual lifting. | O | O | O | O |
| 6. All employees performing manual lifting have received training on how to lift safely. | O | O | O | O |

| | | | | |
|---|---|---|---|---|
| 7. Manual lifting control measures are evaluated during assessments. | o | o | o | o |
| 8. Manual lifting incidents are reviewed as part of the HSE Program reviews. | o | o | o | o |
| 9. Manual lifting incidents are reviewed as part of the HSE Program reviews. | o | o | o | o |
| **Office Environments (5.1.1)** | **Yes** | **No** | **N/A** | **N/O** |
| 10. Employees have received lifting training. | o | o | o | o |
| 11. Mechanical devices are readily available to employees handling equipment or supplies weighing more than 40 pounds (18 kilograms). | o | o | o | o |
| **Field Projects (5.1.2)** | **Yes** | **No** | **N/A** | **N/O** |
| 12. All manual lifting tasks or activities have been addressed in the written site safety plan. | o | o | o | o |
| 13. Employees have received safe lifting training as required by the written site safety plan. | o | o | o | o |
| **Mechanical Lifting (5.2)** | **Yes** | **No** | **N/A** | **N/O** |
| 14. Hand trucks and trolleys are visually inspected before use. | o | o | o | o |
| 15. Hand trucks and trolleys do not have any broken or damaged parts. | o | o | o | o |
| 16. Hand truck and trolley paths are free of uneven surfaces, water, oil, or cracks and holes. | o | o | o | o |
| 17. Loads carried by hand trucks are balanced and sturdy. | o | o | o | o |
| 18. Hand trucks or dollies are being pushed when on level ground. | o | o | o | o |
| 19. When going up or down a slope using a hand truck or trolley, the load is downslope of the person. | o | o | o | o |
| 20. Employees using hand trucks or dollies are moving slowly and cautiously. | o | o | o | o |
| 21. Employees using hand trucks or trolleys are able to see over the load. | o | o | o | o |
| **Assisted Lifting (5.3)** | **Yes** | **No** | **N/A** | **N/O** |
| 22. Personnel are not performing manual lifting beyond their physical capabilities. | o | o | o | o |
| 23. Loads are evenly distributed when being handled by multiple people. | o | o | o | o |
| **Manual Lifting (5.4)** | **Yes** | **No** | **N/A** | **N/O** |
| 24. Before the lift, the load and path was assessed. | o | o | o | o |
| 25. Loads being lifted are free of sharp edges, slivers, or wet or greasy spots. | o | o | o | o |
| 26. Gloves are used for manual lifts of loads with sharp or splintered edges. | o | o | o | o |
| 27. Employees performing manual lifts use the proper lifting techniques. | o | o | o | o |
| 28. Special tools fabricated for lifting grates or manhole covers are used. | o | o | o | o |

| Item # | Corrective Action Planned/Taken | Date Corrected |
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Auditor: _____ Project Manager: _____

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STANDARD OPERATING PROCEDURE A-6

# Soil Sampling for VOCs Using the Terra Core® Sampler

## I. Purpose and Scope

This document provides standardized procedures for obtaining samples of surface and subsurface soils (and sediment depending on stiffness of sediment) for volatile organic compounds (VOCs) using the Terra Core® sampler.

## II. Equipment and Materials

- The Terra Core® sampler
- 2 pre-preserved tared 40 ml VOA with stir bar with 5 ml DI water for VOC analysis
- 1 pre-preserved tared 40 ml VOA with stir bar with 5 ml methanol for low level VOC analysis

## III. Procedures and Guidelines

The sampling point and depth is located and recorded in the field logbook. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

### A. Surface and Shallow Subsurface Sampling

Collect soil core in accordance with *Soil Boring Drilling and Abandonment* and *Soil Sampling* SOPs. Collect sediment according to *Sediment Sampling* SOP. Sediment samples should be collected in jars if sediment is not sufficiently stiff to allow appropriate sampling with Terra Core® sampler.

Remove Terra Core® sampler from package and have the 40 ml glass VOA vial with preservative ready. If using a hand auger to obtain the samples, collect the 5 gram sample from the end of hand auger immediately after removing it from the hole. Using the handle, push the Terra Core® sampler into the soil or sediment until the plunger is fully depressed, and the Terra Core® sampler is completely full of sample. If split spoon or DPT is used to obtain the samples, collect the 5 gram sample immediately from the core or split spoon at the target location (based on visual observations and PID/FID readings).

Use the edge of the sampling tool (hand auger, lexan tube) to scrape the bottom lip of the Terra Core® sampler so that the soil is flush with the lip. Wipe off all soil or debris from the outside of the Terra Core® sampler. Rotate the plunger that was seated in the handle top 90° until it is aligned with the slots in the body. Place the mouth of the sampler into the 40 ml

VOA vial containing the appropriate preservative and extrude the sample by pushing the plunger down. Quickly place the lid back on the 40 ml VOA vial. When capping the 40 ml VOA vial, be sure to remove any soil or debris from the top and /or threads of the vial. Fill out label on VOA.

The Terra Core® sampler preserved with DI water has to reach the lab to be frozen within 48 hours of collection. Collect the number of VOA vials per sample specified by the laboratory.

# IV. Key Checks and Preventative Maintenance

Check that sample collection is swift to avoid loss of VOCs during sampling.

Double check labels filled out correctly and match log book.

Check the FedEx pick up time for that particular day prior to collection in order to ensure FedEx drop-off can be made with sufficient packing time.

STANDARD OPERATING PROCEDURE B-1

# Groundwater Sampling Procedure
# Low Stress (Low Flow) Purging and Sampling

## I. Scope & Application

This Low Stress (or Low-Flow) Purging and Sampling Procedure is based on the EPA Region II standard method for collecting low stress (low flow) groundwater samples from monitoring wells. Low stress Purging and Sampling results in collection of groundwater samples from monitoring wells that are representative of groundwater conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater. This procedure does not address the collection of light or dense non-aqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only.

## II. Method Summary

The purpose of the low stress purging and sampling procedure is to collect groundwater samples from monitoring wells that are representative of groundwater conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, potentially producing a sample with low turbidity (i.e., low concentration of suspended particles). Second, this procedure minimizes aeration of the groundwater during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of groundwater purged from a well and the costs associated with its proper treatment and disposal.

## III. Addressing Potential Problems

Problems that may be encountered using this technique include:

a. difficulty in sampling wells with insufficient yield;

b. failure of one or more key indicator parameters to stabilize;

c. cascading of water and/or formation of air bubbles in the tubing;

d. cross-contamination between wells.

### A. Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump's intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading of the sand pack. Pumping the well dry should therefore be avoided if possible. If the well is pumped dry, just before the pump is stopped, the tubing should be restricted so that the water does not rush back down the tubing and surge the well. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, groundwater samples may be obtained with other techniques, such as bailing.

### B. Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameter fails to stabilize after approximately 4 hours, one of three options may be considered:

a. continue purging in an attempt to achieve stabilization, especially if stabilization appears imminent;

b. discontinue purging, collect samples, and document attempts to reach stabilization in the log book; or

c. Stop pumping, secure the well. The next day, purge and collect samples, and document attempts to reach stabilization in the log book.

### C. Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8-inch ID) to ensure that the tubing remains filled with groundwater during sampling.

### D. Cross-Contamination

To prevent cross-contamination between wells, in-place pumps can be used. As an alternative, the potential for cross-contamination can be reduced by performing decontamination procedures between sampling of each well (see SOP Decontamination of Personnel and Equipment).

## IV. Planning Documentation and Equipment

- Well construction data, location map, field data from last sampling event, as warranted.
- Polyethylene (or similar) sheeting.
- Flame Ionization Detector (FID) or Photo Ionization Detector (PID) or similar equipment.

- Adjustable rate, positive displacement groundwater sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may be used for inorganic sample collection.
- Interface probe or equivalent device for determining the presence or absence of NAPL, as needed.
- Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material will be available so that each well has dedicated tubing.
- Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).
- Flow measurement supplies.
- Power source (generator, marine battery, etc.).
- Monitoring instruments for indicator parameters.
- Decontamination supplies (see SOP Decontamination of Personnel and Equipment).
- Sample bottles.
- Sample preservation supplies (if necessary).
- Sample tags or labels, chain of custody.
- Equipment failure is a common occurrence and it is difficult to get equipment to Vieques. Consider keeping two functioning sets of equipment on hand. When all equipment is functioning, two teams may be able to sample two wells simultaneously.

# V. Sampling Procedures

## A. Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated groundwater and proceed systematically to the well with the most contaminated groundwater.
2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.
3. Remove well cap, measure and record VOCs in the breathing zone above the well with a PID or FID. Do not take the reading directly above or within the well casing as this air tends to be moisture-laden and may interfere with the instrument reading.
4. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), high point or north side of well casing. Note that the reference point should be surveyed for correction of groundwater elevations to the mean geodesic datum (MSL).
5. Measure and record the depth to water in accordance with *SOP H-2. Water-Level Measurements* in all wells to be sampled prior to purging. Care should be taken to

minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well. Decontaminate water level probe between well locations in accordance with SOP Decontamination of Personnel and Equipment.

6. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the log book.

## B. Sampling Procedures

1. A field log book or groundwater sampling form will be kept each time groundwater monitoring activities are conducted in the field. The field log book or groundwater sampling form should document the following:

   - Well identification number and physical condition
   - Well depth (from well completion records; do not measure depth prior to sampling)
   - Static water level depth (to 0.01 ft), date, time, and measurement technique
   - Presence and thickness of immiscible liquid layers and detection method
   - Collection method and quantity of immiscible liquid layers (if removed from the well)
   - Pumping rate, drawdown, indicator parameters values, and clock time, at approximately 3- to 5-minute intervals
   - Well sampling sequence and time of sample collection
   - Sample identification numbers
   - Field observations of sampling event
   - Name of sample collector(s)
   - Weather conditions
   - QA/QC data for field instruments (often in separate calibration log)

2. Assuming no NAPL is present, install pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well generally to a depth of mid-screen or mid-point of water within the screen in the total depth of the well. Record the depth to which the pump is lowered in the well. In order to minimize the disturbance of sediment when lowering the pump, do not strike the bottom of the well with the pump. Where possible, the pump intake should be kept at least 2 feet above the bottom of the well to prevent disturbance and resuspension of any sediment present in the bottom of the well. Measure and record the depth to water after installing the pump. Use the pre-pump installation water level for drawdown calculations.

3. Purge Well: Purging can be done at flow rates of 200 to 500 milliliters per minute (ml/min). However, if possible, purge the well at flow rates between 100 and 250

ml/min because these are the recommended sampling rates and changing the flow rate between purging and sampling should be avoided, if possible. The water level should be monitored approximately every 3 to 5 minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment. Record final volume of groundwater purged.

4. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters approximately every 3 to 5 minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows:

   ±0.1 for pH
   ±3% for specific conductance (conductivity), except in the cases of very low conductivity, as discussed below
   ±10 mv for redox potential, except in the cases of very positive or very negative values, as discussed below.
   ±10% for DO and turbidity, except in the cases of very low DO and turbidity, as discussed below

   Calculate the differences in the three consecutive readings (i.e., last three readings) as follows:

   For pH, subtract the lowest reading from the highest reading.

   For conductivity, subtract the lowest reading from the highest reading and divide the result by lowest reading (multiply by 100 to get the percent difference).

   For redox potential (ORP), subtract the lowest reading from the highest reading.

   For DO, subtract the lowest reading from the highest reading and divide the result by lowest reading (multiply by 100 to get the percent difference).

   At certain levels of conductivity (very low), redox potential (very positive or very negative), DO (very low), and turbidity (very low), it is not practical, nor is it warranted, to use percent differences to assess stability. For example, it may not be feasible to achieve ±3% specific conductance if conductivity is very low (close to zero), even though the values can be considered stable. For example, a difference in specific conductivity measurements of 0.001 mS/cm and 0.002mS/cm is a 100% difference, but these values should be considered to represent acceptable stability. Another example is turbidity. Below about 30NTU, percent differences should no longer be considered indicators of stability. At 30NTU, a 10% difference is only 3NTU; therefore, any three consecutive turbidity readings below 30NTU can be considered stable.

5. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min (if possible) and such that drawdown of the water level within the well does not exceed a drawdown

of 0.3 ft (if possible). If neither of these is possible due to insufficient well yield, follow the procedures in Section III above. VOC samples must be collected first and directly into sample containers. All sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.

If pumping rates less than 100mL/min are needed to maintain less than 0.3′ of drawdown, consider how long it will take to fill the required bottleware. If it will take an unreasonable duration of time (i.e., greater than approximately 2 hours) to fill the required bottleware, consider documenting an exception to the 0.3′ drawdown goal. Stressing the well by drawing down more than 0.3′ is not ideal, but if all parameters (including drawdown) stabilize at a water level lower than 0.3′ from static, then this will yield a higher-quality sample than pumping to just above the pump intake, allowing the well to recharge, and then collecting a sample without purging or stabilizing. Where filtered metals samples are to be collected, a disposable in-line filter (0.45 micron filter, QED® FF8100 or equivalent) will be added to the end of the discharge tubing and the sample collected using the pressure provided by the pump or use of a peristaltic pump or similar device.

6. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.
7. Close and lock the well.

# VI. Field Quality Control Samples

In accordance with the site-specific QAPP, quality control samples may be collected to determine if sample collection and handling procedures have adversely affected the quality of the groundwater samples.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples may be collected during a sampling event:

- Field duplicates
- Trip blanks for VOCs only
- Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, groundwater samples should be collected systematically from wells with the lowest level of contamination through to wells with highest level of contamination, if known.

# Sample Groundwater Sampling Sheet

CH2MHILL

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 362196.FI.ZZ.01 | CGW1MW02 | SHEET 1 OF 2 |

## GROUNDWATER SAMPLING DATA SHEET

PROJECT : SI/ESI Former VNTR LOCATION : VE-SWMU-1 DATE: 5-4-09

Weather: Fair 78°F

Sample Team: Juan Acaron
Matthew Anderson

Total Depth: 36.67 FT.(BTOC) Measured

Depth to Water: (-) 19.98 FT.(BTOC) Measured

Water Column(h): (=) 16.69 FT.

Water Volume in Well 2.72 GAL (3.141593*h(in)*(wellDIA/2)^2*0.004329)

Pump Depth: 31.5 FT.(BTOC) Measured

Purge Device/Equip: Monsoon Pump

'Measuring Device/Equipment: Heron Dipper T

Date and Time On Well: 5-4-09 1010

Pump Start Date and Time: 5-4-09 1034

Pump Finish Date and Time: 5-4-09 1400

Date and Time Off Well: 5-4-09 1410

Air Monitoring Readings: 0.0 ppm

**Total Purge Volume:** 2.5 **GAL.**

### SAMPLE INFORMATION

Sample ID: VEW01-MW02-0509

Sample Date/Time: 5-4-09 1220

Field Dup: YES/NO ID: ----

FD Sample Date/Time: ----

MS/MSD: YES / NO

Were samples filtered? YES/NO

If YES, Which samples? Filt. Metals

Parameters Collected for VOC, VOC SIM, SVOC, SVOC SIM, Pest., PCB, CN, Total Met, Filt, Met., Explo., Perch.

Parameters Collected for (FD) ----
----

Sample Appearance: Clear

Field Test Kit Details: ----

### FIELD PARAMETERS

| Time | Purged Vol. (gals) | Depth to Water (ft) | Flow Rate (mL/min) | Temp., (°C) | SpCond (uS/cm) w/in 3% | Salinity (ppt) | DO (%) | DO (mg/L) w/in 10% | pH w/in 0.1 | ORP (mV) w/in 10mV | Turbidity (NTU) w/in 10% | Color / Odor / Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1040 | <0.5 | 20.25 | 100 | 26.80 | 4972 | 2.66 | 6.2 | 0.48 | 6.79 | 207.6 | 114 | cloudy |
| 1045 | <0.5 | 20.20 | 100 | 27.08 | 5076 | 2.72 | 3.7 | 0.29 | 6.76 | 217.4 | 110 | |
| 1050 | <0.5 | 20.18 | 100 | 27.23 | 5079 | 2.72 | 2.9 | 0.23 | 6.77 | 225.9 | 76.7 | |
| 1055 | 0.5 | 20.20 | 100 | 27.32 | 5086 | 2.72 | 2.4 | 0.19 | 6.78 | 233.5 | 51.0 | |
| 1100 | <0.75 | 20.20 | 100 | 27.29 | 5095 | 2.73 | 2.2 | 0.17 | 6.78 | 238.1 | 38.2 | |
| 1105 | 0.75 | 20.17 | 100 | 27.31 | 5097 | 2.73 | 2.1 | 0.16 | 6.78 | 243.0 | 23.0 | |
| 1110 | <1.0 | 20.18 | 100 | 27.31 | 5100 | 2.73 | 2.0 | 0.16 | 6.79 | 246.0 | 19.3 | |
| 1115 | <1.0 | 20.19 | 100 | 27.32 | 5099 | 2.73 | 1.9 | 0.15 | 6.79 | 251.0 | 13.3 | |
| 1120 | 1.0 | 20.19 | 100 | 27.38 | 5100 | 2.73 | 1.8 | 0.14 | 6.79 | 255.8 | 11.4 | |
| 1125 | <1.25 | 20.20 | 100 | 27.45 | 5098 | 2.73 | 1.8 | 0.14 | 6.80 | 260.0 | 8.71 | |
| 1130 | 1.25 | 20.21 | 100 | 27.57 | 5099 | 2.73 | 1.8 | 0.14 | 6.80 | 264.1 | 7.26 | |
| 1135 | <1.50 | 20.16 | 100 | 27.65 | 5097 | 2.73 | 1.9 | 0.15 | 6.79 | 266.8 | 6.17 | |
| 1140 | 1.50 | 20.15 | 100 | 28.10 | 5103 | 2.73 | 1.6 | 0.13 | 6.79 | 271.9 | 5.32 | |
| 1145 | <1.75 | 20.20 | 100 | 28.28 | 5098 | 2.72 | 1.6 | 0.13 | 6.79 | 275.4 | 4.98 | |
| 1150 | <1.75 | 20.20 | 100 | 28.08 | 5107 | 2.73 | 1.6 | 0.12 | 6.79 | 279.3 | 4.44 | |
| 1155 | 1.75 | 20.21 | 100 | 27.86 | 5098 | 2.73 | 1.7 | 0.13 | 6.79 | 283.9 | 3.76 | |
| 1200 | <2.0 | 20.21 | 100 | 27.94 | 5093 | 2.72 | 1.4 | 0.11 | 6.80 | 287.0 | 2.85 | |
| 1205 | 2.0 | 20.20 | 100 | 27.89 | 5101 | 2.73 | 1.5 | 0.11 | 6.80 | 289.9 | 2.95 | |
| 1210 | <2.25 | 20.16 | 100 | 27.90 | 5093 | 2.72 | 1.5 | 0.11 | 6.80 | 291.9 | 2.67 | |
| 1215 | 2.25 | 20.18 | 100 | 28.08 | 5092 | 2.72 | 1.5 | 0.11 | 6.80 | 291.9 | 2.32 | clear |
| | | | | | | | | | | | | |

Signature: Juan Acaron Date: 5/4/2009

CH2MHILL

| PROJECT NUMBER | WELL NUMBER | |
|---|---|---|
| 362196.FI.ZZ.01 | CGW1MW02 | SHEET 2 OF 2 |

# GROUNDWATER SAMPLING DATA SHEET

PROJECT : SI/ESI Former VNTR LOCATION : VE-SWMU-1 DATE: 5-4-09

**SOP(s) used (refer to SOPs in back of this log)?** B-1

**Were all requirements of the SAP, PIs and above mentioned SOP(s) met?** See Below.

**Explanation of exceptions to SOP(s)** ***including why, under what conditions, who authorized exception, anything considered in the decision*****:**

1.) Unable to have the purge rate set at the minimum purge rate and attain the 0.3 ft. draw down criteria. Purge rate was still within the sample flow rate allowed. The 0.3 ft. drawdown criteria was met.

2.) The turbidity was not within 10%, but was under 5 NTUs. Under 5 NTUs is considered optimal.

3.) Perchlorate is not being filtered in the field per PC. This method will be lab filtered.

## PHOTO LOG

| Photo Number | Compass Direction | Time | Description |
|---|---|---|---|
| | | | |

Signature: Juan Acaron Date: 5/4/2009

STANDARD OPERATING PROCEDURE C-1

# Calibration and Measurement with Field Instruments

## I. Purpose and Scope

The purpose of this document is to provide standardized procedures for using field instruments to collect measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of liquid sample media (groundwater or surface water). The operator's manual should be consulted for detailed calibration and operating procedures for each specific instrument. This guideline will cover field equipment used on a routine basis for field conditions likely encountered on a Vieques site. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs).

## II. Equipment and Materials

- Instruments to be calibrated (and spares)
- Manufacturer's calibration manual
- Distilled water in squirt bottle
- Calibration Standard Solution(s ) applicable to site conditions and manual

## III. Procedures and Guidelines

### A. Documentation of Field Calibration and Measurements

Document successful calibration and verification for each instrument in the project logbook. This calibration will be linked with the associated sample measurements.

- Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument used.
- Record manufacturer name, model number and identifying number such as a serial number for each instrument.
- Record the time and date of all initial calibrations and all calibration verifications.
- Record the instrument reading (value in appropriate measurement units) of all calibration verifications.
- Record the name of the analyst(s) performing the calibration or verification.

- Document the specific standards used to calibrate or verify the instrument or field test with the following information:
  - Type of standard or standard name (e.g., pH, buffer, isobutylene) and value of standard, including correct units (e.g., pH = 7.0 SU)
  - Document lot number on calibration gas bottle
- Document whether successful initial calibration occurred or failed.
- Document any corrective actions taken to modify instrument performance and date and time of any corrective actions.
- Note any incidence of discontinuation of use of the instrument due to calibration failure.

## B. Instrument Calibration

Prior to each day's use, clean and calibrate the instrument using the procedures described by the manufacturer of the instrument..The following describes typical calibration checks for specific field parameters:

1. pH

   Use at least two standards for initial calibration. One of the standards must be pH 7.0, the other at a value such that it will bracket the anticipated pH of the samples. Always the pH 7 first and rinse the probe between solutions. Follow the manufacturer's calibration instructions specific to your meter.

   Most instruments allow for a two-point calibration and a few models can perform a three-point calibration. Use the appropriate number of standard buffer solutions for calibration. Groundwater is usually between pH 4 and 7 and surface water between pH 7 and 10 (including salt water). Acceptance criteria for initial or continuing calibrations will be Std X – 0.2 < Reading < Std X + 0.2

2. Conductivity

   Check the meter in the field with at least one KCl std with a value close to the conductivity expected in the field. For fresh water groundwater and surface water applications, a standard of 1000 µS (or µmhos) is used while standards of 10,000, 30,000, and 50,000 µS are available for estuarine and marine surface water conditions. Acceptance criterion for this check is that the meter reads in the interval within Std X ± 3% of Std X.

3. Dissolved Oxygen

   Calibrate the meter at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument.

   Allow an appropriate warm up period before initial field calibration. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into the chamber (this

ensures 100% humidity). Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate.

Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table (See FT 1500-1) what the DO should measure. A stable and accurate temperature is required for a valid calibration. The acceptance criterion for DO calibration verification is +/- 0.3 mg DO/L.

The dissolved oxygen probe requires careful attention to the following items:

- Check sensor for bubbles and membrane for wrinkles or tear (before mobilization)
- Always store probe in saturated atmosphere
- Salinity affects DO readings (make correction, if needed)
- Common interferences: reactive gases, chlorine gas and sulfide will cause bias in results

4. Turbidity

This SOP describes the use of true nephelometric measurement which measures the scattering effect that suspended solids have on the propagation of light through a body of water (surface or ground waters). The higher the effect (i.e., intensity of scattered light), the higher the turbidity value. The use of in-situ probes with turbidity sensors (infra-red light source) may be used for screening purposes (e.g., groundwater purge stabilization measurements) only. Do not report their results for regulatory purposes.

Perform an initial calibration verification by reading at least one primary standard as a sample. The acceptance criterion for the initial calibration verification depends on the range of turbidity of the standard value:

- Standard Value = 0.1-10 NTU: the response must be within 10% of the standard;
- Standard Value = 11-40 NTU: the response must be within 8% of the standard;
- Standard Value = 41-100 NTU: the response must be within 6.5% of the standard; and
- Standard Value > 100 NTU: the response must be within 5% of the standard.

Take readings with a turbidimeter using the following procedure:

- Gently agitate the sample and wait until air bubbles disappear.
- Double-rinse the sample cell or cuvette with a small amount of the sample. Discard, and pour an aliquot into the sample cell or cuvette.
- Gently dry out its external surface with lint-free paper.
- Insert the cell in the instrument and read the turbidity directly from the meter display.
- Pour out the sample, double-rinse the cuvette with de-ionized water in preparation for the next sample.

5. Oxidation Reduction Potential (ORP)

   Oxidation Reduction Potential (ORP) is a measurement of the potential for a reaction to occur where a positive value indicates that the water is in an oxidized state or oxygen is present and a negative value is indicative of an anaerobic type environment or reducing condition. Equilibrate the standard solution to the temperature of the sample. Calibrate as follows:

   - Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell). Turn the meter on, placing the function switch in the millivolt mode.
   - Let the electrode equilibrate for several minutes and record the reading to the nearest millivolt. The reading must be within ±10 mV from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.
   - Record the mV reading and temperature in the field notebook.
   - Rinse the electrode with distilled water and proceed with the sample measurement.

### C. Sample Measurement

Obtain readings and record them in the field notebook or sampling log. Watch for potential fouling of probes, high concentrations of odors, drifting of calibrated zero, or other factors that may skew readings. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units for the measurement
- Initials or name of analyst performing the measurement

## IV. Key Checks and Preventive Maintenance

- Refer to operations manuals for recommended maintenance and calibrations and follow them to the extent practical. Note deviations in logbook.
- Clean all instruments when done.

# V. Optional but Suggested Practices

- Have a spare unit readily available in case of an equipment malfunction. Check batteries, and have a replacement set on hand.
- Confirm there is sufficient calibration standard on hand. Compressed gas calibration standards cannot be air shipped to Vieques; they must be shipped to mainland Puerto Rico and either brought over by a subcontractor, or an employee must take the ferry to Puerto Rico and courier them back on the ferry. Confirm there is sufficient supply on hand and write "Empty" on empty cylinders, vent the dregs and throw them away immediately (regular landfill disposal of empty cylinders is acceptable). Segregate "in-use" cylinders.
- Check age date on calibration gas cylinders and vent and dispose of out of date cylinders, reconfirming sufficient supplies on hand.

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STANDARD OPERATING PROCEDURE C-2

# Electromagnetic Induction

## I. Purpose

The purpose of this SOP is to provide general reference information for using electromagnetic induction (EM) methods.

## II. Scope

This SOP provides a description of field procedures, equipment, and interpretation methods necessary to fully utilize this procedure.

## III. Definitions

Conductivity - Ability of a material to transmit an electrical current. Inverse of resistivity.

Horizontal dipole mode - Transmitter and receiver coils oriented vertically.

Vertical dipole mode - Transmitter and receiver coils oriented horizontally.

Vertical sounding - Multiple EM measurements centered at a point with varying coil spacings.

Vertical profiling - EM measurements along a traverse with a fixed coil spacing and coil orientation.

## IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that the project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for ensuring that the personnel operating and interpreting the geophysical data are trained, skilled in that endeavor, so far as to receiving documentation on the training and experience of the operating personnel.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the geophysical technique and equipment to be used. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that the field investigation personnel performing the activities have been briefed and trained to execute these procedures.

Field team - It is the responsibility of the field team to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and the Project Manager. Field personnel are responsible for the proper acquisition of geophysical data.

# V. Procedures

## A. Overview

Electromagnetic Induction (EM) methods are non-intrusive geophysical techniques of measuring the apparent conductivity of the subsurface materials. Electrical conductivity values of subsurface materials are determined by transmitting a high frequency electromagnetic (primary) field into the earth and measuring the secondary electromagnetic field produced by the eddy current. The transmitter and receiver coils do not require direct ground contact thus permitting continuous profiling and rapid data acquisition.

The strength of the secondary field is a function of the inter coil spacing, operating frequency and ground conductivity. The ratio of the secondary to the primary magnetic field is directly proportional to the terrain conductivity which enables direct instrument readout of apparent conductivity values (measured conductivity values are the bulk average conductivity for the area or volume of earth sampled). EM conductivity values are usually expressed in units of milliohms per meter. Conductivity values are converted to resistivity values in ohm-meters by use of the following relationship:

$$\text{resistivity (ohm - meters)} \quad \frac{1{,}000}{\text{EM instrument readout (milliohms per meter)}}$$

The apparent conductivity of the subsurface materials is dependent upon subsurface conditions such as:

- Lithology
- Porosity
- Permeability
- Conductivity of subsurface pore fluids

Changes in these parameters causing measurable variations in electromagnetic conductivity can result from:

- Conductive contaminant plumes
- Abandoned trenches and lagoons
- Lateral changes such as backfill or landfill materials
- Bedrock fracture zones
- Lithological variations
- Buried metallic objects

The sampling depth or depth of investigation is related to the coil spacing and coil mode. The two coil modes used are the vertical dipole mode (coils horizontal) and the horizontal dipole mode (coils vertical).

Two common terrain conductivity meter are EM-31 and the EM-34-3. The EM-31 has a fixed intercoil spacing of 3.7 meters and an effective depth of penetration of approximately 6 meters. The EM-34-3 has two coils which can be separated by 10, 20, or 40 meters and can be oriented in either the horizontal or vertical dipole modes, Intercoil separations increase the effective depth-of investigation as shown below.

| Intercoil Spacing (meters) | Depth of Investigation (meters) | |
|---|---|---|
| | Horizontal Dipoles | Vertical Dipoles |
| 10 | 7.5 | 15 |
| 20 | 15 | 30 |
| 40 | 30 | 60 |

The coil orientation (horizontal or vertical) allows the EM-34-3 to respond to materials of different depths.

Vertical sounding and horizontal profiling are the two EM survey techniques. Vertical profiling is accomplished by multiple measurements about a point with varying coil spacing. Horizontal profiling is performed by making measurements along traverses with a fixed coil spacing. General discussions of electromagnetic induction methods are presented in texts by Grant and West (1965), Telford and others (1976), and Griffiths and King (1981).

## B. Applications and Uses

The measurement of subsurface conductivity at a hazardous waste site provides a valuable contribution to site characterization. The conductivity (resistivity) of the hydrogeologic section is predominantly influenced by the pore fluids. Consequently, conductivity measurements provide indirect information on the porosity and permeability of subsurface materials, the degree of saturation, and the conductivity of the pore fluids. The conductivity of the pore fluid is influenced by the presence of dissolved electrolytes. Contaminant plumes in the unsaturated and saturated zones can be mapped provided there is a sufficient change in the conductivity to be detected by the EM instrument. Generally, contaminant plumes of inorganic waste are easily detected because the pore fluids often have conductivity values as much as three orders of magnitude above background values. EM conductivity measurements can also be used to detect the presence of buried waste; filled disposal trenches, and buried metal objects such as drums, tanks or metal debris. Electromagnetic surveys can be used to locate conductive as well as and non-conductive bodies. The many applications include:

- Contaminant plume mapping
- Locating abandoned trenches and lagoons
- Delineating bedrock fracture zones
- Determining thickness of weathered layers
- Lithology mapping

- Locating buried metallic objects
- Lateral anomalies such as pockets or pits of different materials

Examples of EM applications at sites where groundwater is contaminated are presented by Duran (1982), Greenhouse (1983), and Greenhouse and Slaine (1983).

## C. Equipment

The two-coil EM instrument and the VLF (very low frequency) instrument are basically the two different types of electromagnetic surveying instruments in use; each is capable of sensing to different depths. There are several models and manufacturers of this equipment.

The two-coil system consists of a transmitter coil and a receiver coil. The transmitter coil induces an electromagnetic field of known strength and the receiver coil measures the resulting quadrature, or ratio of primary to secondary fields resulting from subsurface features. Each instrument is read directly in units of milliohms per meter (conductivity). EM readings represent the average bulk conductivity at a point halfway between the two coils.

The VLF instrument is a receiver which relies on specialized, very low frequency communication antennas for induction of an electromagnetic field. Surveying with the VLF or equivalent instrumentation is commonly referred to as VLF surveying.

The VLF Instrumentation is a small, lightweight hand-held instrument which can be operated by one person. Principal components of the instrument are a pair of mutually perpendicular coils and a receiving crystal with a frequency specific to a transmitting antenna. The two receiving coils are used to measure local characteristics of the primary induced field and any secondary fields emanating from bodies of variable conductivity. Typical sources of induced electromagnetic fields for VLF surveying are the very low frequency antennas used for submarine communications.

## D. Data Acquisition

The advantage of the EM survey method is the speed and accuracy with which lateral changes of terrain conductivity can be measured. The EM conductivity data can be acquired using sounding and profiling techniques similar to those used in electrical resistivity. EM profiling is accomplished by traversing an area with a fixed coil spacing and orientation; EM sounding is accomplished by expanding the inter-coil spacings in a manner similar to that used by electrical resistivity soundings. Some commonly used EM equipment is limited in the number of available inter-coil spacings that can be used; however, there are other EM instruments available that can operate at many coil spacings and frequency ranges to provide numerous sounding data points necessary for accurate computer modeling and profiling.

The factors determining which instrument is used and what the grid spacing should be at particular sites are:

- Depth to target and size of target
- Accessibility of the site
- Effects of manmade structures and utilities, such as electric power lines

- Conductivity of the earth materials

EM induction instruments may have a depth of investigation of up to 200 feet depending upon coil spacing and orientations used. The very low frequency VLF device has the greatest depth of investigation and is generally used to evaluate large geologic structures.

In conducting a VLF survey, VLF readings should be acquired with the instrument oriented perpendicular to a straight line from the site to the transmitter antennas. This orientation is necessary to ensure optimum data quality. All readings from a particular VLF station must be obtained with the instrument oriented in the same direction.

For an EM induction survey, a regular pattern of survey stations will provide coverage of the area in question. Typically, use of a grid spacing which is approximately equal to the size of the target sought by the survey, and coil spacing with a maximum response for the depth of interest will produce satisfactory results. Specific needs for local detail, however, may require a refined coverage. The chosen spacing should always be site and target specific.

In conducting an EM survey, the field operator must avoid or note any potential sources of anomalous (noise) conductivity values such as power lines, buildings, fences, buried pipelines or any other large metal objects. Noise sources should be noted on the profiles or contour maps accounting for anomalies due to these known sources.

Important information that should be known for planning and before conducting an EM conductivity survey are: assumed hydrogeologic characteristics of the site, potential source locations and migration paths, characteristics of the hazardous substance of interest, and depths of interest. The level of detail necessary (size of object of interest and detail of resolution) determines the number of lines and station spacings of readings required.

EM data, if not recorded on a strip chart or digital recording instrument, should be recorded on standardized data sheets. At a minimum all data (strip chart, digital disks, or standard forms) should have the following information listed:

- Project/site location identification
- Company
- Date and time
- Operators name
- Instrument make, model
- Coil spacings and configuration
- Line and station numbers
- Instrument reading scales
- Weather conditions/temperature

# E. Interpretation

## 1. Data Analysis

In general, electromagnetic survey data require relatively little processing before they can be interpreted. This is especially true for fixed coil spacing surveys because the data are recorded in units of conductivity; preliminary interpretations are made by comparison of conductivity values. A contour map can be prepared from the data and compared with results of other surveys. EM instruments also can be used for vertical soundings similar to resistivity sounding. Vertical sounding with EM equipment, however, has lower resolution than that performed with the resistivity technique. As a result, EM data are generally more useful for continuous profiling surveys.

VLF instruments do not read directly in units of conductivity. The in-phase measurement (the tilt of primary induced field) is read in terms of the tangent to the angle of tilt and is given as a percentage. Quadrature measurements, which are the ratios of voltage required to equalize the primary to secondary signal strengths, are also given as percentages. For field interpretation these two sets of data can be plotted in profile form, percentage versus distance. Greenhouse and Slaine (1983) describe a simple mathematical conversion so that VLF data can be presented in contour format and compared to other available data such as resistivity and magnetics. Digital data acquisition systems are now available that allow calculation of conductivity.

## 2. Presentation of Results

Results of an EM conductivity survey can be presented in profile and/or contour map form. The orientation of the traverses should be indicated on profiles in lines of coverage on contour maps. Locations of observed surface metal and other cultural features such as topography, buildings, fences, power lines etc. should be noted on both the profiles and the contour maps.

## 3. Interpretation

EM conductivity data can be analyzed qualitatively and quantitatively. Generally, profiling data are presented as a contour map or profiles. Profile lines should be stacked and aligned. A qualitative analysis of the contour map or aligned profiles usually can allow an interpreter to identify any conductivity trends that may be indicative of buried metal, groundwater flow and contaminant transport. A comparison of available geologic data, cultural ferrous metal and debris maps prepared during data acquisitions should be made to evaluate the causes of any conductivity trends observed.

Computer or chart comparisons of EM sounding data with available theoretical models can be made. This type of interpretation is similar to that used in electrical resistivity, but in EM sounding it is limited to relatively simple hydrogeologic conditions.

# F. Advantages and Limitations

Advantages of the electromagnetic induction method include:

- No ground contact required
- Rapid data acquisition (faster than resistivity)

- Lightweight, one or two man operation
- Wide range of applications
- High lateral resolution
- Field interpretation possible

Limitations of the electromagnetic induction method include:

- Limited dynamic range l-1,000 milliohm/meter
- Susceptible to effects of man-made structures, utilities, etc.
- Less vertical resolution than resistivity
- Limited penetration
- Does not distinguish even simple layering without more complex application and interpretation
- Setting and maintaining instrument at zero

# VI. Quality Assurance Records

Field data will be recorded in log books and/or data recording sheets accompanying the monitoring equipment. Data recorded in a field log book will be entered with the following data: date, site location, Contract Task Order number, personnel conducting the investigation, time (military time), start time and end time, weather.

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STANDARD OPERATING PROCEDURE C-3

# Magnetometry

## I. Purpose

This SOP provides general reference information and standard techniques for using magnetometry.

## II. Scope

This SOP provides a description of the field procedures, equipment, and interpretation methods necessary to fully utilize this procedure.

## III. Definitions

Diurnal variations - daily changes in the total magnetic field strength due to solar activity and which (may be as large as 100 gammas or more)

Gradient - change in magnetic field strength in a given vertical or horizontal distance

Magnetic storm - sudden and simultaneous variations of up to several hundred gammas throughout the world. Magnetic storms can occur as often as several times a month and can last one to several days.

Total magnetic field intensity - a scaler measurement of the magnitude of the earth's magnetic field vector independent of its direction.

## IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that the project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for ensuring that the personnel operating and interpreting the geophysical data are trained, skilled in that endeavor, so far as to receiving documentation on the training and experience of the operating personnel.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the geophysical technique and equipment to be used. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that the field investigation personnel performing the activities have been briefed and trained to execute these procedures.

# V. PROCEDURES

## A. Overview

Magnetic surveying is a passive geophysical technique which measures the strength of the earth's magnetic field. The earth's field is a vector quantity having a unique magnitude and direction at every point on the earth's surface. A magnetometer is the instrument which measures the magnetic field strength in units of gammas or nanoteslas. In order to recognize a magnetic anomaly, it must be several times larger than the background noise level along that profile. Buried ferrous metal objects such as steel drums or tanks cause local variations or anomalies in the earth's magnetic field that can be detected by a magnetometer. Geologic features such as igneous intrusion or iron rich sands can also be mapped using magnetic surveying.

The earth's magnetic field is not completely stable. It undergoes long-term (secular) variations over centuries; small, daily (diurnal) variations (less than 1% of the total field magnitude); and transient fluctuations called magnetic storms resulting from solar flare phenomena. Both naturally-occurring and manmade magnetic materials can modify the earth's magnetic field locally.

Analysis of magnetic data by an experienced geophysicist can provide an estimate of the areal extent and quantity of buried ferrous objects. Depth of burial approximations can be made using graphical methods of interpretation such as slope techniques and half-width rules as described in Nettleton (1976).

## B. Application and Uses

Buried ferrous metal objects such as pipelines, barrels, tanks, etc., generally produce a perturbation in the earth's naturally occurring magnetic field. The size (amplitude) of this perturbation is related to the size of, distance to, susceptibility and remnant magnetization of the buried object. The magnetic survey method, therefore, is a useful tool for site studies to locate and identify buried ferrous metal. Non-anomalous magnetic data acquired over EM conductivity anomalies is an indication of the existence of buried conductive, non-ferrous metal (copper, aluminum, brass) objects.

Magnetic data also can be helpful in determining the size and geometry of geologic features such as fault zones, mineralized zones, and bedrock valleys and depressions. These features are characterized generally by longer wavelength anomalies and are readily distinguishable from anomalies associated with buried metal. In many areas, such geologic features may control or affect the direction and magnitude of groundwater flow.

The total field proton precession magnetometer, the fluxgate magnetometer, and the magnetic gradiometer are commonly used magnetometers in environmental site investigations. The total field proton precession magnetometer is the most commonly used magnetometer because they are easy to operate, have no instrumental drift, and can acquire data rapidly. The fluxgate magnetometer can better define the boundaries of buried ferrous objects than the proton precession magnetometer but is subject to instrument drift, and needs to be exactly oriented. Magnetic gradiometer measurements enhance anomalies resulting from shallow magnetic sources.

## C. Equipment

Magnetometers commonly used in hazardous waste site investigations include the total field proton procession magnetometer, the flux gate magnetometer, and the magnetic gradiometer. Text books such as Telford (1976) and Nettleton (1976) discuss in detail the operation and construction of these and other magnetometers.

The total field proton procession magnetometer is the most commonly used magnetometer in hazardous waste investigations. This instrument utilizes the precession of spinning protons of hydrogen atoms in a sample fluid (kerosene, alcohol or water) to measure the total magnetic field intensity. Total field proton precession magnetometers are portable and do not require precise orientation and leveling; the sensor must be oriented with one side facing approximately north and the sensor held stationary during the cycling period. Proton precession magnetometers have no instrument drift, do not require calibrations, are easy to operate, and have an accuracy of 0.1 gamma. Most modern proton precession magnetometers have digital readouts and electronic storage of data.

Vertical magnetic gradiometers are magnetometers that measure vertical differences of the earth's total magnetic field. Gradient measurements enhance magnetic anomalies resulting from near surface magnetic source and discrimination between neighboring magnetic anomalies is also enhanced. These measurements are generally made using an instrument similar to a total field magnetometer that has two or more sensors mounted on a staff. The sensors are vertically separated by a constant distance, usually one to three feet. Gradient readings are adversely affected by ferrous metal surface debris since signals from this surface debris are also amplified. Consequently, removal of surface metal should be considered before conducting a gradiometer survey.

The flux gate magnetometer was developed during World War II as a submarine detector. Text books such as Telford (1976), RAO and Murthy (1978) explain in detail the principals of operation of the flux gate magnetometer. A fluxgate magnetometer can define the boundaries of regions of buried ferrous metal objects more precisely than the proton precession magnetometer. There are several sources of errors in flux gate magnetometers including unbalance in the two coils, thermal and shock noise, circuit drift and temperature sensitivity. The advantages are direct readout, no azimuth orientation, coarse leveling required, light weight and portability (Telford, 1976).

## D. Field Procedures

Magnetic data are generally acquired at relatively close station spacings (5 to 50 foot intervals) along closely spaced (10 to 50 feet) parallel survey lines.

Magnetic data can be acquired in a rectangular grid pattern or along traverses. Grid data are readings acquired at the nodes of a rectangular grid; traverse data is acquired at fixed intervals along a line. Traverse data is often preferable to grid data because it generally is less expensive to acquire (heavily vegetated sites require time consuming brush cutting to establish a complete grid) and more useful for interpretation than an equal number of grid readings. Traverse lines generally ought to be oriented in a north-south direction so that the maximum amplitude of an anomaly can be detected. However, line orientations are often more dependent on site obstacles and sources of magnetic noise.

Station and line spacing intervals are determined on the basis of the desired resolution of the survey. If individual drums or clusters of deeply (greater than 25 feet) buried drums are the objective of the survey, then a detailed magnetic survey with relatively close station spacings (approximately 5 to 10 feet) and line spacings (approximately 10 to 25 feet) should be used. If large metal objects such as 10,000 gallon tanks or trenches filled with barrels are the objective of the magnetic survey, then a reconnaissance or screening survey with longer station spacings (25, 50, or 100 feet) and line spacings of (25, 50, or 100 feet) may be appropriate.

In conducting a survey, the field operator must avoid or note any sources of high magnetic gradients and alternating currents, such as power lines, buildings, and any large iron or steel objects. It is also important that the operator be relatively free of magnetic materials on his/her person and the magnetometer sensor be kept clean to avoid possible magnetic-bearing soil. Periodically during a survey, and particularly when an anomaly is detected, it is important to establish that the magnetometer is providing valid readings and not random, meaningless instrument noise. The simplest means of verifying magnetometer field readings is to take several successive readings at one location. These readings should repeat to within ± 1 gamma. Readings are taken at predetermined intervals which depend on the nature of the survey and which may have to be modified depending on the gradients encountered. For detailed surveys, a base station or the reoccupation of a set of stations several times a day or a continuous monitoring station (within 100 miles) is established to check for diurnal variations and magnetic storms. At the height of a magnetic storm, magnetic surveying may be impractical due to the large instantaneous changes in the total magnetic field.

## E. Interpretation

### 1. Data Analysis

Magnetic data can be corrected for diurnal variations; however, diurnal changes are generally very gradual and linear and should not have the extreme fluctuations associated with buried ferrous metal objects. Magnetic data can be plotted in profile form or contoured depending upon the survey coverage. Noise sources (surface ferrous metal objects, fences, power lines, etc.) should be noted on the profiles or contour map so that anomalies due to these known sources can be accounted for. The amplitudes of similar sized surface metal objects should be compared. If similar sized ferrous metal surface objects have extremely different anomaly amplitudes, it may be an indication that buried ferrous metal objects exist in the vicinity of the higher amplitude anomalies.

### 2. Presentation of Results

The results of a magnetic survey should be presented in profile and/or contour map form. The orientation of the traverses should be indicated on profiles and lines of coverage on contour maps. Locations of observed ferrous metal and other cultural features (hills, valleys, streams, etc.) should be noted on both the profile and the contour maps.

### 3. Interpretation

Magnetic anomalies can be analyzed both qualitatively and quantitatively. The shape and gradient of an anomaly (slope, wave-length, amplitude, etc.) contains enough information to draw qualitative conclusions regarding the location and depth of the causative source.

Quantitative computer modeling interpretations of magnetic data are complicated both by the inherent complexity of dipole magnetic behavior and by the fact that a number of different types and configurations of sources can cause the same anomaly. Where the properties of the earth's field and the local geologic materials (inclination, declination, susceptibility, and remnant magnetization) are well known, reasonable assumptions regarding the nature of the source- can be made, and a fairly accurate model of the source generally can be derived.

### F. Advantages and Limitations

Advantages of the magnetic survey method include:

- Rapid operation
- Low expense
- Identification of buried metal (ferrous)
- Sensitivity to small ferrous objects

Limitations of the magnetic survey method include:

- Susceptible to effects of manmade structures, utilities, buildings, fences, etc.
- Detection is limited to the distance to and quantity of ferrous metal present

## VI. Quality Assurance Records

All data will be recorded in log books and/or data logging sheets designed for this procedure. All data will be entered with the following basic information: date, start and end times (military time), location, personnel on site, Contract Task Order number, and weather.

## VII. References

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STANDARD OPERATING PROCEDURE D-1

# Monitoring Well Installation

## I. Purpose and Scope

This document provides site personnel with a review of the well installation procedures for unconsolidated and bedrock wells. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

## II. Equipment and Materials

1. Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite, grout, and surface-finish materials)
3. Boring logs, well completion diagrams, field logs, field decontamination equipment

## III. Procedures

### A. Guidelines

- Screen depths will be based on site-specific information and project-specific goals, and discussed in the project-specific SAP. Screen depths will be designed based on the depth of known or anticipated contamination, the type of contamination, etc. In general, 10-foot screens will be placed at the first encountered groundwater (i.e., across the top 10 feet of the water-bearing unit), unless site-specific information or project-specific goals suggest screening a different interval (check project-specific SAP). For wells where floating product is anticipated or detected during drilling, the well screen should be installed across the water table.
- Threaded connections will be water-tight. No glues can be used to make well casing connections.
- Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will generally be 5 to 10 feet in length depending on target saturated interval. The exact slot size and length will be determined by the project objectives and site conditions. Stainless steel may be required under certain contaminant conditions.
- Above ground completion wells will have at least one concrete filled bollard built within the proximity the pad, if not built into the right of way (ROW) of a road.
- A record of the finished well construction will be compiled.

- All soils and liquids generated during well installations will be containerized for proper disposal.

## B. Monitoring Well Installation

- Monitoring wells will be installed in at least 6-inch-diameter boreholes and if completed in augers, a minimum of 6-inch ID augers to accommodate well completion materials.
- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer, if the confining layer thickness permits. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).
- Monitoring wells in unconsolidated materials will generally be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC screen with threaded bottom plug and riser.
- Screens will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, well-rounded siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.
- The filter sand pack (typically Morie #2) will extend from approximately 1 to 2 feet below the base to approximately 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack may be placed using a tremie pipe and flowing water.
- Annular well seals will consist of a minimum of 2 feet of pelletized or granular bentonite clay placed above the filter pack. If necessary, the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A high-solids bentonite slurry introduced with a side-discharging tremie pipe may be used instead of solid bentonite for the bentonite seals in wells greater than 30 feet deep. High-solids slurries will have solids content of at least 20 percent.
- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 30 minutes before work in the well continues.
- The annular space above the bentonite seal will be filled to near grade with a cement-bentonite slurry grout mixture.
- The grout mixture will consist of approximately 94 pounds (lbs) of cement (1 bag) per 6 gallons of water and 2 to 3 lbs of powdered bentonite per bag of cement to reduce shrinkage. The grout mixture will be thoroughly mixed before pumping down-hole.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; if not poured into the annular space, the method of grout placement must force grout from the

bottom of the space to be grouted to the near-surface, using a j-fitting or disperser at the base of the tremmie pipe to avoid jetting the grout through the bentonite seal.

- After allowing the grout to settle and set up overnight, additional grout may be added to maintain near-grade, while allowing room to build the protective casing.

## C. Surface-Casing Installation

- Surface casings will be constructed of minimum 6-inch ID steel with a minimum wall thickness of 0.20 inches or Schedule 80 PVC. Casing lengths for permanent surface casings will be welded or connected by threaded connections sealed with Teflon tape, while casing lengths for temporary surface casings will be either threaded connections or drilling casing installed as part of the rotary-drilling method. The steel casing and threaded couplings must be free of paint, varnish, or coatings of any kind, both inside and outside. Threaded connections must be free of oils or grease. Welding of the casing is permissible provided that the welds meet the Standards of the American Welding Society.
- Surface casings will be installed approximately 5 feet into a confining layer, if adequate thickness is available.
- Permanent surface casings will be placed in the bottom of the borehole and the surface casing will be pressed into the clay (if present). The surface casing will be grouted in place by installing the grout through a tremie pipe from the bottom of the annulus to the ground surface.
- Alternatively, the surface casing may be installed and grouted in place by a grout displacement method. The bottom of the surface casing is fitted with a tight, drillable plug. The borehole is then filled with the estimated volume of cement-bentonite grout to fill the annular space, and the casing is lowered to the bottom of the borehole (displacement method). If the weight of the casing is not sufficient to displace the grout and allow the casing to sink to the bottom of the borehole, the casing may be filled with potable water.
- Well installation will proceed in the surface casing once the grout has been allowed to set up for approximately 16 to 24 hours. All water in the surface casing will be removed before drilling resumes in order to prevent carrying the water downward into the water-bearing unit below the confining unit. Unless derived from the grout displacement method, all water in the casing will be disposed of according to the Master Waste Management Plan.
- Temporary surface casing installed independently of the drilling process will be placed in the bottom of the borehole and the surface casing will be pressed into the clay (if present). However, it will not be grouted into place.

## D. Bedrock Drilling

- If there is the potential for there to be contamination in the unconsolidated water-bearing unit and where there is no confining unit between the unconsolidated water-bearing unit and the bedrock water-bearing unit, the borehole will be advanced several feet into the bedrock in order to install a surface casing. The borehole will be of

sufficient diameter (at least 8 inches ID) so that a minimum 6-inch ID surface casing can be installed into the borehole. Once the borehole is drilled, the surface casing is installed as per the procedure described in the Section C above.

- Air-rotary or air-hammer drilling techniques will be used to install wells into bedrock boreholes. The minimum bedrock borehole diameter for well completion is 6 inches.

### E. Well Completion

- For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend approximately 2 feet above ground and approximately 1 foot into the ground but will not penetrate the bentonite seal. The upper edge of the monitoring well casing should stick up very slightly into the opening of the protective casing cap to prevent having to reach down into the protective casing to unscrew the cap. The space between the protective casing and the well should be filled with clean sand to prevent creating insect habitat, to avoid a space that keys can be dropped into, and to allow the protective casing to be reused if the well is abandoned. The concrete pad will be square (up to 36 inches on each side), poured into wooden forms, and sloped away from the protective casing.
- Guard posts may be installed in high-traffic areas for additional protection. If installed immediately adjacent to the well, they may be constructed through the concrete pad. At least one steel guard post will be installed near the protective casing. Guard posts will be concrete-filled, at least 3 inches in diameter, and will extend approximately 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with a primer and epoxy paint to prevent rust.
- For monitoring wells that are flush-mount, the protective cover will contain a Morrison 9-inch or 12-inch 519 manhole cover or similar, a rubber-sealed cover, and a drain. The top of the manhole cover will be positioned approximately 1 inch above grade. A concrete pad, up to 3 feet in diameter, will be installed as a concrete collar surrounding the protective cover, and will slope uniformly downward to the adjacent grade. The protective cover and installation thereof will be of sufficient strength to withstand normal vehicular traffic. Do not install a guard posts in the road right-of-way.
- Concrete pads will be approximately 6 inches below grade, approximately 12 inches thick at the center and taper to approximately 6 inches thick at the edges. Slope the surface of the pad away from the protective casing to prevent water from pooling around the casing.

## IV. Attachments

- Monitoring Well construction schematic diagram
- Schematic diagram of double-cased monitoring-well construction

# V. Key Check and Items

- Ensure that all downhole equipment is properly decontaminated, as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the wells.
- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.
- As applicable, secure boreholes every night as drilling continues, and lock wells as soon as wells are completed using the standard key-alike locks.
- Confirm drillers have sufficient drums to contain cuttings and water.

Typical well completion diagrams follow

CH2MHILL

| PROJECT NUMBER | WELL NUMBER<br>SHEET 1 OF 1 |
|---|---|

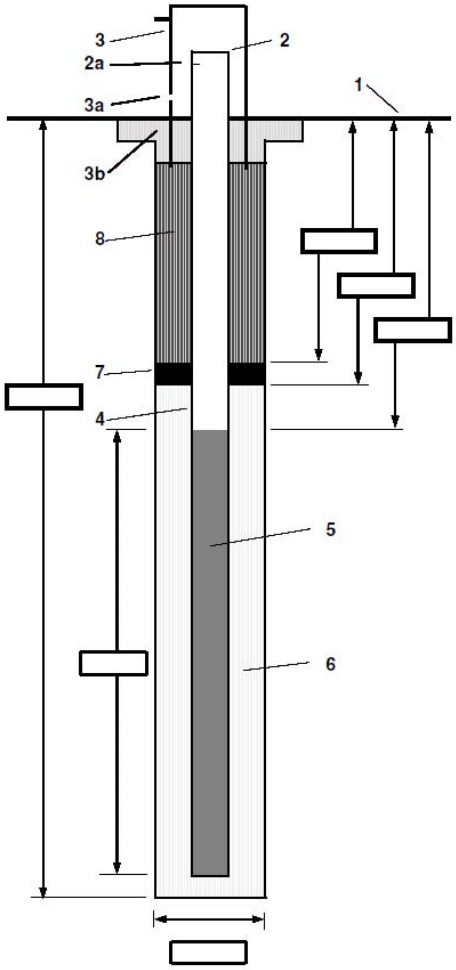
# WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :




1- Ground elevation at well _____

2- Top of casing elevation _____
   a) vent hole? _____

3- Wellhead protection cover type _____
   a) weep hole? _____
   b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Type/slot size of screen _____

6- Type screen filter _____
   a) Quantity used _____

7- Type of seal _____
   a) Quantity used _____

8- Grout
   a) Grout mix used _____
   b) Method of placement _____
   c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments _____

CH2MHILL

| PROJECT NUMBER | WELL NUMBER<br>SHEET 1 OF 1 |
|---|---|

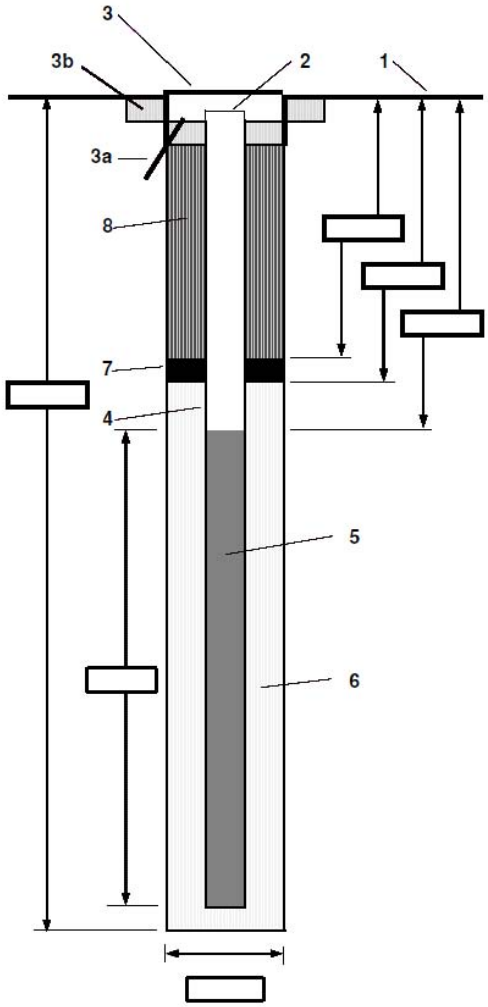
# WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :




1- Ground elevation at well _____

2- Top of casing elevation _____

3- Wellhead protection cover type _____
a) drain tube? _____
b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Type/slot size of screen _____

6- Type screen filter _____
a) Quantity used _____

7- Type of seal _____
a) Quantity used _____

8- Grout
a) Grout mix used _____
b) Method of placement _____
c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments _____

CH2MHILL

| PROJECT NUMBER | WELL NUMBER<br>SHEET 1 OF 1 |
|---|---|

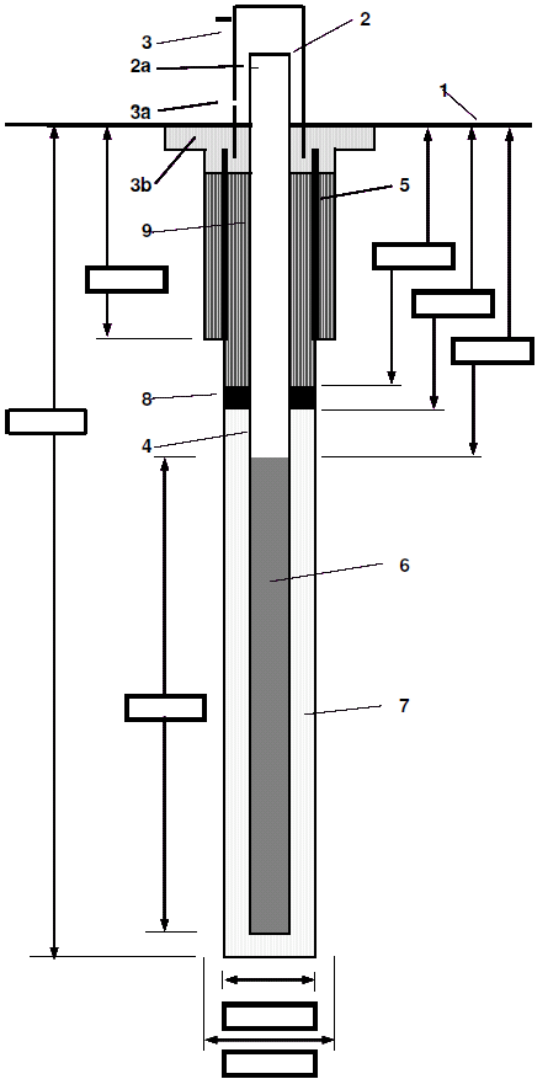
# WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :




1- Ground elevation at well _____

2- Top of casing elevation _____
   a) vent hole? _____

3- Wellhead protection cover type _____
   a) weep hole? _____
   b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Dia./type of surface casing _____

6- Type/slot size of screen _____

7- Type screen filter _____
   a) Quantity used _____

8- Type of seal _____
   a) Quantity used _____

9- Grout
   a) Grout mix used _____
   b) Method of placement _____
   c) Vol. of surface casing grout _____
   d) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments _____

STANDARD OPERATING PROCEDURE D-2

# Monitoring Well Development

## I. Purpose and Scope

This standardized procedure describes the methods used to develop monitoring wells so as to allow for the collection of representative water samples for analysis. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

## II. Equipment and Materials

- Surge block and enough pipe to reach the bottom of the well plus 2 feet.
- Well-development pump (GeoSub, whale pump or other disposable non reactive pump) with the appropriate power supply.
- Enough tubing to reach the bottom of the well plus 8 feet.
- Calibrated meters to measure turbidity, pH, temperature, specific conductance, oxygen reduction potential (ORP), and dissolved oxygen of development water.
- Water level indicator.
- Containers (e.g., department of transportation-approved 55-gallon drums, water transportation carboys, or 5-gallon buckets with lids) for water produced from well.

## III. Procedures and Guidelines

### A. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized.

Lower the surge block to the bottom of the well, threading together each length of pipe as it is lowered. Once the surge block is resting on the bottom, gently surge the block up and down a couple of inches to move the silt/sand into the water column. After several small surges, begin surging the entire screen at least 10 times. Make sure the surge block is not so tight a fit as to damage the screen.

Remove the surge block and lower the pump into the well to the water's surface. Turn the pump on, and continue to lower the pump to just above the bottom of the well. Take care not to allow the pump to contact the well bottom as it may clog the pump with fines. Raise and lower the pump for several minutes to try to remove the bulk of the sand and the silt in

the water column. After several minutes, lower the pump to 6-8" above the bottom of the well and continue to pump.

During pumping, take measurements of depth-to-water, turbidity, pH, temperature, and specific conductance and record in the logbook or well-development log. When taking analytical measurements, avoid moving the hose connecting the pump and the flow through cell. Moving the hose will disturb any sediment that has accumulated along the hose, which may give falsely higher than actual NTU readings, and possibly affecting other parameters.

Continue to develop the well by alternately surging and pumping and monitor the water for pH, turbidity, specific conductance and temperature. When the turbidity (using a target turbidity of less than 5 NTUs) and the other parameters have stabilized for at least three consecutive readings (pH within 0.1 units, temperature within 1°C, specific conductivity within 3%), discontinue development.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Solids and water generated during well development and decontamination fluids will be contained and managed as detailed in the Master Waste Management Plan.

### B. Other Development Methods

Backwashing and bailing may be used in specific circumstances as discussed below. Use of backwashing should be limited only to the water removed from the well, and is used to "pinpoint" a small area of the screen that appears especially in need of development (i.e., that produces substantial silt or fine sand even after the rest of the screen appears developed). Backwash by allowing the pumped water in the tubing to backflow down the tubing back into the well.

Bailing shallow (less than approximately 15 feet bgs), slow recharging, or small diameter wells that have a high potentiometric surface may be preferred over pumps. It is suggested that the well is still surged for 10 to 20 minutes prior to bailing it. The bailer itself acts to a limited extent as a surge block; however, because the outside diameter of the bailer is still smaller than the inside diameter of the well, it is much less effective. Allow the bailer to come to rest on the bottom before retrieving it so as to remove the most amount of sediment from the well. Performing short, rapid, upward and downward motions, allowing the bailer to return to the bottom with each stroke may allow the bailer to entrain more bottom sediment.

Complete well development, decontaminate equipment, and manage purged solids/water and decontamination fluids as defined above in Section III.A.

## IV. Attachments

Well development log

# V. Key Check and Items

- New monitoring wells will be developed after the well has been installed and the grout has cured (at least 24 hours).
- Make sure surge block is not so tight that it damages the screen when surging.
- If information is available, begin developing in the least-contaminated well first.
- If backwashing to develop the well is required, pipes and pumps should not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.

CH2MHILL

| PROJECT NUMBER | WELL NUMBER<br>SHEET 1 of |
|---|---|

# WELL DEVELOPMENT LOG

PROJECT : LOCATION : DATES:

DEVELOPMENT CONTRACTOR : CH2M HILL

DEVELOPMENT METHOD AND EQUIPMENT USED :

START WATER LEVELS : START Date/Time: END Date/Time: LOGGER :

MAXIMUM DRAWDOWN DURING PUMPING:

RANGE AND AVERAGE DISCHARGE RATE:

TOTAL QUANTITY OF WATER DISCHARGED (gal):

DISPOSITION OF DISCHARGE WATER:

TOTAL DEPTH OF WELL:

| Time | Water Volume Discharged (gal) | Water Level (ft BTOC) | Turbidity (NTU) | Temperature (°C) | pH | Conductivity (µmhos/cm) | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

CH2MHILL

| PROJECT NUMBER | WELL NUMBER<br>SHEET 2 of |
|---|---|

# WELL DEVELOPMENT LOG

PROJECT : LOCATION : DATES:

| Time | Water Volume Discharged (gal) | Water Level (ft BTOC) | Turbidity (NTU) | Temperature (°C) | pH | Conductivity (µmhos/cm) | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

CH2MHILL

| PROJECT NUMBER | WELL NUMBER<br>SHEET 3 of |
|---|---|

# WELL DEVELOPMENT LOG

PROJECT : LOCATION : DATES:

| Time | Water Volume Discharged (gal) | Water Level (ft BTOC) | Turbidity (NTU) | Temperature (°C) | pH | Conductivity (µmhos/cm) | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

STANDARD OPERATING PROCEDURE D-3

# Monitoring Well and Borehole Abandonment

## I. Purpose and Scope

This procedure outlines equipment and standardized procedures that will be used for abandoning monitoring wells and boreholes. Temporary or permanent monitoring wells or boreholes may be abandoned, or sealed, in order to prevent the borehole or well from as acting as a conduit and/or to prevent cross contamination between hydrogeologic units. Abandoning surface casings installed for double-cased wells also is discussed. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

## II. Equipment and Materials

- Drilling rig with appropriate equipment.
- Pure, additive-free powdered bentonite for grout.
- Cement-bentonite grout. Proportion approximately 6 to 8 gallons of water per 94-pound bag of Portland cement; approximately 3 to 5 pounds of bentonite added per bag of cement to reduce shrinkage.
- Grout mixer/pump with tremie pipe.
- Department of transportation approved containerization for well riser, casing, and/or cuttings produced if riser and casing are removed and for water displaced from the well, borehole, or surface casing during abandonment.

## III. Procedures and Guidelines

Boreholes and monitoring wells may be abandoned in place using grout. Wells may also be abandoned by removing the well and sealing any remaining open borehole. Surface casings may be abandoned by similar means. Prior to any abandonment, obtain construction information pertaining to the well. Have this information readily available at the respective well abandonment.

### A. Abandoning the Well in Place

Monitoring wells constructed with an impermeable annular space seal may be abandoned by filling the well in place with a cement-bentonite grout.

1. Prior to sealing, the monitoring well stick-up or flush mounted protective cover and ground surface seal (and protective bollards) shall be removed and the well riser will be cut off approximately 30 inches below the ground surface.

2. Monitoring wells will be filled with bentonite-cement grout. More than one pour may be required to fill the well if the grout settles. For boreholes used for sample collection, bentonite-cement grout will be used to fill remaining annular space to near-surface following backfilling with soil cuttings.
3. A gravity-fed or pumped tremie pipe may be used to abandon boreholes or monitoring-wells deeper than 30 feet or boreholes with standing water if the potential for bridging of the grout is a concern. For monitoring wells and boreholes greater than 100 feet in depth, bentonite-cement grout shall be delivered by pumping through a tremie pipe.

## B. Well Riser Removal and Sealing the Remaining Borehole

Monitoring wells that are not constructed with an impermeable annular space seal or are otherwise deemed appropriate to remove (e.g., very shallow and easily pulled) will be abandoned by pulling the well, if possible, or drilling out the well and then sealing the remaining borehole.

1. Prior to abandonment, the monitoring well stick-up or flush-mounted protective cover and ground surface seal (and protective bollards) will be removed.
2. The well may be removed by pulling the casing or by over-drilling around the casing and then removing it from the ground. Over-drilling is not the preferred method because it will likely result in generation of soil cuttings that may require management as waste. However, over-drilling may be necessary if the well cannot be pulled from the ground and abandoning the well in place has been eliminated as an option. It is noted that pulling the well and over-drilling may result in some well casing remaining in the borehole.
3. After the well casing is removed or drilled out, the remaining borehole will be sealed according to Section A.2 above.
4. If possible, decontaminate the well casing and dispose of as normal trash. If possible, reuse or recycle protective casing, protective bollards, and concrete.

## C. Surface Casing Removal and Sealing the Remaining Borehole

1. A decision must be made as to whether or not to remove the surface casing. The assumption is that the surface casing does not fully penetrate the confining layer into which it is set, so it is often appropriate to leave it in place and abandon the well inside of it. The available information on the surface casing and its age and appearance should be considered in making this decision.
2. Any work to abandon the surface casing will be done after the well riser and screen have been removed and the borehole grouted up to the bottom of the surface casing.
3. If the decision is made to leave the casing, it can be grouted up according to Section A.2 above and the aboveground part of the surface casing and any concrete pad removed.
4. If the decision is made to remove the surface casing, either over-drill or pull the surface casing. The remaining borehole then is sealed according to Section A.2 above.

# IV. Attachments

None.

# V. Key Checks and Items

- If possible, obtain the construction details of the well, surface casing, or borehole so that abandonment decisions can be tailored.
- If well depth is such that potential bridging of grout is a concern, use a tremie pipe to ensure proper placement of grout (from the bottom up).
- Control investigation derived waste.
- For wells, submit well abandonment letter to EQB with well coordinates and abandonment procedure.

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STANDARD OPERATING PROCEDURE D-4

# Temporary Injection Points

## I. Purpose and Scope

Provide guidelines for installing subsurface temporary injection points for injection of soil treatment fluids.

## II. Equipment and Materials

- Personal Protection Equipment
- Geoprobe or direct push rig with the capability of installing well screen and riser
- 1-inch ID schedule 40 PVC
- 1-inch 0.020-inch factory slotted screen

## III. Procedures and Guidelines

All personnel shall be wearing PPE per HASP. Decontaminate all equipment per SOP "*Decontamination of Drilling Rigs and Equipment*." Locate and record the injection point in the logbook. Draw a diagram of the injection point array and local landmarks with sufficient angle and distance measurements to permanently fixed objects that the location of the injection array can be re-established later if needed. On completion and abandonment of borehole, install PVC stake identifying the location for future reference.

Using a Geoprobe/direct push rig, push 3.5-inch rods down to the bottom depth of the interval to be injected. Install 1-inch ID screen and riser. The screen interval should fully penetrate the interval to be injected. Use a Morie number 2 sand or equivalent to backfill the screen zone to approximately 2 feet above the screen zone. Install a bentonite seal from the top of the filter pack to approximately 2 feet above the top of the filter pack. Install a bentonite cement grout from the top of the bentonite grout seal to just below ground surface. A flush mount protective casing or secure vault will be installed to secure the injection point.

## IV. Key Checks and Preventative Maintenance

- Thorough decontamination of all equipment.
- Make sure well materials don't bridge. Measure volumes installed, and calculate borehole volume to confirm no bridging. Measure well materials in the borehole as they are installed.

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STANDARD OPERATING PROCEDURE E-1

# Decontamination of Personnel and Equipment

## I. Purpose and Scope

This standard operating procedure (SOP) provides standardized procedures for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments. Any project required deviations from SOPs, will be provided in site specific sampling and analysis plans (SAPs).

## II. Equipment and Materials

1. Potable water from a municipal water supplier.
2. ASTM Type II reagent water with analysis certification.
3. Soap solution, such as 2.5% (W/W) Liquinox, or Alconox.
4. 10% solvent such as methanol, isopropyl, hexane or other approved solvent (DO NOT USE ACETONE). Pesticide-grade solvents will only be used if directed by project-specific SAPs.
5. Large plastic pails or tubs, scrub brushes, squirt bottles for soap and solvent solutions, plastic bags and sheets.
6. Department of transportation approved 55-gallon drum for disposal of waste (if required)Personal protective equipment (PPE).

## III. Procedures and Guidelines

### A. Personnel Decontamination

This is a guide, and may be modified if the contamination is less or more than what is required here.

- Only if there is gross contamination present that cannot be removed using the procedures below should the PPE be disposed of with investigation derived waste (IDW).
- Wash boots in soap solution and rinse with water. If disposable latex booties are worn over boots in the work area, rinse with soap solution, remove, and discard with normal trash.
- Wash outer gloves in soap solution, rinse, remove, and discard with normal trash.
- Remove disposable coveralls ("Tyveks"), wash any obvious dirt or contamination off with soap solution, rinse, and discard with normal trash.

- Remove respirator (if worn).
- Remove inner gloves and discard with normal trash.
- Sanitize respirator if worn in accordance with manufacturer's instructions.
- At the end of the work day, shower entire body, including hair, either at the work site or at home.

## B. Sampling Pump Decontamination

- Don disposable gloves.
- Spread plastic on the ground to keep hoses from touching the ground.
- Turn off pump after sampling. Remove pump from well and place pump in decontamination container.
- Pre-rinse the pump in potable water to remove bulk soil or contamination.
- Disassemble pump, as practical, and scrub pump with soap solution. If disassembly of pump not practical, run solution through pump for 1 minute.
- Scrub in tap water, then reassemble and run pump in tap water for one minute.
- Disassemble and spray pump with 70-100% solvent solution. (DO NOT USE ACETONE). If disassembly of pump not practical, run 10 percent solution through pump for 1 minute.
- Allow to air dry.
- Spray with ASTM type II reagent water with analysis certification.
- Reassemble and wrap pump in aluminum foil or clean plastic sheeting and place into decontamination tube.
- Collect all rinsate and dispose of according to the Master Waste Management Plan.
- Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment can be decontaminated (using the above procedure) and disposed of with normal trash or can be disposed of according to the Master Waste Management Plan.

## C. Other Sampling Equipment Decontamination

- Don latex-free gloves.
- Pre-rinse and scrub equipment with potable water.
- Wash all equipment surfaces that contacted the potentially contaminated soil/water with soap solution.
- Rinse with potable water.
- Rinse with distilled water and 10% solvent solution.

- Air dry.
- Rinse with ASTM type II reagent water with analysis certification.
- Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling.
- Collect all rinsate and dispose of according to the Master Waste Management Plan.
- Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment can decontaminated (using the above procedure) and disposed of with normal trash or can be disposed of according to the Master Waste Management Plan.

### D. Sample Container Exterior Decontamination

- The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection.
- Wipe container with a paper towel dampened with soap solution. Repeat the above steps using potable water.
- Dispose of all used paper towels according to the Master Waste Management Plan.

### E. Water Level Meter

Water level meters will be decontaminated before being used in the first well, and after measuring each well as follows:

1. Wipe tape, first with a towel dampened with 10 percent solvent solution, then with a towel dampened with DI water.
2. Spray off probe, first with 10 percent solvent solution, then with ASTM type II reagent water with analysis certification.

## IV. Key Checks and Items

- Clean with solutions of soap, solvent, and ASTM type II reagent water with analysis certification.
- Do not use acetone for decontamination.
- Minimize generation of IDW to the maximum extent possible by decontaminating to the extent practical and disposing with normal trash.

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STANDARD OPERATING PROCEDURE E-2

# Decontamination of Drilling Rigs and Equipment

## I. Purpose and Scope

This document provides standardized procedures for the decontamination of drilling rigs and down-hole drilling tools. Any project required deviations from standard operating procedures (SOPs), will be provided in site specific sampling and analysis plans (SAPs).

## II. Equipment and Materials

- Portable steam-cleaner and related equipment
- Equipment to build a decontamination pad
- Potable water
- Brushes

## III. Procedures and Guidelines

All drilling rigs and down-hole tools will be steam-cleaned prior to drilling, drilling through permanent isolation casing, between boreholes, and prior to leaving each site.

### A. Drilling Rigs and Heavy Equipment

The steam-cleaning area will be designed to contain the decontamination fluids and solids. A pumping system will be used to convey decontamination fluids from the pad to the drums or other appropriate storage containers.

### B. Down-hole Drilling Tools

Down-hole tools will be steam-cleaned and, if necessary, scrubbed with a stiff brush before drilling operations and between borehole locations. This will include, but is not limited to, rods, split spoons or similar samplers, coring equipment, augers, and casing.

Soil samplers will be decontaminated between each sampling event. Clean the samplers according to SOP "Decontamination of Personnel and Equipment" III.C. Use of aluminum foil is not required if the sampler will be used immediately.

# IV. Key Checks and Preventative Maintenance

- The effectiveness of field cleaning procedures will be monitored by rinsing decontaminated equipment with ASTM type II water with analysis certificate and submitting the rinse water as equipment blanks.
- High pressure steam cleaners are dangerous. Follow AHA for steam cleaner safety while operating steam cleaner.

STANDARD OPERATING PROCEDURE G-1

# Surface Water Sampling

## I. Purpose and Scope

This procedure presents the techniques used in collecting representative surface water related data, including samples for analytical chemistry, and stream flow measurements.

For typical collection of surface water samples, this SOP describes acceptable equipment selection and construction materials, as well as standard grab, depth-specific, and depth-composited surface water sampling techniques.

## II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the SAP should be consulted for project-specific details. Typical equipment required includes some or all of the following:

### Surface Water Analytical Sample Collection

- Dip sampler for direct grabs
- Clean unpreserved containers
- Peristaltic pump and appropriate tubing
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Sample containers
- Polypropylene rope and weight
- Extendable pole
- Meters for specific conductance, temperature, pH, and dissolved oxygen

### A. Streamflow Measurement

- Current meter such as the Marsh-McBirney with a steel wading rod and electronic meter to measure the relative velocity of the flow at different locations within the stream channel
- Measuring tape or cable marked in even increments for determining the width of the stream and controlling the location where measurements are taken
- Waders (if necessary)

# III. Procedures and Guidelines

Before surface water analytical samples are taken, all sample collection equipment are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment*. For surface water samples collected from tidal water bodies, the tide stage should be considered when selecting sampling time(s).

Methods for surface water sample collection and streamflow are described below.

## A. Surface Water Analytical Sample Collection

### Manual Sampling

Use manual sampling for collecting grab samples for immediate in-situ field analyses. Measurements of specific conductance, temperature, pH, and dissolved oxygen, are collected after all surface water samples are collected at each station.

#### 1. Surface Grab Samples

Collect surface grab samples within the top 12 inches of the water column unless a specific depth strata has been specified in the Sampling and Analysis Plan (SAP) Avoid skimming the surface of the water during collection unless specifically required by the SAP Very shallow water bodies may require careful techniques of sample collection to avoid disturbing sediments.

Where practical, use the actual sample container (unpreserved) as the collection device (direct grab). Sample containers attached to poles are also considered direct grabs.

#### 2. Direct Grab Technique

- Use an unpreserved sample container to collect the sample.
- Slowly remove the container cap and slowly submerge the container, opening first, into the water.
- Invert the bottle so the opening is upright and pointing towards the direction of water flow (if applicable). Allow water to run slowly into the container until filled.
- Return the filled container quickly to the surface.
- Pour out a small volume of sample away from and downstream of the sampling location. This procedure allows for addition of preservatives and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
- Add preservatives, if required, securely cap container, label and complete field notes.
- If preservatives have been added, invert the container several times to ensure sufficient mixing of sample and preservatives.
- Check preservation of the sample and adjust pH with additional preservative, if necessary.
  - If the sample cannot be collected directly into the sample container to be submitted to the laboratory or if the laboratory provides prepreserved sample containers, use

an unpreserved sample container or an intermediate vessel (e.g., beakers, buckets or dippers) to obtain the sample. These vessels must be constructed appropriately including any poles or extension arms used to access the sample location.

- If the intermediate vessel is not a precleaned sample container, decontaminate the vessel following the SOP E1 *Decontamination of Personnel and Equipment.* Rinse the intermediate vessel with ample amounts of site water prior to collecting the first sample. Discard rinsate away from or downstream of the sampling location. After adequate rinsing, fill the intermediate vessel with sample water. Minimize agitation of the sample.
- Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
- Add preservatives if required, securely cap container, label and complete field notes. Invert the container several times to ensure sufficient mixing of sample and preservatives.

### 3. Pumping Technique

Use appropriate pumps, equipment, and tubing (confirming reusable equipment has been appropriately decontaminated) when using a pump to collect surface water samples. Do not collect oil & grease or TRPH with a pump. Follow this procedure:

- Measure the water column to determine the maximum depth and the sampling depth (for surface samples collect at least 12 inches below the surface, where feasible).
- Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure. Do <u>not</u> use a lead or metallic weight if collecting metals samples. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament polypropylene, etc.) so that it is located below the inlet of the tubing.
- Lower tubing to a depth 6-12 inches below water surface, where possible.
- Pump several tubing volumes through the system to flush the tubing prior to collecting the first sample.
- Fill individual sample bottles via the discharge tubing, being careful not to remove the inlet tubing from the water.
- Try to avoid touching the discharge tubing to the sample container.
- Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

### 4. Depth Grab Samples

Examples of equipment that may be used for depth grab sampling include Kemmerer, Niskin, Van Dorn and similar samplers; pumps with tubing (see above section), and double

check-valve bailers. Before using any reusable equipment, confirm equipment is appropriately decontaminated.

Many of these Kemmerer, Niskin and Van Dorn type samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Stainless steel or Teflon-coated devices are acceptable for all analyte groups.

- Measure the water column to determine maximum depth and sampling depth prior to lowering the sampling device.
- Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.
- Lower the sampler slowly to the appropriate sampling depth, taking care not to disturb the sediments.
- At the desired depth, send the messenger weight down to trip the closure mechanism.
- Retrieve the sampler slowly.
- Rinse the sampling device with ample amounts of site water prior to collecting the first sample. Discard rinsate away from and downstream of the sampling location.

## B Streamflow Measurement

Water discharge can be measured in shallow (less than 4 feet deep) rivers and streams using a hand-held probe that measures instantaneous velocity, and is positioned at multiple depths and distances across that stream cross section.

The current meter is used by suspending the sensing probe in the stream and pointing it in the upstream direction. The assumption is that the stream to be measured is sufficiently shallow to wade in. The sensing probe is attached to a special rod which is graduated in such units as centimeters and which allows the probe to be positioned in the stream at a known depth. The probe measures water velocity by creating a magnetic field and measuring the voltage produced when water flows through the field.

A straight stretch of stream with a fairly constant depth is preferred for conducting streamflow measurements. This will maximize the likelihood that the streamlines are parallel to one another. There should be few if any rocks, holes, or structures in the stream. Preferably the depth of the section to be measured is greater than 0.5 feet and the velocity is greater than 0.5 feet per second.

A tape or marked cable is stretched across the stream channel and anchored securely at each end. The total width of the stream is determined. Flow measurements are taken at known increments (even increments are best because it simplifies the subsequent calculations). There should be 10 to 20 measurements across a large stream, fewer across a small one. The data collected are used to calculate the discharge by the midsection method normally employed by the USGS.

Set the rod firmly on the stream bottom and hold it vertically at the desired distance mark on the tape. Point the probe upstream and stand to the side so that the flow around your legs does not affect the meter.

If the stream is less than 2.5 feet deep, a one point method is used. The probe should be placed at a depth of 0.6 of the total stream depth measured downward from the surface.

If the stream is more than 2.5 feet deep, then the two-point method is used. Measurements are taken at depths of 0.2 and 0.8 of the total stream depth. The measurements at 0.2 and 0.8 are averaged.

The velocity of flow for each set of measurements is determined using tables provided with the current meter used.

# IV. Attachments

- Surface water quality sampling field data form.

# V. Key Checks and Items

- When using watercraft, take samples near the bow, away and upwind from any gasoline outboard engine. Orient watercraft so that bow is positioned in the upstream direction.
- When wading, collect samples upstream from the body.
- Avoid disturbing sediments in immediate area of sample collection.
- Collect water samples prior to taking sediment samples when obtaining both from the same area (site).
- Collect water samples for chemical analyses prior to taking field measurements.
- Consider the representativeness of selected sampling locations, for example, when attempting to characterize a water body that may be stratified or heterogeneous.
- Unless dictated by the SAP, sampling at or near structures (e.g., dams, weirs or bridges) may not provide representative data because of unnatural flow patterns.
- Collect surface water samples from downstream toward upstream.

## Surface Water Quality Sampling Field Data

**SITE:**

**FIELD CREW:**

**DATE:** **CLOUD COVER:**

**TIME:** **ANTECEDENT RAIN:**

**DEPTH OF WATER (FT):** **AMBIENT TEMPERATURE:**

**FLOW VELOCITY AND DIRECTION:**

**FIELD MEASUREMENTS**

| Time | Conductivity (µmhos) | DO (mg/L) | Salinity (ppt) | Temperature (°C) | pH (su) | ORP | Turbidity (NTU) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
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**SAMPLE PARAMETERS ( GRAB OR COMPOSITE ) :**

**OBSERVATIONS**

**COLOR:** CLEAR , AMBER , TAN , BROWN , GREY , MILKY WHITE , OTHER:

**ODOR:** NONE , LOW , MEDIUM , HIGH , VERY STRONG , H2S , FUEL LIKE , CHEMICAL ?, UNKNOWN

**TURBIDITY:** NONE , LOW , MEDIUM , HIGH , VERY TURBID. HEAVY SILTS

**COMMENTS:**

**OTHER:** PLEASE USE BACK OF SHEET.FOR SKETCHING MAPS , **SEE BACK OF SHT Y / N.**

**Q.C. SAMPLE TYPE:** DUPLICATE , EQUIPMENT BLANK , OTHER :

**SIGNED/SAMPLER:** _____

Updated May 2007 PAGE_____OF_____

STANDARD OPERATING PROCEDURE G-2

# Sediment Sampling

## I. Purpose

These standardized procedures describe the collection and handling of sediment samples during field operations.

## II. Scope

Sediments occur in freshwater and marine environments such as streams/rivers, ponds/lakes, canals, ditches, wetlands, lagoons, and estuaries. The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Always collect surface water quality samples prior to collecting sediment samples if sampling locations are located with or near each other.

The sampling team will document the site conditions (e.g., surrounding land use, surface water characteristics, obvious nearby sources of contamination) and sediment characteristics (e.g., color, texture, odor, sediment depth sampled) through a brief description in the logbook, sediment log sheet, and/or representative site photos. It is also important to document that the media being sampled is in fact sediment (and not soil), meaning that overlying water was present at the time of sampling, or that there is obvious evidence of frequent and recent inundation (e.g., sampling exposed sediment at low tide). Any project required deviations from the standard operating procedures (SOPs) will be provided in the site specific sampling and analysis plan (SAP).

## III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device).
- Rope to lower sediment grab or dredge.
- Measuring tape to measure water depth.
- Sediment log sheets.
- Camera (to document sample characteristics and site conditions).
- Hip waders.
- Materials for classifying soils, particularly the percentage of fines.
- Sample jars, including jars for grain size, total organic carbon, and pH, as appropriate.
- Boat or canoe with U.S. Coast Guard-approved safety equipment.

# IV. Procedures and Guidelines

Sediment samples can be collected using one of three different types of equipment: (1) scoops, (2) corers and (3) dredges/grab samplers. Soil sampling equipment is generally not applicable to sediments because of the low cohesion of the medium, but may be used if appropriate. When selecting the appropriate sampling equipment, consider sampling location (edge or middle of lagoon), depth of water and sediment, sediment grain size (fineness), water velocity, and analytes of interest.

Direct collection with the appropriate sample container may be appropriate in very low water or where sediment is exposed. Use dredges for hard or rocky substrates (can also be used for fine sediment). They are heavy enough to use in high velocity streams. Use coring devices in quiescent waters, unless water depth precludes effective sample collection. Always note the depth of sediment actually collected; environmental and mechanical factors may prevent collection to targeted depth (e.g., 0-6 inches).

## A. Scoops or Similar Equipment

- Scooping is generally most useful in shallow waters, and where water flow is minimal so as not to disturbed the scooped sample as it is brought up through the water column. Collect samples by facing the direction of minimal flow and approach the location from the downstream direction. Take precautions not to disturb the bottom prior to scooping. Scoop and transfer the sample to the appropriate sample container(s) or to a decontaminated bowl if homogenization is required.

## B. Corers

Coring devices can be easily fabricated from many materials. Some corers are simple "push tubes," whereas other more sophisticated models may be finned, gravity driven devices. A core may be useful for preserving the historical layering of sediments.

The corer is an acceptable choice for sampling fine sediments. Corer diameter, grain size, and sample consistency will determine if the sample will remain in the corer upon withdrawal. Sample washout can be a problem, and ways to reduce or prevent it are as follows:

- Fit the leading edge of the corer with a nosepiece or core catcher that physically keeps the sample from slipping back out of the corer. The core catcher material must also be compatible with the analytes of interest.
- A second option is fit the top or back end with a check valve which creates negative pressure as it is being pulled from the substrate, and prevents surface water from washing out the top portion of the sample.
- Rotate the corer, if needed, as it is pushed into the sediment but do not rock the coring device back and forth. Rotation improves penetration and prevents compaction of the sample.
- Upon withdrawal from the water surface, place a cap on the bottom to prevent the sample from sliding out.

- Corers can also be fitted with liners if a complete core is desired.
- As the core is extruded, carefully remove the sample with a decontaminated, non-reactive utensil and transfer into the appropriate sample container(s) or a bowl if homogenization is required or if a specific depth fraction is required to be sampled.

## C. Dredges or Grab Samplers

The three main types of devices used in freshwater are the Peterson, Ponar, and Ekman. The Peterson and Ponar dredges are suitable for hard or rocky substrates, deep water bodies, and streams with fast currents. The Peterson and Ponar are virtually the same, except that the Ponar has been adapted with a top screen and side plates to prevent sample loss upon ascent. Use the following method to collect a sediment sample:

- Open the jaws and place the cross bar into the proper notch.
- Lower the dredge to the bottom, making sure it settles flat.
- When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.
- Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.
- Carefully open the jaws, remove the sample with a decontaminated, non-reactive utensil and transfer the sample into the appropriate sample container(s) or bowl for homogenization.

The Ekman is designed for sampling soft substrates (e.g., sand, silt, or mud) in areas with little current and is used as follows:

- Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.
- Lower the dredge to the bottom, making sure it settles flat.
- Holding the line taut, send down the messenger to close the jaws of the dredge.
- Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.
- Carefully open the jaws, remove the sample with a clean, non-reactive utensil and transfer the sample into the appropriate sample container(s) or bowl for homogenization.

## D. General Sampling Procedures

1. Field personnel will start downstream and work upstream to prevent disturbance of or influence on unsampled areas. In surface water bodies that are tidally influenced, sampling should be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants; however, sampling at other tide stages may be warranted to provide data representative of other, actual conditions. Sediment sampling activities should not occur immediately after periods of heavy rainfall.

2. As needed, make a sketch of the sample area that shows important nearby river features and permanent structures that can be used to locate the sample points on a map. Use a GPS to gather station coordinates, if needed. Also characterize depth and width of waterway, rate of flow, type, consistency, and odor of sediment, and point and depth of sample removal (along shore, mid-channel, etc.).
3. Transfer sample into appropriate sample jars with a stainless steel utensil. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. Minimize the amount of overlying water that is collected with the sample matrix. Decant the excess water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since skin or gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.
4. Samples for volatile organics (and, if applicable, acid volatile sulfides/simultaneously extracted metals [AVS/SEM]) should immediately be placed in jars prior to homogenization of sediment. Rocks and other debris should be removed with utensils before placement in jars. If sediment is stiff enough to sample with EnCore® or Terra Core® samplers for VOC analysis, follow the instructions contained in the EnCore® or Terra Core® SOPs, as applicable.
5. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, broken bottles, sharps, snakes, drop-offs, loose silt and muck) which can make wading dangerous.
6. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.
7. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

# V. Attachments

Sediment Log Form.

# VI. Key Checks and Items

- When working in flowing streams, start downstream and work upstream.
- As necessary and practical, log exact locations using permanent features, and gather GPS coordinates.
- Beware of hidden hazards in the water column.
- When sediment sampling at a location for the first time, bring several types of sampling equipment in case one does not work.

CH2MHILL

| PROJECT NUMBER | SAMPLE NUMBER<br>SHEET 1 OF 1 |
|---|---|

# SEDIMENT LOG

PROJECT : LOCATION : DATE:

WEATHER:

METHOD AND EQUIPMENT USED :

LOGGER :

| DEPTH BELOW SURFACE (FT) | INTERVAL (FT) | RECOVERY (IN) | #/TYPE | STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N) | SEDIMENT DESCRIPTION<br>COLOR, ODOR, MOISTURE CONTENT<br>PARTICLE SIZE CHARACTERIZATION | COMMENTS<br>UNUSUAL CHARACTERISTICS |
|---|---|---|---|---|---|---|
| 0.5 | | | | | | |
| 1.0 | | | | | | |
| 1.5 | | | | | | |
| 2.0 | | | | | | |
| 2.5 | | | | | | |

Sampler Signature: _____ Date: _____

G-2_Sediment SAMPLING FORMS2_jrm_jl.xls Updated May 2007

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STANDARD OPERATING PROCEDURE H-1

# Preparing Field Log Books

## I. Purpose and Scope

This SOP will provide standardized procedures and basic requirements for entering field data into log books during field activities. Log books are legal documents. They must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy.

## II. Equipment and Materials

- Log book
- Indelible pen

## III. Procedures and Guidelines

Properly completed field log books are a requirement of the work performed under the Navy CLEAN contract.

### A. Procedures for Completing Field Log Books

1. Field notes are to be kept in bound, hard-covered logbooks, as well as task-specific logs. The pages are to be water-resistant and notes will be taken only with a water-proof, non-erasable permanent ink pen.
2. The inside cover of the log book generally should include:
    - Company name and address.
    - Log-holders name if log book was assigned specifically to that person.
    - Activity or location.
    - Project name.
    - Project manager's (PM's) name.
    - Phone numbers of the company, supervisors, emergency response, etc.
3. Daily entries will be made chronologically. Each page of the log book will have the date of the work and the note takers initials.
4. Information will be recorded directly into the field log during the work activity. Entries into the log should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on memory. Entries must be legible and complete.

5. Every line should be used to prevent later additions of text, or be marked through with a line, initialed and dated. Unused pages will be marked through with a line, the author's initials, date, and the note "Intentionally Left Blank."
6. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the person performing the correction. If possible, all corrections should be made by the individual keeping the log.
7. Only information relevant to the subject project will be added to the log book.
8. The final page of each day's notes will include the note-takers signature and date.
9. Copies of the field notes generally should be sent to the PM or designee in a timely manner (generally by the end of each week of work being performed).

## B. Information generally to be Included in Field Logs

1. Use the left side border to record times and the remainder of the page to record information.
2. General project information will be recorded at the beginning of each field project; the project title, project number, staff, scope of the day's work and weather conditions (note changes).
3. Subcontractor Information: Record name of company, names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List start and stop times, and quantities of billable line items accomplished.
4. Technical and Project Information: Describe the details of the work being performed. The project SAP will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the PM prior to beginning the field work.
5. Any conditions that might adversely affect the work or data obtained.
6. Time: Keep a running time log explaining field activities as they occur throughout the day.
7. Tail Gate Safety Talks: Record topics discussed.
8. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE). Also record other required health and safety procedures as specified in the project specific health and safety plan.
9. Instrument Calibration: Record calibration information for each piece of health and safety/field equipment if not recorded elsewhere.
10. Personnel: Record when personnel and visitors enter and leave the site.
11. Communications: Record all communications that impact performance of the project.
12. Deviations from the SAP: Record deviations from the SAP; document the reasons and communications authorizing deviations.

13. Heath and Safety Incidents: Record all health and safety incidents in detail, immediately reporting them to the field team leader (FTL) and PM.
14. Problems and Corrective Actions: Clearly describe problems encountered during the field work and the corrective actions taken.
15. Sampling Information: Specific information that will be relevant to most sampling jobs includes the following:
    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier.
    - Description of the sample location – estimate location in comparison to two fixed points – If location not already identified on a map or figure, draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
    - Sample matrix and type.
    - Sample identifier, date and time.
    - Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples.
    - Number and type of sample containers collected.
    - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity).
    - Parameters to be analyzed for, if appropriate.
    - Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.
    - If the PM specifies, some of the above can be entered in GBC or spiral bound field sampling books printed specifically for the sampling task instead of in the hard cover log book.

## C. Suggested Format for Recording Field Data

1. Use tables to record sampling information and field data from multiple samples. Keep data organized for easier review.
2. Sketch sampling locations, construction sites, and other pertinent information.
3. Sketch well construction diagrams or use well-completion logs.

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**STANDARD OPERATING PROCEDURE H-2**

# Water-Level Measurements

## I. Purpose and Scope

To provide standardized procedures for the measurements of the depth to groundwater and free product in wells and on staff gages in surface-water bodies. Any project required deviations from standard operating procedures (SOPs) will be provided in the site specific sampling and analysis plans (SAPs).

## II. Equipment and Materials

- Electronic water-level meter tape; the tape should have graduations in increments of 0.01-foot or smaller, or
- Interface probe (for second phase liquids) graduated in increments of 0.01-foot or smaller, and/or
- A calibrated staff gage.

## III. Procedures and Guidelines

For depth-to-water (DTW) measurements, ensure the electronic water-level meter or interface probe is decontaminated and functioning as per SOP "*Decontamination of personnel and equipment*" and the owner's manual. Lower the probe into the well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Record the DTW from a reference point indicated by notch or sharpie mark on lip on the well riser, or, if no survey point notched or marked, the northern edge of the riser, to the nearest 0.01-foot in the logbook.

If the presence of free product (light or dense non-aqueous phase liquid) is suspected, determine the thickness of the product using the appropriate equipment. The instrument manual will indicate how the depth free-product is to be determined.

The apparent elevation of the water level in the well is determined by measuring both the thickness of the floating free-product and the apparent depth to water floating. Do not use this calculation if free-phase product is located at the bottom of the well. The corrected water-level elevation is calculated by the following equation:

$$WL_c = Wl_a + (\text{Free-product thickness} \times 0.80)$$

Where $WL_c$ = Corrected water-level elevation
$Wl_a$ = Apparent water-level elevation
0.80 = Typical value for the density of petroleum hydrocarbon products.

If free-product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gages may be installed in some surface-water bodies. The tools are constructed by attaching a calibrated staff gage to a wood or metal post, driven into the bottom of the surface-water body. The top of the gage elevation is surveyed to a resolution of 0.01-foot. The elevation of the water is determined by the distance the water level is from the top of the gage. Protection may be needed to reduce fluctuations by wind or current.

# IV. Key Checks

- Verify the unit is decontaminated before each use.
- Verify that the battery is charged by pressing the test button on the water-level meter.

STANDARD OPERATING PROCEDURE H-3

# Aquifer Slug Testing

## I. Purpose and Scope

The purpose of this procedure is to outline the equipment and methods that will be used to perform variable-head tests ("slug" tests) on piezometers and monitoring wells. The guidance covers use of both air and solid displacement methods. Any project required deviations from standard operating procedures (SOPs) will be provided in the site specific sampling and analysis plans (SAPs).

## II. Equipment and Materials

Air displacement equipment needs:

- In-situ downhole data logger/pressure transducer or equivalent
- Laptop
- Well-testing assembly
- Packer
- Fittings for pressure transducers
- Fittings for air supply
- Release valve
- Compressed air
- Water level meter

Solid displacement equipment needs:

- Solid displacement device with rope
- Water level meter

## III. Procedures and Guidelines

The rising-head tests are performed by lowering the head of water in the well and monitoring the recovery of the water level to the static water level. The water level will be lowered by one of two methods outlined below.

### A. Air Displacement

The air displacement apparatus consists of a packer assembly, fittings to accommodate transducers and air pressurization, and a pressure-release valve. The packer is lowered into the upper portion of the monitoring well, secured in place and inflated, providing a seal between the apparatus and the inside of the well. Two fittings are provided for pressure transducers: one transducer is fed through the inside of the device and positioned below the water surface and the other is inserted to measure the air pressure inside the assembly. A third fitting is connected to the pressurized air supply.

The datalogger will be programmed to display the air pressure in units of head, the head measured by the submerged transducer, and the difference between the two. The difference between the two pressure transducers is the height of the water column on the submerged transducer. Record each reading before starting the test. The pressure applied will be equivalent to 3 to 7 feet of head. When applied, allow the pressure to stabilize. Do not permit the water level to fall below the base of the bentonite seal (within 2 feet of the top of the screen).

Each test is started by releasing the air pressure inside the assembly and allowing the water level to rise to the static water level. The datalogger should begin recording the water levels and elapsed time. Terminate each test when the water level has recovered to at least 90% of the original equilibrium level. This test method cannot be used if the well is screened across or near the water table.

### B. Solid Displacement

An alternate method is to use a solid displacement device to lower the water level. A single transducer will be installed in the well below the water table. A weighted solid displacement device is added to the well, and the water level is allowed to stabilize to the original static water level. The test is started by rapidly removing the displacement device,. The data logger begins recording the water level and elapsed time . Readings are taken as above, and the test stopped when the well has recovered to 90% of the original level.

At least two tests will be performed in each well. Additional tests will be required if the test results are not similar.

Download tests as each well is completed and check the data, ensuring the data are complete.

## IV. Attachments

None.

## V. Key Checks and Preventive Maintenance

- Check that the packer assembly is in good condition and not leaking. Provide a repair kit including tape and clamps. Take additional packer assembly and other spare parts.
- Check the batteries for the datalogger and computer. Check that the computer programs for the datalogger are available.

STANDARD OPERATING PROCEDURE H-4

# Chain-of-Custody

## I. Purpose

This SOP provides standardized procedures for completing chain of custody (COC) forms. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs).

## II. Scope

This procedure describes the steps necessary for transferring samples through the use of a COC. A COC is required for the tracking and recording of samples collected during program activities. Use of the COC creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over regional- or site-specific requirements.

## III. Definitions

Chain-of-Custody Record - A COC is a printed form that accompanies a sample or group of samples as custody is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes the custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and is secured to prevent tampering.

Sample - A sample is physical evidence which is representative of conditions at the point and time that it was collected.

## IV. Procedures

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

## A. Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which may be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,
- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

### 1. Sample Label

Samples removed and transported from the sample location to a laboratory or other location for analysis will be collected into laboratory provided containers and labeled. Sample labels will include:

- Project - CTO Number.
- Sample Identification - The SAP/SSP I.D. provided for the sample.
- Date - Day, month, and year of sample collection.
- Time - A four-digit number in the 24-hour format at time of collection.
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type of preservation.
- Analysis – Type of analysis to be performed (e.g., VOC).

- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

## B. Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under COC procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

### 1. Field Custody Procedures

- Care must be taken to ensure that the sample information on the label matches the COC exactly.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- Sample labels shall be completed for each sample, using waterproof ink.

### 2. Transfer of Custody and Shipment

Samples are accompanied by a COC. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the COC. This documents sample custody transfer from the sampler to the analyst in the laboratory. The COC is shipped as described below:

- Place the original (top, signed copy) of the COC in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.
- Sign and date two custody seals, 1-inch by 3-inch white paper labels with black lettering and an adhesive backing. The custody seals are part of the COC process and are used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seals across the shipping container opening on diagonally opposite corners, so that one would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.

Any corrections are made by drawing a line through, initialing and dating the change, then entering the correct information. Erasures are not permitted.

As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment then signs and dates the COC, completing the sample transfer process. It is then the laboratory's responsibility to maintain custody records throughout sample preparation and analysis.

# V. Quality Assurance Records

Once samples have been packaged and shipped, the COC copy and airbill receipt become part of the QA record.

# VI. Attachments

Chain of Custody Form.

# VII. References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

# Vieques ERP
## CH2M HILL
## Chain of Custody Form

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project Site | | AOC E | | | Number of Containers | Analysis Requested | | | | | | | | | | | | | Project No. |
| Project Manager | | Brett Doerr | | | | | | | | | | | | | | | | | |
| Contact Tel No. | | 757-289-9246 (Adrienne Jones) | | | | | | | | | | | | | | | | | Lab Batch/SDG ID |
| Contact Address | | 4350 W. Cypress Street, Suite 600, Tampa, FL 33607 | | | | | | | | | | | | | | | | | |
| Lab Name | | | | | | | | | | | | | | | | | | | Lab Tel No./Fax No. |
| Lab Contact | | | | | | | | | | | | | | | | | | | |
| Lab Address | | | | | | | | | | | | | | | | | | | |
| Item | Sample ID | Station ID | Matrix | Date & Time Collected | | MET_SO/CN | PCB_SO | PEST_SO | SVOC_SO | TL_SO | TOC_SO | TPH_SO_DRO/ORO | TPH_SO_GRO | VOC_SO | GRAIN_SIZE | TPH_W_GRO | VOC_W | | Comments |
| 1 | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | |

| | | | |
|---|---|---|---|
| Sampled By: | Date/Time: | Custody Seal: Y / N Relinquished By: | Date/Time: |
| Shipped Via: UPS FedEx Hand Other (Please specify): | | | |
| Samples Temperature and Condition Upon Receipt (for lab's use): | | | |
| Received By: | Date/Time: | Custody Seal: Y / N Relinquished By: | Date/Time: |
| Received By: | Date/Time: | Custody Seal: Y / N Relinquished By: | Date/Time: |
| Remarks: | | | |

Updated May 2007

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STANDARD OPERATING PROCEDURE H-5

# Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods

## I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of samples of various media to a laboratory for analysis. This standardized procedure only covers samples of sufficiently low concentration as to not be considered dangerous goods for purposes of shipping.

## II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have sufficiently low concentrations of chemical constituents as to not be considered dangerous goods when being shipped. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped following procedures for dangerous-goods shipping specified by the intended shipper (e.g., Federal Express).

## III. Equipment and Materials

- Coolers
- Clear tape
- Duct tape
- “This Side Up” labels
- “Fragile” labels
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

# IV. Procedures and Guidelines

## A. Sample Packing

1. Prepare coolers for shipment:
   - Tape drains shut from the inside of the cooler.
   - Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler, if available.
   - Place mailing label with laboratory address on top of coolers.
   - As necessary (helpful for large bottle ware), fill bottom of coolers with about 3 inches of bubble wrap.
2. Arrange decontaminated sample containers in groups by sample number. Consolidate volatile organic compound (VOC) samples into one cooler to minimize the need for trip blanks.
3. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.
4. Seal each set of sample bottles within a separate water proof zipper-type plastic bag and bubble wrap, if available. Make every attempt to ensure the samples are water proof. Double bag Encore VOC samples and soil samples. Sample label should be visible through the bag.
5. Place two large plastic bag liners, one inside the other, openings up. Arrange sample containers in liners so bags do not touch each other. Temp blank should go on the bottom of the cooler, in an area where it can be completely surrounded by ice.
6. If ice is required to preserve the samples, use at least two full bags and place on and around the containers.
7. Fill remaining spaces with bubble wrap or ice as required and add the laboratory provided trip blank.
8. Close the inside liner first by twisting the opening to the bag liner closed, allowing as much air to escape as possible. Zip-tie the bag closed and tie the end into a knot. Do the same to the second liner being sure to remove as much air as possible.
9. Complete and sign COC (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier. Place into a zip-type bag and tape it to the inside of the lid of the cooler.
10. Close lid and latch.
11. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
12. Tape cooler shut on both ends, making several complete revolutions with tape. Do not cover custody seals.

13. Relinquish to Federal Express or to a courier arranged with the laboratory. Scan airbill receipt and COCs to the sample documentation coordinator (or mail if scanner not available) along with the other documentation.

### B. Medium- and High-Concentration Samples

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with several additional restrictions. The sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier.

## V. Attachments

None.

## VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label.
- Pack sample bottles carefully, with adequate bubble wrap or other packaging and without allowing bottles to touch.
- Be sure there is adequate ice.
- Include COC.
- Affix custody seals.

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STANDARD OPERATING PROCEDURE H-6

# Equipment Blank Preparation

## I. Purpose and Scope

This document provides standardized procedures for collecting equipment blanks used to determine whether decontamination procedures are adequate during sampling. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs). The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

## II. Equipment and Materials

- ASTM Type II reagent water with analysis certification (blank water).
- Sample bottles with preservatives according to the SAP.
- Gloves.

## III. Procedures and Guidelines

A. Decon all sampling equipment according to "Decontamination of Personnel and Equipment" SOP.

B. For volatile organic compound (VOC) analysis from the surfaces of equipment other than pumps, pour blank water over one piece of equipment and into three 40-ml vials as per VOC water sampling procedure.

C. For non-VOC analyses, one aliquot is to be used for equipment. Pour blank water into the sampling bowl and other equipment so surfaces which previously contacted the sample are now in contact with the blank water. Pour blank fluid from pan into the appropriate sample bottles.

D. For pumps, run an extra gallon of blank water through the pump while collecting the pump outflow into appropriate containers. If a pump with disposable tubing is used, put new tubing onto the pump to collect the equipment blank.

E. Document and ship samples in accordance with the procedures for other samples.

# IV. Attachments

None.

# V. Key Checks and Items

- Wear gloves.
- Do not use any disposable or non-decontaminated equipment to prepare blank.
- Use ASTM-Type II reagent water with analysis certification.

STANDARD OPERATING PROCEDURE H-7

# Surveying Specifications

## I. Purpose and Scope

The purpose of this memorandum is to provide standardized procedures for survey support.

## II. Procedures and Guidelines

Except for locating points using Global Positions System (GPS), all land survey work shall be completed by a licensed surveyor. The remainder of this SOP applies to surveying work conducted by a licensed surveyor. All survey work shall be conducted using equipment, personnel, and procedures that will ensure compliance with the accuracy standards as defined below. It is the responsibility of the licensed surveyor to ensure that all work under this agreement complies with applicable regulations. All documents submitted shall bear the surveyor's seal, signature, and a certificate that all work was done under the surveyor's supervision and that all information contained in the document is true and accurately shown.

Horizontal Control work can be done using either standard surveying techniques or Global Positioning System (GPS) techniques meeting the specification requirements outlined in this scope. If standard surveying techniques are used, all horizontal control work shall comply with Third Order – Class I standard of accuracy for geodetic control as established by the FGDC Geospatial Positioning Accuracy Standards, Part 4: Standards for Architecture, Engineering, Construction (A/E/C), and Facility Management.

If GPS is used by the licensed surveyor, the relative horizontal accuracy shall conform to the FGDC Geospatial Positioning Accuracy Standards, Part 2: National Standard for Spatial Data Accuracy.

Vertical Control work shall be Third Order, as outlined in the FGDC Geospatial Positioning Accuracy Standards, Part 4: Standards for Architecture, Engineering, Construction (A/E/C) and Facility Management.

Horizontal control shall be based on the North American Datum of 1983 (NAD 83) Latest Adjustment Vertical control shall be based on the North American Vertical Datum 1988 (NAVD 88). Potential exceptions to this include the use of site-specific coordinate systems if use of the aforementioned datums is not possible.

The surveyor shall collect X, Y and Z coordinates for the top of the well casing feature accurate to +/- 0.01 feet and shall collect a ground elevation 1 foot north of the well casing accurate to +/- 0.10 feet. The datum point for the top of the well casing shall be collected from an existing mark or notch on the well casing. The surveyor shall demarcate the datum point (black marker) on the north side of the casing if marking is not present.

Surveyed elevations for the topographic survey shall be accurate to within 0.1-feet on natural ground and to within .03-feet on hard surfaces.

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STANDARD OPERATING PROCEDURE I-1

# Vegetation Clearance SOP for Environmental Investigations

## I. Purpose and Scope

The purpose of the Vegetation Clearance SOP is to minimize damage to plants, wildlife, and habitats (especially threatened, endangered, or otherwise sensitive) while enabling efficient and effective environmental investigations. This SOP contains some general guidance that will be followed, to the extent possible, when developing and implementing a vegetation clearance process for each site-specific investigation. Additionally, this SOP enumerates the process that will be implemented to facilitate US Navy (Navy) and US Fish and Wildlife Service (USFWS) concurrence on specific vegetation clearance activities at each environmental site prior to initiation of those activities.

This vegetation clearance SOP applies to only environmental investigation activities. The different objectives associated with other activities such as removal or remedial actions, or munitions response program (MRP) activities, necessitate a different approach to vegetation clearance. Therefore, this SOP is not applicable to activities other than environmental investigations, unless concurred upon by USFWS and Navy personnel on a case-by-case basis. For activities conducted under the MRP and environmental investigations conducted within the Live Impact Area (LIA), Surface Impact Area (SIA), Eastern Maneuver Area (EMA), and Eastern Conservation Area (ECA), collectively referred to here as "munitions areas," a threatened and endangered species survey will be conducted in accordance with the "Methods and Approach for Threatened and Endangered Species and Habitat Surveys Within the ECA, SIA, and EMA on Vieques, Puerto Rico" (Geomarine Inc., January 2007). Any mitigation measures for munitions areas identified based on the Threatened and Endangered Species and Habitat Surveys in those areas supersede any other vegetation clearance protocol discussed in this SOP.

## II. General Guidance

Where technically practical and economically feasible, hand clearing of vegetation using hand or power tools (e.g., machetes, chainsaws, etc.) will be considered during evaluation of vegetation clearance routes. Whether clearing by hand or with mechanized equipment, large trees (3 inches in diameter or larger) will be avoided, if possible, while the thicker underbrush is cleared to make the investigation and site access easier. Because all vegetation clearance routes will be reviewed in the field by USFWS personnel prior to implementing the clearance activities, any large tree proposed for removal in order to meet the investigation objectives will be evaluated by USFWS.

Mechanized land clearing will be used judiciously, if possible, avoiding areas with old growth trees and favoring areas that have been previously cleared or disturbed, if present.

The use of large wheeled or tracked vehicles makes selective vegetation clearance difficult, but its use may be necessary when clearing large areas or wide paths for access by large sampling equipment. The type of vegetation present will also be considered when developing the site-specific vegetation clearance process. Large-vehicle mechanized vegetation clearance may not pose a concern in previously cleared areas, or areas with heavy mesquite infestations, but will be carefully evaluated in other mature forested or otherwise sensitive areas.

If mechanized land clearing is to be used, the smallest piece of equipment available will be favored. Equipment that can maneuver around certain trees and selectively cut according to the clearance criteria is preferable to that which needs to clear cut a wide access path for itself. The preferred method of mechanized clearing will be a brush hog type tractor where the cutting mechanism is attached to a tractor and can be lifted and lowered onto the vegetation. This machinery is sometimes referred to as a hydro ax. However, if not available, or not technically or economically practical, other types of machinery will be considered.

Areas such as the banks of ephemeral streams will be avoided if possible, and proposed for selective hand clearing if not. Maintaining the vegetative cover of the ephemeral stream banks to the extent possible helps assure that there is minimal bank failure and erosion. Fording of ephemeral streams with mechanized equipment will be avoided unless necessary to meet project objectives. As with vegetation clearance routes, any proposed ephemeral stream crossings and/or vegetation clearance will be discussed with USFWS personnel prior to the activity. Further, collection of samples within ephemeral streams will be conducted by hand equipment as long as the objectives of the investigation can still be met. Of note is that there are several ephemeral streams on the northeast side of Vieques that have been previously designated as conservation zones.

The primary wetland type on Vieques is mangrove wetlands and associated saltflats. Extensive mangrove wetlands are found on west Vieques associated with the Laguna Kiani/Boca Quebrada complex, and Laguna Grande. On east Vieques, there are numerous mangrove lagoons along the coastal areas and in the Live Impact Area (LIA). Like ephemeral streams, mangrove areas will be avoided if possible, and proposed for selective hand clearing if not and if the objectives of the investigation can still be met. Further, soil sampling and placement of monitoring wells in the soft soils associated with mangrove areas will be made by hand, if possible and if the objectives of the investigation can still be met.

Because the type and size of the necessary sample collection equipment dictates, in part, the type of vegetation clearance equipment to be used, the type and size of drilling equipment will be considered when selecting sample types and associated locations. Where possible, sample collection by hand will be considered as long as the investigation objectives can still be met. Because of the limited number of drill rigs available for mobilization to Vieques, control over the size and type of rigs used for site-specific investigations may not be possible.

In areas where threatened and endangered species surveys have been performed, any mitigation measures identified based on those surveys will be implemented during any subsequent vegetation clearance.

During identification of proposed vegetation clearance routes and during vegetation clearance, if threatened or endangered plant species are identified, they will be flagged and reported to USFWS personnel. If during vegetation clearance a snake is accidentally killed by the mechanized equipment, it will be brought to USFWS personnel. Reasonable effort will be made to avoid cutting or damaging threat and endangered plant species, as well as snakes and other wildlife. Attached to this SOP is a list of snakes on Vieques (with pictures) and a list of the Threatened and Endangered Plants possibly found on Vieques (with pictures).

# III. Steps for Developing Site-specific Vegetation Clearance Process

## Step 1 – Determine if a Threatened and Endangered Species and Habitat Survey has been Conducted or is Required

For any site to be investigated, determine if a Threatened and Endangered Species and Habitat Survey has been conducted. If one has been conducted, incorporate that information, including any mitigation measures, into Step 2. If a survey has not been conducted, consult with USFWS to determine if a survey is required. If so, conduct the survey and incorporate that information, including any required mitigation measures, into Step 2. If not, proceed to Step 2.

## Step 2 – Develop Study Area Map(s) Showing Proposed Sampling Locations, and Associated Tables Listing Sampling Methodology for Each Location

As part of site-specific work plan development and upon regulatory agency approval of the site-specific work plan, the following information will be provided to the Navy contractor site reconnaissance field team that will investigate routes of access to each sampling location.

1. Threatened and Endangered Species and Habitats Survey information, as applicable.
2. Sampling Station Maps - Study area map(s) illustrating all sampling stations proposed for investigation.
3. Supplemental Maps - Aerial, topographic, or other maps of the study area that clearly show environmental features (e.g., roads, ephemeral streams), if available, will be compiled. Maps showing known locations of protected plants and animals and sensitive habitats (e.g., wetlands, salt flats, conservation zones), and identification guides (e.g., snake species flyer) will also be compiled, if available.
4. Information Tables - Tables will be produced summarizing investigation details for each station and provided to the field reconnaissance team. The tables will contain the following information:

   ***Table 1***

   - Station ID
   - Station coordinates

- Investigation activity (e.g., well installation; existing well sampling; or surface soil, subsurface soil, surface water, sediment sampling)
- Mandatory equipment or acceptable alternatives needed on station to collect the samples (e.g., drill rig, 4 wheel drive truck, gear carried in by hand), excluding vegetation clearance equipment
- Notes – Additional information for the field team to consider during the access route evaluation, as applicable

***Table 2***

- A reference table will be produced outlining minimum surface clearances, maximum grades, and other limit information required for the transport and operation of each type of sampling equipment. This will allow the reconnaissance team to understand what characteristics of the route need to be achieved. Similarly, vegetation clearing equipment characteristics (e.g., minimum width and maximum height of clearance that can be achieved) will be outlined so that the reconnaissance team can better identify appropriate method(s) for clearing the route.

## Step 3 – Initial Site Visit to Delineate Access Routes

A Navy contractor biologist and UXO technician (if required) will visit each proposed location and evaluate access conditions. The objective will be to ground truth and flag safe and effective routes of access to each target station through which vegetative clearing and equipment maneuvering will minimize damage to vegetation, habitat, and wildlife, while still enabling the investigation objectives to be met. In addition, the biologist will identify issues that may limit the types of investigative equipment or clearing methods to be used, or that may prevent investigation of the proposed station altogether.

The following steps will be conducted for each sampling location:

1. Have in hand the study area maps and information described in Step 2.
2. Ground truth a route from the nearest drivable roadway to the station, noting or conducting the following:
    a. Along the route use orange flagging to mark the proposed width of the path to be cleared of vegetation. The width will be based on the minimum distance required for the proposed investigative equipment type.
    b. Routes that can follow previously cleared areas will be given preference over older growth areas.
    c. Trees greater than 3 inches in diameter that fall within the route because they cannot be avoided will be tagged with white flagging to indicate that they should be left standing, if possible, which will be later evaluated by the USFWS personnel for any concerns regarding potential removal.
    d. Vegetation that should not be damaged or removed (e.g., a protected species or sensitive habitat) that is located within or adjacent to the route will be clearly flagged with red and white flagging. The dual-color flagging is intended to emphasize the

vegetation not to be damaged or removed and to avoid confusion with other flag types/configurations.

e. Ephemeral streams will be avoided, if possible, since clearing of vegetation in the ephemeral stream and movement of machinery across the ephemeral stream may increase the potential for erosion. If ephemeral stream crossing is unavoidable, preference will be given to identifying a route that will minimize damage to the ephemeral stream and associated vegetation.

f. Wetlands (typically mangrove communities) will be avoided, if possible. If routes or stations necessarily occur in or near wetlands, minimal clearing will be proposed, ideally conducted by hand, as long as this enables the objectives of the environmental investigation to be met.

g. GPS coordinates will be gathered along the centerline of the flagged route(s).

h. Any observations of protected plant and animal species on or near the route will be documented.

i. Photographs will be taken as deemed helpful

    1. Complete a Draft - Route Documentation Form for each route while in the field. This form documents important characteristics of the proposed route, recommendations for and against certain equipment types to be used for investigation and vegetation clearing, and any other information that should be brought up for review with the Navy and USFWS personnel.

## Step 4 –Documentation of Proposed Route and Clearing Methods

The station map from Step 2 will be updated to add the proposed routes to each station using the field GPS coordinates. The Draft - Route Documentation Form for each location will be modified to include a close-up map view of the proposed route and type-written documentation of key information. The station map and route documentation forms will be sent to the USFWS Refuge Manager, or his/her designee(s), prior to conducting a site reconnaissance with USFWS personnel.

If the USFWS Refuge Manager or his/her designee determine, based on the Draft Route Documentation Form and associated supporting documentation, that a coordinated site visit is not necessary in order to concur with the proposed vegetation clearance approach and route(s), skip to Step 6. If the USFWS Refuge Manager or his/her designee determines a coordinated site visit is necessary, he/she will notify the Navy RPM within 5 days of the receipt of the documentation from the Navy.

## Step 5 – Conduct Site Visit with USFWS

The Navy contractor biologist (or other Navy contractor personnel, if appropriate) and UXO technician (if required) will escort the USFWS Refuge Manager and/or his/her designee(s) along each flagged route to determine if proposed plans regarding location, clearing equipment, investigation equipment, and vegetation to be cleared or protected are acceptable, and to document any recommended changes to the proposed plan. The Route Documentation Form will be used in the field to support review of the proposed route and

record recommended changes by USFWS. If feasible, recommended adjustments along the route will be made during this visit. If no changes are made to proposed vegetation clearance procedures or routes alter the associated sample collection methods or sample locations, the Navy contractor will present the revised Route Documentation Form(s) to the Navy for concurrence.

If the USFWS personnel recommendations regarding vegetation clearance along any particular route alter the method of sample collection, ability to collect the sample as intended, or sample location, the Navy will set up a call or meeting with the Environmental Technical Subcommittee to discuss the proposed sample collection changes. If the changes are agreed upon, the updated Route Documentation Forms will be finalized. If the proposed sample collection changes are not acceptable to the regulatory agencies, additional discussions among the agencies will be required before vegetation clearance and the field investigation can commence.

## Step 6 – USFWS Concurrence Letter

Within 5 days of the final site-specific vegetation clearance process being concurred upon by the Navy and USFWS, the concurrence will be documented in a letter provided to the Navy by the USFWS Refuge Manager or his/her designee.

## Step 7 – Oversight of Actual Clearing Activities

The Navy contractor biologist involved with the field reconnaissance and USFWS site review (or other Navy contractor personnel, if appropriate) will be present during implementation of clearing activities. Using the final, concurred upon Route Documentation Forms, the contractor biologist will ensure that final decisions regarding route layout, clearing machinery, plants to avoid, and any other documented issues are maintained during vegetation clearance.

# Route Documentation Form

**Station ID:** _____ **p. 1 of 3**

**Draft sketch of route and key environmental features/issues (made in field)**

**or Final aerial map with plotted GPS route and any important elements to avoid (made in office after first site visit)**

**Station ID:** _____

**Station Coordinates:** _____

**Date(s) of initial Site Visit:** _____

**Date(s) of Agency Site Visit:** _____

**Planned Investigation at Station**

**Mandatory equipment types for investigation**

**Clearences required for mandatory equipment**

**Optional equipment types for investigation, ranked in order of importance**

**Clearences required for optional equipment**

**Important environmental elements observed/expected in vicinity of Station that are to be avoided**

| | | | | | |
|---|---|---|---|---|---|
| Ephemeral Stream | ☐ | Trees > 3inches | ☐ | Mangroves | ☐ |
| Wetland habitat | ☐ | Protected plant | ☐ | Salt Flats | ☐ |
| | | Protected wildife | ☐ | Lagoon | ☐ |

Other…

**Following ground truthing of route, and considering investigation needs and environmental concerns…**

**... describe recommended type of sampling equipment to be used at Station**

**… describe clearing method/equipment to be used for clearing the route**

**… describe potentially unavoidable environmental issues (e.g., trees > 3inches) that occur within the route that require Navy or agency review.**

## NOTES:



**Station ID:**

# WHAT SNAKE WAS IT ?

## Garden Snake
*Arrhyton exiguum*

**Description**: 1-1 ½ feet long, slender like a pencil, dark brown, white cheeks, dark stripe down sides
**Habitat**: Forest floor, under leaf litter and rocks, boards, etc., common in gardens
**Distribution**: St. Thomas, St. John, (Water Island?)

## Puerto Rican Racer
*Alsophis portoricensis*

**Description**: 3-4 feet long, thin, olive to brown with white belly, light stripes down sides, sometimes with dark markings on head; aggressive but harmless
**Habitat**: Active during the day in grass and shrublands
**Distribution**: Only on small islands and Water Island, not on St. Thomas, St. John or St. Croix

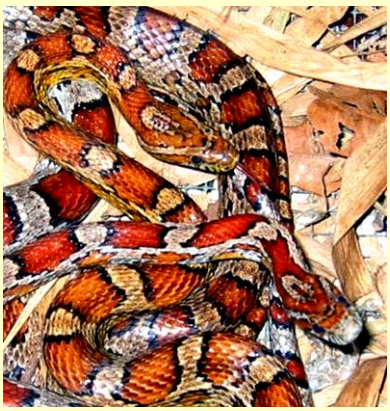
## Virgin Islands Tree Boa (ENDANGERED)
*Epicrates monensis granti*

**Description**: 2 ½ to 3 ½ feet long, very thin neck, tan or brown with dark brown zig-zag blotches, shines iridescent in sun, vertical pupils; only native snake with an obvious pattern
**Habitat**: Active only at night in forest canopy; prefers dry forest, mangroves, and coastal scrub
**Distribution**: Only east side of St. Thomas (Redhook, Nazareth, Friedenhoj, Bovoni, Nadir, Smith Bay), not on St. John, Water Island, or St. Croix

## Blind Snake
*Typhlops richardii*

**Description**: Under 1 foot long, pale grey to black, slender, blunt head with eyespots, short sharp pointy tail, tiny mouth; looks like a worm
**Habitat**: Under ground, sometimes found under rocks or logs in forests, woodlands, and coastal scrub; also found in gardens around houses
**Distribution**: All major islands and some cays

## Corn Snake (INTRODUCED)
*Elaphe guttata*



**Description**: 3-4 feet long, red and orange blotches on a brown or creamy base, checkered belly, long thin head with vertical lines along mouth
**Habitat**: Grasslands, shrublands, coastal scrub, often deep in crevices
**Distribution**: Only observed in industrial areas around Subbase, Tutu, and Smith Bay on St. Thomas; likely arrived in container ships and cargo

To report any of these snakes or for more information, contact Renata Platenberg at the Division of Fish and Wildlife 775-6762, vi.wildlife@gmail.com

## Federal and Commonwealth Listed Plants Plants of Vieques Island, Puerto Rico [1]

| Common Name (Scientific Name) | Federal Status | Commonwealth Status | General Habitat Description |
|---|---|---|---|
| Cobana negra (*Stahlia monosperma* ) | Threatened | Threatened | Seasonally flooded wetlands in association with mangroves; are limited to drier, elevated soil not occupied by mangroves |
| Thomas' lidflower (*Calyptranthes thomasiana* ) | Endangered | Endangered | Moist deciduous formation of the inner hills and slopes that include semi-evergreen forests at 300 feet to 800 feet altitude |
| (*Chamaecrista glandulosa* ) | Endangered | Endangered | Grows on almost pure sands with no organic layer; and frequently in open areas |
| (*Eugenia woodburyana* ) | Endangered | Endangered | Subtropical dry forest zones, which are either deciduous or semi-evergreen seasonal forests |
| Beautiful goetzea (*Goetzea elegans* ) 1 | Endangered | Endangered | Moist limestone and moist coastal semi-evergreen forests at 200 feet to 600 feet |
| (*Tillandsia lineatispica* ) | Candidate[2] | Rare[3] | Rocky outcrops and bases of trees |
| (*Mariscus urbanii* ) | Candidate[2] | Rare[3] | Grassy banks and woodlands at higher elevations |
| (*Maytenus cymosa* ) | Candidate[2] | Rare[3] | Coastal moist forests below 984 feet altitude |

[1] Source: Integrated Natural Resources Management Plan, Navy Lands on Vieques, Vieques Island, Puerto Rico, Plan Years 2003-2012,

[2] Candidate species are not protected under the Endangered Species Act (ESA), but concerns about their status indicate that they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

[3] A species that is naturally scarce, as opposed to one that once was abundant, but whose numbers have fallen drastically due to natural or human-induced changes in its environment.

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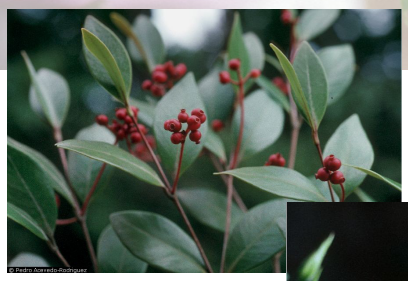
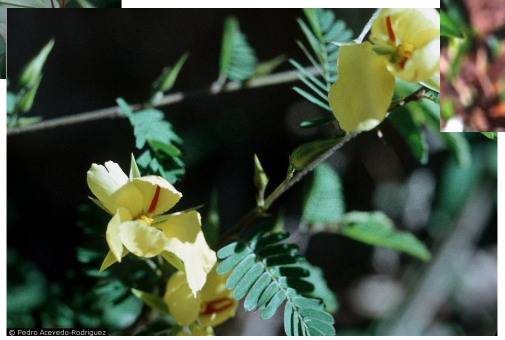
# Threatened and Endangered Plants Possibly on Vieques





# Stahlia monosperma

# Calyptranthes thomasiana

# Chamaecrista glandulosa

# Eugenia woodburyana

# Goetzea elegans

# Maytenus cymosa

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# Examples of Potentially Non-CERCLA-related Constituents

## Pesticides and Herbicides

In accordance with their intended use, pesticides and herbicides were commonly applied to the soil at Department of Defense (DoD) facilities to control pests and weeds, which may have resulted in pesticides and herbicides accumulating in environmental media. This type of pesticide presence is distinct from pesticide contamination that is the result of a spill, or from improper storage, disposal, or use. A Public Works Technical Bulletin prepared by the U.S. Army Corps of Engineers (USACE) addresses DoD procedures regarding management of pesticide-contaminated soil (USACE, 2004). Although it specifically references chlordane, the process is equally applicable to other pesticides registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). It states:

> *"Not all chlordane in the environment is required to be remediated under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA). The requirements for managing chlordane contaminated soil will depend upon whether it was legally applied or whether it was illegally disposed or 'released' into the environment."*

The memo further states:

> *"Concentrations of chlordane should not be used as the basis for concluding whether a spill occurred. It was DoD practice to periodically reapply pesticide, thus chlordane may have accumulated without being indicative of a spill. The location of chlordane, rather than its concentration, should be used as the basis for determining whether it is reasonably present due to intentional use."*

It also states that "[l]legally applied chlordane is not required to be remediated under either CERCLA . . . " and that:

> *"It is not appropriate to undertake a CERCLA response for legally applied chlordane. This is because courts have found that normal application of pesticide does not constitute a release or disposal under CERCLA. Section 107(i) of CERCLA specifically addresses application of registered pesticide product by stating, 'No person may recover under the authority of this section for any response costs or damages resulting from the application of a pesticide product registered under FIFRA . . . .' This has been found to mean that contamination caused by the application of a pesticide product registered under FIFRA, such as chlordane, is explicitly exempted from CERCLA liability. So not only is a CERCLA response not*

> *required for legally applied chlordane, but because there is no liability, there is no ability to expend environmental restoration funds under CERCLA for legally applied chlordane."*

RCRA has similar guidance that can be found at 42 USC 6901 through 6992. The three most common pesticides found at multiple Vieques sites are dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethene (DDE), and dichlorodiphenyldichloroethane (DDD). Both DDE and DDD are contaminants in technical grade DDT as well as breakdown products of DDT (ATSDR, 2002). Numerous studies have been performed on global DDT concentrations and its persistence in the environment. In 1975, EPA published a report entitled: "DDT: A Review of Scientific and Economic Aspects of the Decision to Ban Its Use as a Pesticide." In this report, EPA indicates that DDT degradation rates are highly variable because they are dependent on such factors as rate of pesticide application, mode of application, soil type, climatic conditions, and several other factors. Studies cited by EPA indicated that in the early 1970s, average DDT concentrations in soils from eight major US cities were between 6,000 micrograms per kilogram (µg/kg) and 350 µg/kg and that significant variations in DDT degradation rates had been measured (EPA, 1975). ATSDR noted that half of the DDT initially present can remain after 30 or more years (ATSDR, 2002). EPA also noted that as levels of DDT decline, the ratio of DDE to DDT should increase (EPA, 1975).

As indicated above, pesticide concentrations should not be used as the sole basis to determine whether a pesticide release has occurred at a site because of the nature of pesticide application (e.g., targeted application, periodic reapplication). In addition, other than potentially PAOC L and SWMU 1 on the former VNTR, none of the historical information for the sites on Vieques indicates that the sites were used for pesticide handling, storage, or disposal. This information, coupled with the nature of the sites and the fact that pesticides were detected at most of the sites where analyzed, suggests the pesticides are present as a result of normal pesticide application associated with maintenance of the facilities when they were active. However, while the pesticide concentrations at a particular site are not used solely to conclude whether a pesticide release occurred, because pesticides were detected at most sites, the pesticide concentrations across all sites are considered relative to each other to help identify if and where a pesticide release may have occurred.

Tables 1 through 4 attached summarize the pesticides and associated concentrations that have been detected in surface soil and subsurface soil, respectively, at all former NASD and VNTR sites (excluding PAOC L and SWMU 1). The data in these tables represent a general range of pesticide concentrations likely attributable to normal pesticide, use, not a pesticide release.

## Dioxins

Dioxins are another potential example of contaminants that, even if detected, are not necessarily the result of a CERCLA-related release. Dioxins are produced when chlorine-based chemical compounds are burned with hydrocarbons. They are unintended byproducts of combustion, the most common sources of which are industrial, municipal, and domestic waste burning (which accounts for more than 90 percent of dioxin releases to the environment) and production of paper, polyvinyl chloride (PVC) plastics, and certain chlorinated chemicals, such as phenoxy herbicides (EPA, 1994). Other anthropogenic

sources of small quantities of dioxins are cigarette smoke, home heating systems, and combustion of fossil fuels (e.g., oil, gas, diesel, coal). They are also formed in minor quantities by natural burning processes such as forest fires and volcanic eruptions. In 1997, the National Center for Environmental Assessment (NCEA) estimated the mean dioxin concentration (in terms of toxicity equivalence [TEQ]) within the continental United States at 20 parts per trillion (ppt) for urban soils and 4 ppt for rural soils (NCEA, 1997). In 1994, EPA estimated the background concentration of dioxins (in terms of TEQ) in soils within the continental United States to be approximately 8 ppt (EPA, 1994).

Table 5 provides the TEQ calculations for all sites and samples for which dioxin analysis was conducted. TEQ concentrations detected at the Consent Order sites were all approximately 8 ppt or less. Based on historical records and personnel interviews, there is no knowledge that dioxin-producing activities such as waste burning of paper or plastic, or herbicide production occurred at these sites. In fact, there are no known site-related sources of dioxins at any of the sites under investigation. Based on the above information, dioxin presence in historical samples is likely attributable to background. Dioxin analysis at the 12 Consent Order sites was done simply because the Phase I RFI took place under RCRA; the Appendix IX list, which is commonly used for RCRA investigations, includes dioxins. Dioxin analysis at the 12 Consent Order sites was not warranted based on historical site activities and would very likely not have been included in the analytical parameter list had the investigation been conducted under CERCLA.

### Polycyclic Aromatic Hydrocarbons

A third class of chemicals that may have non-site-related sources is polycyclic aromatic hydrocarbons (PAHs), which are a subset of semivolatile organic compounds (SVOCs). PAHs have both natural and anthropogenic sources on a local, regional, and global scale. Natural sources include volcanic eruptions and forest fires. Anthropogenic sources, which contribute much more than natural sources (on a global scale), include domestic wood burning and automobile emissions (ATSDR, 1995). Background concentrations of PAHs reported for the United States vary by setting (i.e., rural, agricultural, and urban) and by specific PAH, as shown in Table 6.

Unlike pesticides and dioxins, PAHs found at Vieques sites may be from CERCLA-related releases due to the nature of historical activities at the sites. Therefore, where PAHs are detected at the sites, they are evaluated as a potential release. The information above regarding sources and background levels of PAHs is presented primarily to emphasize that non-site-related sources are possible and to provide a basis of comparison in the event that site data other than PAHs (i.e., absence of other constituents) and historical information about a particular site indicate a release of PAHs is unlikely.

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**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 2 | SWMU 2 | SWMU 2 | SWMU 2 | SWMU 2 | SWMU 2 | SWMU 2 | SWMU 2 | | SWMU 2 | SWMU 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW2SS01 | CGW2SS02 | CGW2SS03 | CGW2SS04 | CGW2SS05 | CGW2SS06 | CGW2SS07 | CGW2SS08 | | CGW2SS09 | CGW2SS10 |
| **Sample ID** | **Detected** | **Detected** | CGW2SS01-R01 | CGW2SS02-R01 | CGW2SS03-R01 | CGW2SS04-R01 | CGW2SS05-R01 | CGW2SS06-R01 | CGW2SS07-R01 | CGW2FD01P-R01 | CGW2SS08-R01 | CGW2SS09-R01 | CGW2SS10-R01 |
| **Sample Date** | **Concentration** | **Concentration** | 01/21/04 | 01/21/04 | 01/21/04 | 01/21/04 | 01/21/04 | 01/21/04 | 01/21/04 | 01/21/04 | 01/21/04 | 01/21/04 | 01/21/04 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.7 U | 3.9 U | 3.9 U | 3.7 U | 3.7 U | 3.8 U | 3.9 U | 3.9 U | 3.9 U | 3.4 U | 3.4 U |
| 4,4'-DDE | 0.08 J | 1,200 | 3.7 U | 3.9 U | 0.40 J | 0.28 J | 0.73 J | 3.8 U | 0.16 J | 3.9 U | 3.9 U | 0.59 J | 0.50 J |
| 4,4'-DDT | 0.30 J | 990 | 3.7 U | 3.9 U | 3.9 U | 3.7 U | 3.7 U | 3.8 U | 3.9 U | 3.9 U | 3.9 U | 3.4 U | 3.4 U |
| beta-BHC | 1.9 J | 1.9 J | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 1.8 U | 1.8 U |
| Chlordane | 14 | 14 | 4.7 U | 4.9 U | 4.9 U | 4.7 U | 4.7 U | 4.8 U | 5.0 U | 5.0 U | 5.0 U | 4.4 U | 4.4 U |
| delta-BHC | 0.41 J | 0.84 J | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 1.8 U | 1.8 U |
| Dieldrin | 0.37 J | 0.74 J | 3.7 U | 3.9 U | 3.9 U | 3.7 U | 3.7 U | 3.8 U | 3.9 U | 3.9 U | 3.9 U | 3.4 U | 3.4 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 1.8 U | 1.8 U |
| Endrin | 2.4 J | 2.4 J | 3.7 U | 3.9 U | 3.9 U | 3.7 U | 3.7 U | 3.8 U | 3.9 U | 3.9 U | 3.9 U | 3.4 U | 3.4 U |
| Endrin ketone | 1.3 J | 1.3 J | 3.7 U | 3.9 U | 3.9 U | 3.7 U | 3.7 U | 3.8 U | 3.9 U | 3.9 U | 3.9 U | 3.4 U | 3.4 U |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 1.8 U | 1.8 U |
| Heptachlor | 0.76 J | 0.76 J | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 1.8 U | 1.8 U |
| | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 5.2 J | 11 UJ | 12 UJ | 12 U | 11 U | 11 UJ | 12 U | 12 U | 12 U | 12 U | 10 U | 10 UJ |
| 2,4,5-TP (Silvex) | 60 | 87 | 11 UJ | 12 UJ | 12 U | 11 U | 11 UJ | 12 U | 12 U | 12 U | 12 U | 10 U | 10 UJ |
| 2,4-D | 14 J | 14 J | 11 UJ | 12 UJ | 12 U | 11 U | 11 UJ | 12 U | 12 U | 12 U | 12 U | 10 U | 10 UJ |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 2 | SWMU 2 | SWMU 4 | SWMU 4 | SWMU 4 | SWMU 4 | SWMU 4 | SWMU 4 | SWMU 4 | SWMU 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW2SS11 | CGW2SS12 | CGSWMU4SS001 | CGSWMU4SS002 | CGSWMU4SS003 | CGSWMU4SS004 | CGSWMU4SS005 | CGSWMU4SS006 | CGSWMU4SS007 | CGSWMU4SS008 |
| **Sample ID** | **Detected** | **Detected** | CGW2SS11-R01 | CGW2SS12-R01 | NDD021 | NDD022 | NDD023 | NDD024 | NDD025 | NDD026 | NDD027 | NDD028 |
| **Sample Date** | **Concentration** | **Concentration** | 01/21/04 | 01/21/04 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.5 U | 3.4 U | 3.4 UJ | 34 UJ | 3.7 UJ | 36 UJ | 32 UJ | 3.6 UJ | 3.2 UJ | 3.0 UJ |
| 4,4'-DDE | 0.08 J | 1,200 | 0.13 J | 0.080 J | 1.1 J | 17 UJ | 4.3 J | 18 UJ | 16 UJ | 1.8 UJ | 2.3 J | 3.2 J |
| 4,4'-DDT | 0.30 J | 990 | 3.5 U | 3.4 U | 1.2 J | 34 UJ | 2.2 J | 36 UJ | 4.1 J | 4.3 J | 0.59 J | 1.8 J |
| beta-BHC | 1.9 J | 1.9 J | 1.8 U | 1.8 U | 1.7 UJ | 17 UJ | 1.9 UJ | 18 UJ | 16 UJ | 1.8 UJ | 1.6 UJ | 1.5 UJ |
| Chlordane | 14 | 14 | 4.5 U | 4.4 U | 15 UJ | 150 UJ | 16 UJ | 159 UJ | 142 UJ | 16 UJ | 14 UJ | 13 UJ |
| delta-BHC | 0.41 J | 0.84 J | 1.8 U | 1.8 U | 1.7 UJ | 17 UJ | 1.9 UJ | 18 UJ | 16 UJ | 1.8 UJ | 1.6 UJ | 1.5 UJ |
| Dieldrin | 0.37 J | 0.74 J | 3.5 U | 3.4 U | 1.7 UJ | 17 UJ | 1.9 UJ | 18 UJ | 16 UJ | 1.8 UJ | 1.6 UJ | 1.5 UJ |
| Endosulfan I | 0.44 J | 0.44 J | 1.8 U | 1.8 U | 343 UJ | 3,400 UJ | 372 UJ | 3,620 UJ | 3,230 UJ | 356 UJ | 320 UJ | 297 UJ |
| Endrin | 2.4 J | 2.4 J | 3.5 U | 3.4 U | 3.4 UJ | 34 UJ | 3.7 UJ | 36 UJ | 32 UJ | 3.6 UJ | 3.2 UJ | 3.0 UJ |
| Endrin ketone | 1.3 J | 1.3 J | 3.5 U | 3.4 U | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.8 U | 1.8 U | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor | 0.76 J | 0.76 J | 1.8 U | 1.8 U | 1.7 UJ | 17 UJ | 1.9 UJ | 18 UJ | 16 UJ | 1.8 UJ | 1.6 UJ | 1.5 UJ |
| | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 5.2 J | 11 UJ | 10 U | 75 UJ | 755 UJ | 79 UJ | 79 UJ | 71 UJ | 78 UJ | 69 UJ | 69 UJ |
| 2,4,5-TP (Silvex) | 60 | 87 | 11 UJ | 10 U | 75 UJ | 755 UJ | 79 UJ | 79 UJ | 71 UJ | 78 UJ | 69 UJ | 69 UJ |
| 2,4-D | 14 J | 14 J | 11 UJ | 10 U | 14 J | 3,780 UJ | 397 UJ | 393 UJ | 354 UJ | 392 UJ | 345 UJ | 345 UJ |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 4 | SWMU 4 | SWMU 4 | SWMU 4 | | SWMU 5 | SWMU 5 | SWMU 5 | SWMU 5 | SWMU 6/7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGSWMU4SS009 | CGSWMU4SS010 | CGSWMU4SS011 | CGSWMU4SS012 | | CGW5SS01 | CGW5SS02 | CGW5SS03 | CGW5SS04 | CGSWMU6/7SS001 |
| **Sample ID** | **Detected** | **Detected** | NDD029 | NDD030 | NDD031 | NDD032 | NDD033FD1 | CGW5SS01-R01 | CGW5SS02-R01 | CGW5SS03-R01 | CGW5SS04-R01 | NDD034 |
| **Sample Date** | **Concentration** | **Concentration** | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 01/19/04 | 01/19/04 | 01/19/04 | 01/19/04 | 06/13/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.2 UJ | 3.8 UJ | 3.9 UJ | 3.8 UJ | 3.9 UJ | 3.5 U | 3.6 U | 3.6 U | 3.6 U | 3.2 U |
| 4,4'-DDE | 0.08 J | 1,200 | 4.5 J | 3.8 J | 1.9 UJ | 1.9 UJ | 2.0 UJ | 3.5 U | 3.6 U | 3.6 U | 3.6 U | 98 |
| 4,4'-DDT | 0.30 J | 990 | 3.4 J | 0.66 J | 3.9 UJ | 3.8 UJ | 3.9 UJ | 3.5 U | 3.6 U | 3.6 U | 3.6 U | 24 |
| beta-BHC | 1.9 J | 1.9 J | 1.6 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2.0 UJ | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.6 U |
| Chlordane | 14 | 14 | 14 UJ | 17 UJ | 17 UJ | 17 UJ | 17 UJ | 4.4 U | 4.6 U | 4.5 U | 4.5 U | 14 U |
| delta-BHC | 0.41 J | 0.84 J | 1.6 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2.0 UJ | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.6 UJ |
| Dieldrin | 0.37 J | 0.74 J | 1.6 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2.0 UJ | 3.5 U | 3.6 U | 3.6 U | 3.6 U | 1.6 U |
| Endosulfan I | 0.44 J | 0.44 J | 322 UJ | 378 UJ | 387 UJ | 379 UJ | 393 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 1.8 UJ | 319 U |
| Endrin | 2.4 J | 2.4 J | 3.2 UJ | 3.8 UJ | 3.9 UJ | 3.8 UJ | 3.9 UJ | 3.5 UJ | 3.6 UJ | 3.6 UJ | 3.6 UJ | 3.2 U |
| Endrin ketone | 1.3 J | 1.3 J | NA | NA | NA | NA | NA | 3.5 U | 3.6 U | 3.6 U | 3.6 U | NA |
| gamma-Chlordane | 0.52 J | 1.9 J | NA | NA | NA | NA | NA | 1.8 U | 1.9 U | 1.8 U | 1.8 U | NA |
| Heptachlor | 0.76 J | 0.76 J | 1.6 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2.0 UJ | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.6 U |
| | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 5.2 J | 70 UJ | 84 UJ | 84 UJ | 82 UJ | 86 UJ | 11 U | 11 U | 11 UJ | 11 U | 691 U |
| 2,4,5-TP (Silvex) | 60 | 87 | 70 UJ | 84 UJ | 84 UJ | 82 UJ | 86 UJ | 11 U | 11 U | 11 UJ | 11 U | 691 U |
| 2,4-D | 14 J | 14 J | 351 UJ | 418 UJ | 420 UJ | 408 UJ | 431 UJ | 11 U | 11 U | 11 UJ | 11 U | 3,450 U |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 6/7 | SWMU 6/7 | SWMU 6/7 | SWMU 6/7 | SWMU 6/7 | | SWMU 6/7 | SWMU 6/7 | SWMU 6/7 | SWMU 6/7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGSWMU6/7SS002 | CGSWMU6/7SS003 | CGSWMU6/7SS004 | CGSWMU6/7SS005 | CGSWMU6/7SS006 | | CGSWMU6/7SS007 | CGSWMU6/7SS008 | CGSWMU6/7SS009 | CGSWMU6/7SS010 |
| **Sample ID** | **Detected** | **Detected** | NDD035 | NDD036 | NDD037 | NDD038 | NDD039 | NDD043FD1 | NDD058 | NDD040 | NDD041 | NDD042 |
| **Sample Date** | **Concentration** | **Concentration** | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 | 06/13/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.2 U | 3.4 U | 3.9 U | 3.3 U | 3.8 UJ | 6.6 J | 3.2 U | 3.8 U | 3.1 U | 26 J |
| 4,4'-DDE | 0.08 J | 1,200 | 22 | 136 | 3.3 | 5.7 | 6.1 J | 31 J | 8.2 | 3.2 | 22 | 3.5 |
| 4,4'-DDT | 0.30 J | 990 | 7.5 | 146 | 0.81 J | 4.8 | 3.2 J | 54 J | 4.8 J | 3.8 U | 3.1 | 3.1 U |
| beta-BHC | 1.9 J | 1.9 J | 1.6 U | 1.7 U | 2.0 U | 1.6 U | 1.9 U | 1.9 U | 1.6 U | 1.9 U | 1.6 U | 1.6 U |
| Chlordane | 14 | 14 | 14 U | 15 U | 17 U | 14 U | 17 U | 17 U | 14 U | 17 U | 14 U | 14 |
| delta-BHC | 0.41 J | 0.84 J | 1.6 UJ | 1.7 UJ | 2.0 UJ | 1.6 UJ | 0.84 J | 1.9 UJ | 1.6 UJ | 1.9 UJ | 1.6 UJ | 1.6 UJ |
| Dieldrin | 0.37 J | 0.74 J | 1.6 U | 1.7 U | 2.0 U | 1.6 U | 1.9 U | 1.9 U | 1.6 U | 1.9 U | 1.6 U | 1.6 U |
| Endosulfan I | 0.44 J | 0.44 J | 324 U | 344 U | 391 U | 329 U | 380 U | 382 U | 318 U | 384 U | 313 U | 312 U |
| Endrin | 2.4 J | 2.4 J | 3.2 U | 3.4 U | 3.9 U | 3.3 U | 3.8 U | 3.8 U | 3.2 U | 3.8 U | 3.1 U | 3.1 U |
| Endrin ketone | 1.3 J | 1.3 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-Chlordane | 0.52 J | 1.9 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor | 0.76 J | 0.76 J | 1.6 U | 1.7 U | 2.0 U | 1.6 U | 1.9 U | 1.9 U | 1.6 U | 1.9 U | 1.6 U | 0.76 J |
| | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 5.2 J | 702 U | 752 U | 833 U | 709 U | 835 U | 840 U | 702 U | 826 U | 678 U | 688 U |
| 2,4,5-TP (Silvex) | 60 | 87 | 702 U | 752 U | 833 U | 709 U | 835 R | 840 U | 702 U | 826 U | 678 U | 688 U |
| 2,4-D | 14 J | 14 J | 3,510 U | 3,760 U | 4,160 U | 3,550 U | 4,180 U | 4,200 U | 3,510 U | 4,130 U | 3,390 U | 3,440 U |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 8 | | SWMU 8 | SWMU 8 | SWMU 8 | SWMU 8 | SWMU 10 | SWMU 10 | SWMU 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW8SS01 | | CGW8SS02 | CGW8SS03 | CGW8SS04 | CGW8SS05 | CGW10SS05 | CGW10SS06 | CGW10SS07 |
| **Sample ID** | **Detected** | **Detected** | CGW8FD01P-R01 | CGW8SS01-R01 | CGW8SS02-R01 | CGW8SS03-R01 | CGW8SS04-R01 | CGW8SS05-R01 | CGW10SS05-R01 | CGW10SS06-R01 | CGW10SS07-R01 |
| **Sample Date** | **Concentration** | **Concentration** | 01/19/04 | 01/19/04 | 01/19/04 | 01/19/04 | 01/19/04 | 01/19/04 | 01/22/04 | 01/20/04 | 01/20/04 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.6 U | 3.6 U | 4.0 U | 3.5 U | 3.4 U | 3.4 U | 0.26 J | 0.19 J | 3.9 U |
| 4,4'-DDE | 0.08 J | 1,200 | 3.6 U | 3.6 U | 4.0 U | 3.5 U | 3.4 U | 3.4 U | 110 J | 74 J | 28 J |
| 4,4'-DDT | 0.30 J | 990 | 3.6 U | 3.6 U | 0.46 J | 0.31 J | 3.4 U | 3.4 U | 0.92 J | 0.97 J | 3.9 U |
| beta-BHC | 1.9 J | 1.9 J | 1.8 U | 1.9 U | 2.0 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 2.0 U | 2.0 U |
| Chlordane | 14 | 14 | 4.6 U | 4.6 U | 5.0 U | 4.5 U | 4.3 U | 4.4 U | 4.7 U | 5.1 U | 5.0 U |
| delta-BHC | 0.41 J | 0.84 J | 1.8 UJ | 1.9 UJ | 2.0 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 U | 2.0 UJ | 2.0 UJ |
| Dieldrin | 0.37 J | 0.74 J | 3.6 U | 3.6 U | 4.0 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 4.0 U | 3.9 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.8 UJ | 1.9 UJ | 2.0 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 U | 2.0 U | 2.0 U |
| Endrin | 2.4 J | 2.4 J | 3.6 U | 3.6 U | 4.0 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 4.0 U | 3.9 U |
| Endrin ketone | 1.3 J | 1.3 J | 3.6 U | 3.6 U | 4.0 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 4.0 U | 3.9 U |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.8 U | 1.9 U | 2.0 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 2.0 U | 2.0 U |
| Heptachlor | 0.76 J | 0.76 J | 1.8 U | 1.9 U | 2.0 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 2.0 U | 2.0 U |
| | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 5.2 J | 11 U | 11 U | 12 U | 11 U | 10 U | 114 U | 11 UJ | 12 U | 12 U |
| 2,4,5-TP (Silvex) | 60 | 87 | 11 U | 11 U | 12 U | 11 U | 10 U | 114 U | 11 UJ | 12 U | 12 U |
| 2,4-D | 14 J | 14 J | 11 U | 11 U | 12 U | 11 U | 10 U | 114 U | 11 UJ | 12 U | 12 U |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW10SS08 | CGW10SS09 | CGW10SS10 | CGW10SS11 | CGW10SS12 | | CGW10SS13 | CGW10SS14 |
| **Sample ID** | **Detected** | **Detected** | CGW10SS08-R01 | CGW10SS09-R01 | CGW10SS10-R01 | CGW10SS11-R01 | CGW10FD01P-R01 | CGW10SS12-R01 | CGW10SS13-R01 | CGW10SS14-R01 |
| **Sample Date** | **Concentration** | **Concentration** | 01/22/04 | 01/20/04 | 01/20/04 | 01/20/04 | 01/20/04 | 01/20/04 | 01/20/04 | 01/20/04 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 0.30 J | 11 J | 0.44 J | 0.50 J | 0.56 J | 0.60 J | 3.8 U | 3.8 U |
| 4,4'-DDE | 0.08 J | 1,200 | 47 J | 120 J | 70 J | 100 J | 20 J | 40 J | 5.8 J | 12 J |
| 4,4'-DDT | 0.30 J | 990 | 4.0 U | 3.8 U | 4.0 U | 3.7 U | 3.6 U | 3.6 U | 3.8 U | 3.8 U |
| beta-BHC | 1.9 J | 1.9 J | 2.1 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.0 U |
| Chlordane | 14 | 14 | 5.1 U | 4.8 U | 5.1 U | 4.8 U | 4.6 U | 4.6 U | 4.8 U | 4.9 U |
| delta-BHC | 0.41 J | 0.84 J | 2.1 U | 1.9 UJ | 2.1 UJ | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.9 UJ | 2.0 UJ |
| Dieldrin | 0.37 J | 0.74 J | 4.0 U | 0.37 J | 4.0 U | 3.7 U | 3.6 U | 0.74 J | 3.8 U | 3.8 U |
| Endosulfan I | 0.44 J | 0.44 J | 2.1 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.0 U |
| Endrin | 2.4 J | 2.4 J | 4.0 U | 3.8 U | 4.0 U | 3.7 U | 3.6 U | 3.6 U | 3.8 U | 3.8 U |
| Endrin ketone | 1.3 J | 1.3 J | 4.0 U | 3.8 U | 4.0 U | 3.7 U | 3.6 U | 3.6 U | 3.8 U | 3.8 U |
| gamma-Chlordane | 0.52 J | 1.9 J | 2.1 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.0 U |
| Heptachlor | 0.76 J | 0.76 J | 2.1 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.0 U |
| | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 5.2 J | 12 UJ | 11 UJ | 12 UJ | 11 UJ | 11 UJ | 11 UJ | 11 UJ | 12 U |
| 2,4,5-TP (Silvex) | 60 | 87 | 12 UJ | 11 UJ | 12 UJ | 11 UJ | 11 UJ | 11 UJ | 11 UJ | 12 U |
| 2,4-D | 14 J | 14 J | 12 UJ | 11 UJ | 12 UJ | 11 UJ | 11 UJ | 11 UJ | 11 UJ | 12 U |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 12 | SWMU 12 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW10SS15 | CGW10SS16 | CGW10SS17 | CGW10SS18 | CGW10SS19 | CGW10SS20 | CGW12SS01 | CGW12SS02 |
| **Sample ID** | **Detected** | **Detected** | CGW10SS15-R01 | CGW10SS16-R01 | CGW10SS17-R01 | CGW10SS18-R01 | CGW10SS19-R01 | CGW10SS20-R01 | CGW12SS01-R01 | CGW12SS02-R01 |
| **Sample Date** | **Concentration** | **Concentration** | 01/20/04 | 01/22/04 | 01/22/04 | 01/22/04 | 01/20/04 | 01/22/04 | 01/19/04 | 01/19/04 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 0.23 J | 3.8 U | 10 J | 0.16 J | 0.54 J | 0.33 J | 3.5 U | 3.5 U |
| 4,4'-DDE | 0.08 J | 1,200 | 17 J | 4.8 J | 73 J | 19 J | 66 J | 20 J | 3.5 U | 3.5 U |
| 4,4'-DDT | 0.30 J | 990 | 3.8 U | 0.30 J | 84 | 0.39 J | 3.8 U | 0.44 J | 3.5 U | 3.5 U |
| beta-BHC | 1.9 J | 1.9 J | 2.0 U | 2.0 U | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.8 U | 1.8 U |
| Chlordane | 14 | 14 | 4.8 U | 4.9 U | 4.8 U | 5.0 U | 4.9 U | 4.8 U | 4.5 U | 4.5 U |
| delta-BHC | 0.41 J | 0.84 J | 2.0 UJ | 2.0 U | 1.9 U | 2.0 U | 2.0 UJ | 1.9 U | 1.8 U | 1.8 U |
| Dieldrin | 0.37 J | 0.74 J | 3.8 U | 3.8 U | 3.8 U | 3.9 U | 3.8 U | 3.7 U | 3.5 U | 3.5 U |
| Endosulfan I | 0.44 J | 0.44 J | 2.0 U | 2.0 U | 1.9 U | NA | 2.0 U | 1.9 U | 1.8 UJ | 1.8 UJ |
| Endrin | 2.4 J | 2.4 J | 3.8 U | 3.8 U | 3.8 U | 3.9 U | 3.8 U | 3.7 U | 3.5 UJ | 3.5 UJ |
| Endrin ketone | 1.3 J | 1.3 J | 3.8 U | 3.8 U | 3.8 U | 3.9 U | 3.8 U | 3.7 U | 3.5 U | 3.5 U |
| gamma-Chlordane | 0.52 J | 1.9 J | 2.0 U | 2.0 U | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.8 U | 1.8 U |
| Heptachlor | 0.76 J | 0.76 J | 2.0 U | 2.0 U | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.8 U | 1.8 U |
| | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 5.2 J | 11 U | 12 UJ | 11 UJ | 12 UJ | 12 UJ | 11 UJ | 11 UJ | 11 U |
| 2,4,5-TP (Silvex) | 60 | 87 | 11 U | 12 UJ | 11 UJ | 12 UJ | 12 UJ | 11 UJ | 11 UJ | 11 U |
| 2,4-D | 14 J | 14 J | 11 U | 12 UJ | 11 UJ | 12 UJ | 12 UJ | 11 UJ | 11 UJ | 11 U |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 12 | | SWMU 12 | SWMU 12 | AOC G | AOC G | AOC G | AOC G | AOC G | | AOC F | AOC F | AOC F | AOC F | AOC F | | PI 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW12SS03 | | CGW12SS04 | CGW12SS05 | CGAGSS01 | CGAGSS02 | CGAGSS03 | CGAGSS04 | CGAGSS05 | | CGAOCFSS001 | CGAOCFSS002 | CGAOCFSS003 | CGAOCFSS004 | CGAOCFSS005 | | EPI04-SO01 |
| **Sample ID** | **Detected** | **Detected** | CGW12FD01P-R01 | CGW12SS03-R01 | CGW12SS04-R01 | CGW12SS05-R01 | CGAGSS01-R01 | CGAGSS02-R01 | CGAGSS03-R01 | CGAGSS04-R01 | CGAGSS05-R01 | CGAGSSFD01P-R01 | NDD044 | NDD045 | NDD046 | NDD047 | NDD048 | NDD049FD1 | EPI04-SS01-0001 |
| **Sample Date** | **Concentration** | **Concentration** | 01/19/04 | 01/19/04 | 01/19/04 | 01/19/04 | 01/22/04 | 01/22/04 | 01/22/04 | 01/22/04 | 01/22/04 | 01/22/04 | 06/14/00 | 06/14/00 | 06/14/00 | 06/14/00 | 06/14/00 | 06/14/00 | 01/26/06 |
| **Chemical Name** | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.4 U | 3.5 U | 3.5 U | 3.5 U | 0.17 J | 0.31 J | 0.33 J | 0.93 J | 0.72 J | 0.56 J | 3.6 UJ | 3.1 UJ | 4.2 UJ | 3.5 UJ | 3.9 UJ | 3.4 UJ | 3.7 U |
| 4,4'-DDE | 0.080 J | 1,200 | 3.4 U | 3.5 U | 3.5 U | 3.5 U | 13 J | 5.8 J | 9.2 J | 31 J | 12 J | 15 J | 1.8 UJ | 1.5 UJ | 2.1 UJ | 1.7 UJ | 2.0 UJ | 1.7 UJ | 3.8 |
| 4,4'-DDT | 0.30 J | 990 | 3.4 U | 3.5 U | 3.5 U | 3.5 U | 2.4 J | 1.4 J | 1.4 J | 2.0 J | 1.2 J | 0.96 J | 3.6 UJ | 3.1 UJ | 4.2 UJ | 3.5 UJ | 3.9 UJ | 3.4 UJ | 1.4 J |
| beta-BHC | 1.9 J | 1.9 J | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 2.1 U | 2.0 U | 2.0 U | 2.0 U | 1.8 UJ | 1.5 UJ | 2.1 UJ | 1.7 UJ | 2.0 UJ | 1.7 UJ | 1.9 U |
| Chlordane | 14 | 14 | 4.3 U | 4.4 U | 4.4 U | 4.4 U | 4.6 U | 4.7 U | 5.1 U | 4.8 U | 4.9 U | 4.9 U | 16 UJ | 14 UJ | 18 UJ | 15 UJ | 17 UJ | 15 UJ | NA |
| delta-BHC | 0.41 J | 0.84 J | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 2.1 U | 2.0 U | 2.0 U | 2.0 U | 1.8 UJ | 1.5 UJ | 2.1 UJ | 1.7 UJ | 2.0 UJ | 0.73 J | 1.9 U |
| Dieldrin | 0.37 J | 0.74 J | 3.4 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.7 U | 4.0 U | 3.8 U | 3.9 U | 3.8 U | 1.8 UJ | 1.5 UJ | 2.1 UJ | 1.7 UJ | 2.0 UJ | 1.7 UJ | 3.7 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.7 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 U | 1.9 U | 2.1 U | 2.0 U | 2.0 U | 2.0 U | 362 UJ | 307 UJ | 420 UJ | 346 UJ | 395 UJ | 339 UJ | 1.9 U |
| Endrin | 2.4 J | 2.4 J | 3.4 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.6 U | 3.7 U | 4.0 U | 3.8 U | 3.9 U | 3.8 U | 3.6 UJ | 3.1 UJ | 4.2 UJ | 3.5 UJ | 3.9 UJ | 3.4 UJ | 3.7 U |
| Endrin ketone | 1.3 J | 1.3 J | 3.4 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.7 U | 4.0 U | 3.8 U | 3.9 U | 3.8 U | NA | NA | NA | NA | NA | NA | 3.7 U |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 2.1 U | 2.0 U | 2.0 U | 2.0 U | NA | NA | NA | NA | NA | NA | 0.69 J |
| Heptachlor | 0.76 J | 0.76 J | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 2.1 U | 2.0 U | 2.0 U | 2.0 U | 1.8 UJ | 1.5 UJ | 2.1 UJ | 1.7 UJ | 2.0 UJ | 1.7 UJ | 1.9 U |
| | | | | | | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | 10 U | 10 U | 10 UJ | 10 U | 11 UJ | 11 UJ | 12 U | 12 U | 12 UJ | 12 UJ | 79 UJ | 67 UJ | 5.2 J | 75 UJ | 86 UJ | 73 UJ | NA |
| 2,4,5-TP (Silvex) | 60 | 87 | 10 U | 10 U | 10 UJ | 10 U | 11 UJ | 11 UJ | 12 U | 12 U | 12 UJ | 12 UJ | 79 UJ | 67 UJ | 92 UJ | 75 UJ | 86 UJ | 73 UJ | NA |
| 2,4-D | 14 J | 14 J | 10 U | 10 U | 10 UJ | 10 U | 11 UJ | 11 UJ | 12 U | 12 U | 12 UJ | 12 UJ | 394 UJ | 336 UJ | 460 UJ | 376 UJ | 432 UJ | 366 UJ | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PI 4 | PI 4 | PI 4 | PI 4 | | PI 4 | PI 4 | PI 4 | | PI 4 | PI 4 | PI 4 | PI 4 | PI 4 | PI 6 | PI 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPI04-SO02 | EPI04-SO03 | EPI04-SO04 | EPI04-SO05 | | EPI04-SO06 | EPI04-SO07 | EPI04-SO08 | | EPI04-SO09 | EPI04-SO10 | EPI04-SO11 | EPI04-SO12 | EPI04-SO13 | VNTR-PI6-1 | VNTR-PI6-2 |
| **Sample ID** | **Detected** | **Detected** | EPI04-SS02-0001 | EPI04-SS03-0001 | EPI04-SS04-0001 | EPI04-SS05-0001 | EPI04-SS05P-0001 | EPI04-SS06-0001 | EPI04-SS07-0001 | EPI04-SS08-0001 | EPI04-SS08P-0001 | EPI04-SS09-0001 | EPI04-SS10-0001 | EPI04-SS11-0001 | EPI04-SS12-0001 | EPI04-SS13-0001 | VNTR-PI6-1 | VNTR-PI6-2 |
| **Sample Date** | **Concentration** | **Concentration** | 01/26/06 | 01/26/06 | 01/26/06 | 01/26/06 | 01/26/06 | 01/26/06 | 01/25/06 | 01/25/06 | 01/25/06 | 01/24/06 | 01/24/06 | 01/25/06 | 01/24/06 | 01/25/06 | 12/12/02 | 12/12/2002 |
| **Chemical Name** | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 2.1 J | 3.1 J | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.6 U | 3.6 U | 3.7 U | 3.3 U | 3.3 U |
| 4,4'-DDE | 0.080 J | 1,200 | 2.2 J | 12 | 1.2 J | 2.7 J | 4.7 | 620 | 36 | 29 | 27 | 9.1 | 84 | 26 | 180 | 5.9 | 3.3 U | 5.9 |
| 4,4'-DDT | 0.30 J | 990 | 3.6 U | 3.1 J | 3.5 U | 1.4 J | 27 | 100 | 7.8 | 3.1 J | 5.3 | 1.4 J | 2.8 J | 3.6 | 22 | 3.7 U | 3.3 U | 3.3 U |
| beta-BHC | 1.9 J | 1.9 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 3.7 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U |
| Chlordane | 14 | 14 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 17 U | 17 U |
| delta-BHC | 0.41 J | 0.84 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 0.75 J | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U |
| Dieldrin | 0.37 J | 0.74 J | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 7.3 U | 3.7 U | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.6 U | 3.6 U | 3.7 U | 3.3 U | 3.3 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 3.7 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 0.44 J | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U |
| Endrin | 2.4 J | 2.4 J | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 7.3 U | 3.7 U | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.6 U | 3.6 U | 3.7 U | 3.3 U | 3.3 U |
| Endrin ketone | 1.3 J | 1.3 J | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 7.3 U | 3.7 U | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.6 U | 3.6 U | 3.7 U | NA | NA |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.0 J | 1.9 U | 1.8 U | 1.8 U | 0.79 J | 1.8 U | 1.8 U | 1.8 U | 0.57 J | NA | NA |
| Heptachlor | 0.76 J | 0.76 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 3.7 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U |
| | | | | | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 10 U | 13 |
| 2,4,5-TP (Silvex) | 60 | 87 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 10 U | 60 |
| 2,4-D | 14 J | 14 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 40 U | 40 U |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PI 6 | | PI 6 | PI 6 | PI 6 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | VNTR-PI6-3 | | VEP6-SO04 | VEP6-SO05 | VEP6-SO06 | VNTR-PI7-1 | VNTR-PI7-2 | VNTR-PI7-3 | VNTR-PI7-4 | EPI07-SO01 | | EPI07-SO02 | EPI07-SO03 | EPI07-SO04 | EPI07-SO05 | EPI07-SO06 |
| **Sample ID** | **Detected** | **Detected** | VNTR-PI6-3 | VNTR-PI6-3D | VEP6-SS04-0H-0309 | VEP6-SS05-01-0309 | VEP6-SS06-01-0309 | VNTR-PI7-1 | VNTR-PI7-2 | VNTR-PI7-3 | VNTR-PI7-4 | EPI07-SS01-0001 | EPI07-SS01-0001P | EPI07-SS02-0001 | EPI07-SS03-0001 | EPI07-SS04-0001 | EPI07-SS05-0001 | EPI07-SS06-0001 |
| **Sample Date** | **Concentration** | **Concentration** | 12/12/2002 | 12/12/2002 | 03/05/09 | 03/11/09 | 03/11/09 | 12/16/02 | 12/16/02 | 12/16/02 | 12/16/02 | 03/13/06 | 03/13/06 | 03/13/06 | 03/13/06 | 03/13/06 | 03/14/06 | 03/14/06 |
| **Chemical Name** | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.3 U | 3.3 U | NA | NA | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.4 U | 3.5 U | 3.5 U |
| 4,4'-DDE | 0.080 J | 1,200 | 6.9 | 7.3 | NA | NA | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | 7.5 | 6.4 | 4.9 | 12 | 3.4 U | 22 | 13 |
| 4,4'-DDT | 0.30 J | 990 | 3.3 U | 3.3 U | NA | NA | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | 3.5 U | 3.5 U | 1.3 J | 2.5 J | 3.4 U | 3.5 U | 3.5 U |
| beta-BHC | 1.9 J | 1.9 J | 1.7 U | 1.7 U | NA | NA | NA | 1.7 U | 1.7 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Chlordane | 14 | 14 | 17 U | 17 U | NA | NA | NA | 17 U | 17 U | 17 U | 17 U | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | 0.41 J | 0.84 J | 1.7 U | 1.7 U | NA | NA | NA | 1.7 U | 1.7 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.9 U | 0.41 J | 1.8 U | 1.8 U | 1.8 U |
| Dieldrin | 0.37 J | 0.74 J | 3.3 U | 3.3 U | NA | NA | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.4 U | 3.5 U | 3.5 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.7 U | 1.7 U | NA | NA | NA | 1.7 U | 1.7 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Endrin | 2.4 J | 2.4 J | 3.3 U | 3.3 U | NA | NA | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.4 U | 3.5 U | 3.5 U |
| Endrin ketone | 1.3 J | 1.3 J | | | NA | NA | NA | NA | NA | NA | NA | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.4 U | 3.5 U | 3.5 U |
| gamma-Chlordane | 0.52 J | 1.9 J | | | NA | NA | NA | NA | NA | NA | NA | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Heptachlor | 0.76 J | 0.76 J | 1.7 U | 3.3 U | NA | NA | NA | 1.7 U | 1.7 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| | | | | | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | 27 | 27 | NA | NA | NA | 10 U | 10 U | 10 U | 10 U | NA | NA | NA | NA | NA | NA | NA |
| 2,4,5-TP (Silvex) | 60 | 87 | 87 | 10 U | NA | NA | NA | 10 U | 10 U | 10 U | 10 U | NA | NA | NA | NA | NA | NA | NA |
| 2,4-D | 14 J | 14 J | 40 U | 40 U | NA | NA | NA | 40 U | 40 U | 40 U | 40 U | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPI07-SO07 | EPI07-SO08 | EPI07-SO09 | EPI07-SO10 | EPI07-SO11 | EPI07-SO12 | EPI07-SO13 | EPI07-SO14 | EPI07-SO15 | EPI07-SO16 | | EPI07-SO17 | EPI07-SO18 | EPI07-SO19 | EPI07-SO20 | EPI07-SO21 |
| **Sample ID** | **Detected** | **Detected** | EPI07-SS07-0001 | EPI07-SS08-0001 | EPI07-SS09-0001 | EPI07-SS10-0001 | EPI07-SS11-0001 | EPI07-SS12-0001 | EPI07-SS13-0001 | EPI07-SS14-0001 | EPI07-SS15-0001 | EPI07-SS16-0001 | EPI07-SS16P-0001 | EPI07-SS17-0001 | EPI07-SS18-0001 | EPI07-SS19-0001 | EPI07-SS20-0001 | EPI07-SS21-0001 |
| **Sample Date** | **Concentration** | **Concentration** | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/16/06 | 03/16/06 | 03/16/06 | 03/15/06 | 03/15/06 | 03/15/06 | 03/16/06 | 03/16/06 |
| **Chemical Name** | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.5 U | 3.4 U | 3.5 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.5 U |
| 4,4'-DDE | 0.080 J | 1,200 | 1.7 J | 3.4 U | 1.7 J | 6.6 | 0.90 J | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 3.4 U | 150 | 1.4 J | 3.5 U | 3.5 U |
| 4,4'-DDT | 0.30 J | 990 | 3.5 U | 3.4 U | 3.5 U | 1.6 J | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 3.4 U | 31 | 1.7 J | 3.5 U | 3.5 U |
| beta-BHC | 1.9 J | 1.9 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 J | 1.7 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U |
| Chlordane | 14 | 14 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | 0.41 J | 0.84 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U |
| Dieldrin | 0.37 J | 0.74 J | 3.5 U | 3.4 U | 3.5 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.5 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U |
| Endrin | 2.4 J | 2.4 J | 3.5 U | 3.4 U | 3.5 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 2.4 J | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.5 U |
| Endrin ketone | 1.3 J | 1.3 J | 3.5 U | 3.4 U | 3.5 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | 3.5 U |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 J | 1.7 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U |
| Heptachlor | 0.76 J | 0.76 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U |
| | | | | | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4,5-TP (Silvex) | 60 | 87 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4-D | 14 J | 14 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

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J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PI 7 | PI 8 | PI 8 | PI 8 | | PI 8 | PI 8 | PI 8 | PI 8 | | PI 8 | PI 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPI07-SO22 | VNTR-PI8-1 | VNTR-PI8-2 | VNTR-PI8-3 | | VNTR-PI8-4 | VEP8-SO05 | VEP8-SO06 | VEP8-SO07 | | VEP8-SO08 | VEP8-SO09 |
| **Sample ID** | **Detected** | **Detected** | EPI07-SS22-0001 | VNTR-PI8-1 | VNTR-PI8-2 | VNTR-PI8-3 | VNTR-PI8-3D | VNTR-PI8-4 | VEP8-SS05-01-0209 | VEP8-SS06-01-0209 | VEP8-SS07-01-0209 | VEP8-SS07P-01-0209 | VEP8-SS08-01-0209 | VEP8-SS09-01-0209 |
| **Sample Date** | **Concentration** | **Concentration** | 03/16/06 | 12/12/02 | 12/12/02 | 12/12/02 | 12/12/02 | 12/12/02 | 02/19/09 | 02/19/09 | 02/20/09 | 02/20/09 | 02/19/09 | 02/20/09 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.5 U | 66 U | 33 U | 17 U | 17 U | 17 U | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | 0.080 J | 1,200 | 3.5 U | 363 | 634 | 159 | 62 | 147 | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | 0.30 J | 990 | 3.5 U | 411 | 772 | 59 | 59 | 57 | NA | NA | NA | NA | NA | NA |
| beta-BHC | 1.9 J | 1.9 J | 1.8 U | 34 U | 17 U | 8.5 U | 8.5 U | 8.5 U | NA | NA | NA | NA | NA | NA |
| Chlordane | 14 | 14 | NA | 334 U | 167 U | 84 U | 84 U | 84 U | NA | NA | NA | NA | NA | NA |
| delta-BHC | 0.41 J | 0.84 J | 1.8 U | 34 U | 17 U | 8.5 U | 8.5 U | 8.5 U | NA | NA | NA | NA | NA | NA |
| Dieldrin | 0.37 J | 0.74 J | 3.5 U | 66 U | 33 U | 17 U | 17 U | 17 U | NA | NA | NA | NA | NA | NA |
| Endosulfan I | 0.44 J | 0.44 J | 1.8 U | 34 U | 17 U | 8.5 U | 8.5 U | 8.5 U | NA | NA | NA | NA | NA | NA |
| Endrin | 2.4 J | 2.4 J | 3.5 U | 66 U | 112 | 17 U | 17 U | 17 U | NA | NA | NA | NA | NA | NA |
| Endrin ketone | 1.3 J | 1.3 J | 3.5 U | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.8 U | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Heptachlor | 0.76 J | 0.76 J | 1.8 U | 34 U | 17 U | 8.5 U | 8.5 U | 8.5 U | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | NA | 23 | 10 U | 10 U | 57 | 10 U | NA | NA | NA | NA | NA | NA |
| 2,4,5-TP (Silvex) | 60 | 87 | NA | 73 | 10 U | 10 U | 10 U | 10 U | NA | NA | NA | NA | NA | NA |
| 2,4-D | 14 J | 14 J | NA | 40 U | 40 U | 40 U | 40 U | 40 U | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PI 8 | PI 10 | PI 10 | | PI 10 | PAOC I | PAOC I | PAOC I | | PAOC I | PAOC I | PAOC J |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | VEP8-SO14 | VNTR-PI10-1 | VNTR-PI10-2 | | VNTR-PI10-3 | VEPI-SO01 | VEPI-SO02 | VEPI-SO03 | | VEPI-SO04 | VEPI-SO05 | EPAJ-SO01 |
| **Sample ID** | **Detected** | **Detected** | VEP8-SS14-01-0209 | VNTR-PI10-1 | VNTR-PI10-2 | VNTR-PI10-2D | VNTR-PI10-3 | VEPI-SS01-01-0209 | VEPI-SS02-01-0209 | VEPI-SS03-01-0209 | VEPI-SS03P-01-0209 | VEPI-SS04-01-0209 | VEPI-SS05-01-0209 | EPAJ-SS01-0001 |
| **Sample Date** | **Concentration** | **Concentration** | 02/23/09 | 12/12/02 | 12/12/02 | 12/12/02 | 12/12/02 | 02/24/09 | 02/24/09 | 02/24/09 | 02/24/09 | 02/24/09 | 02/24/09 | 03/02/06 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | NA | NA | NA | NA | NA | NA | 2.0 J |
| 4,4'-DDE | 0.080 J | 1,200 | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | NA | NA | NA | NA | NA | NA | 92 |
| 4,4'-DDT | 0.30 J | 990 | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | NA | NA | NA | NA | NA | NA | 28 |
| beta-BHC | 1.9 J | 1.9 J | NA | 1.7 U | 1.7 U | 1.7 U | 1.7 U | NA | NA | NA | NA | NA | NA | 1.8 U |
| Chlordane | 14 | 14 | NA | 17 U | 17 U | 17 U | 17 U | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | 0.41 J | 0.84 J | NA | 1.7 U | 1.7 U | 1.7 U | 1.7 U | NA | NA | NA | NA | NA | NA | 1.8 U |
| Dieldrin | 0.37 J | 0.74 J | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | NA | NA | NA | NA | NA | NA | 3.6 U |
| Endosulfan I | 0.44 J | 0.44 J | NA | 1.7 U | 1.7 U | 1.7 U | 1.7 U | NA | NA | NA | NA | NA | NA | 1.8 U |
| Endrin | 2.4 J | 2.4 J | NA | 3.3 U | 3.3 U | 3.3 U | 3.3 U | NA | NA | NA | NA | NA | NA | 3.6 U |
| Endrin ketone | 1.3 J | 1.3 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 3.6 U |
| gamma-Chlordane | 0.52 J | 1.9 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1.8 U |
| Heptachlor | 0.76 J | 0.76 J | NA | 1.7 U | 1.7 U | 1.7 U | 1.7 U | NA | NA | NA | NA | NA | NA | 1.8 U |
| | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | NA | 10 U | 10 U | 10 U | 10 U | NA | NA | NA | NA | NA | NA | NA |
| 2,4,5-TP (Silvex) | 60 | 87 | NA | 10 U | 10 U | 10 U | 10 U | NA | NA | NA | NA | NA | NA | NA |
| 2,4-D | 14 J | 14 J | NA | 40 U | 40 U | 40 U | 40 U | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections
NA - Not Analyzed
J - Analyte present, value may or may not be accurate or precise
R - Unreliable Result
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PAOC J | PAOC J | PAOC J | PAOC J | | PAOC J | PAOC K | PAOC K | PAOC K | PAOC K | | PAOC K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPAJ-SO02 | EPAJ-SO03 | EPAJ-SO04 | EPAJ-SO05 | | EPAJ-SO06 | EPAK-SO01 | EPAK-SO02 | EPAK-SO03 | EPAK-SO04 | | EPAK-SO05 |
| **Sample ID** | **Detected** | **Detected** | EPAJ-SS02-0001 | EPAJ-SS03-0001 | EPAJ-SS04-0001 | EPAJ-SS05-0001 | EPAJ-SS05P-0001 | EPAJ-SS06-0001 | EPAK-SS01-0001 | EPAK-SS02-0001 | EPAK-SS03-0001 | EPAK-SS04-0001 | EPAK-SS04P-0001 | EPAK-SS05-0001 |
| **Sample Date** | **Concentration** | **Concentration** | 03/01/06 | 03/01/06 | 03/01/06 | 03/02/06 | 03/02/06 | 03/01/06 | 03/01/06 | 02/28/06 | 03/02/06 | 02/28/06 | 02/28/06 | 02/28/06 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.6 U | 4.0 | 6.8 J | 3.5 U | 3.6 U | 3.8 U | 3.8 U | 3.9 U | 3.5 U | 6.1 J | 7.9 | 3.4 U |
| 4,4'-DDE | 0.080 J | 1,200 | 51 | 420 | 1,200 | 49 | 3.0 J | 1.2 J | 25 | 3.3 J | 110 | 1,200 | 830 | 50 |
| 4,4'-DDT | 0.30 J | 990 | 8.5 | 46 | 990 | 11 | 21 | 1.7 J | 8.7 | 3.9 U | 27 | 490 | 320 | 16 |
| beta-BHC | 1.9 J | 1.9 J | 1.9 U | 1.8 U | 8.9 U | 1.8 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 1.8 U | 8.8 U | 1.8 U | 1.8 U |
| Chlordane | 14 | 14 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | 0.41 J | 0.84 J | 1.9 U | 1.8 U | 8.9 U | 1.8 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 1.8 U | 8.8 U | 1.8 U | 1.8 U |
| Dieldrin | 0.37 J | 0.74 J | 3.6 U | 3.4 U | 17 U | 3.5 U | 3.6 U | 3.8 U | 3.8 U | 3.9 U | 3.5 U | 17 U | 3.4 U | 3.4 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.9 U | 1.8 U | 8.9 U | 1.8 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 1.8 U | 8.8 U | 1.8 U | 1.8 U |
| Endrin | 2.4 J | 2.4 J | 3.6 U | 3.4 U | 17 U | 3.5 U | 3.6 U | 3.8 U | 3.8 U | 3.9 U | 3.5 U | 17 U | 3.4 U | 3.4 U |
| Endrin ketone | 1.3 J | 1.3 J | 3.6 U | 3.4 U | 17 U | 3.5 U | 3.6 U | 3.8 U | 3.8 U | 3.9 U | 3.5 U | 17 U | 3.4 U | 3.4 U |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.9 U | 1.8 U | 8.9 U | 1.8 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 1.8 U | 8.8 U | 1.3 J | 1.8 U |
| Heptachlor | 0.76 J | 0.76 J | 1.9 U | 1.8 U | 8.9 U | 1.8 U | 1.9 U | 1.9 U | 2.0 U | 2.0 U | 1.8 U | 8.8 U | 1.8 U | 1.8 U |
| | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4,5-TP (Silvex) | 60 | 87 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4-D | 14 J | 14 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PAOC S | | PAOC S | PAOC S | PAOC S | PAOC S | PAOC U | PAOC U | PAOC U | PAOC U | | PAOC U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPAS-SO01 | | EPAS-SO02 | EPAS-SO03 | EPAS-SO04 | EPAS-SO05 | EPAU-SO01 | EPAU-SO02 | EPAU-SO03 | EPAU-SO04 | | EPAU-SO05 |
| **Sample ID** | **Detected** | **Detected** | EPAS-SS01-0001 | EPAS-SS01P-0001 | EPAS-SS02-0001 | EPAS-SS03-0001 | EPAS-SS04-0001 | EPAS-SS05-0001 | EPAU-SS01-0001 | EPAU-SS02-0001 | EPAU-SS03-0001 | EPAU-SS04-0001 | EPAU-SS04P-0001 | EPAU-SS05-0001 |
| **Sample Date** | **Concentration** | **Concentration** | 02/02/06 | 02/02/06 | 02/02/06 | 02/02/06 | 02/02/06 | 02/02/06 | 03/01/06 | 03/03/06 | 03/03/06 | 03/03/06 | 03/03/06 | 03/03/06 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 7.9 | 4.6 | 1.8 J | 3.4 U | 3.8 U | 6.9 | 3.6 U | 3.4 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| 4,4'-DDE | 0.080 J | 1,200 | 550 | 650 | 270 | 330 | 17 | 580 | 23 | 54 | 82 | 4.5 J | 4.7 | 51 |
| 4,4'-DDT | 0.30 J | 990 | 110 | 100 | 70 | 15 | 5.4 | 270 | 31 | 8.0 | 10 | 1.7 J | 2.1 J | 3.7 |
| beta-BHC | 1.9 J | 1.9 J | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 2.0 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Chlordane | 14 | 14 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| delta-BHC | 0.41 J | 0.84 J | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 2.0 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Dieldrin | 0.37 J | 0.74 J | 3.8 U | 3.6 U | 3.7 U | 3.4 U | 3.8 U | 3.6 U | 3.6 U | 3.4 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 2.0 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Endrin | 2.4 J | 2.4 J | 3.8 U | 3.6 U | 3.7 U | 3.4 U | 3.8 U | 3.6 U | 3.6 U | 3.4 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| Endrin ketone | 1.3 J | 1.3 J | 3.8 U | 3.6 U | 3.7 U | 3.4 U | 3.8 U | 3.6 U | 3.6 U | 3.4 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 2.0 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Heptachlor | 0.76 J | 0.76 J | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 2.0 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4,5-TP (Silvex) | 60 | 87 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4-D | 14 J | 14 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 1**
East Vieques Surface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PAOC U | PAOC U | PAOC U | PAOC U | PAOC X | PAOC X | PAOC X | PAOC X |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPAU-SO06 | EPAU-SO07 | EPAU-SO08 | EPAU-SO09 | VNTR-X-1 | VNTR-X-2 | VNTR-X-3 | VNTR-X-4 |
| **Sample ID** | **Detected** | **Detected** | EPAU-SS06-0001 | EPAU-SS07-0001 | EPAU-SS08-0001 | EPAU-SS09-0001 | VNTR-X-1 | VNTR-X-2 | VNTR-X-3 | VNTR-X-4 |
| **Sample Date** | **Concentration** | **Concentration** | 03/03/06 | 03/03/06 | 03/01/06 | 03/03/06 | 12/12/02 | 12/12/02 | 12/12/02 | 12/12/02 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | |
| 4,4'-DDD | 0.16 J | 26 J | 3.5 U | 3.5 U | 3.4 U | 3.8 U | 14 | 3.3 U | 33 U | 5.5 |
| 4,4'-DDE | 0.080 J | 1,200 | 3.5 U | 53 | 37 | 3.8 U | 19 | 8.3 | 310 | 45 |
| 4,4'-DDT | 0.30 J | 990 | 3.5 U | 18 | 2.9 J | 3.8 U | 38 | 3.3 U | 76 | 8.0 |
| beta-BHC | 1.9 J | 1.9 J | 1.8 U | 1.8 U | 1.8 U | 3.2 R | 1.7 U | 1.7 U | 17 U | 1.7 U |
| Chlordane | 14 | 14 | NA | NA | NA | NA | 17 U | 17 U | 167 U | 17 U |
| delta-BHC | 0.41 J | 0.84 J | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U | 17 U | 1.7 U |
| Dieldrin | 0.37 J | 0.74 J | 3.5 U | 3.5 U | 3.4 U | 3.8 U | 3.3 U | 3.3 U | 33 U | 3.3 U |
| Endosulfan I | 0.44 J | 0.44 J | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U | 17 U | 1.7 U |
| Endrin | 2.4 J | 2.4 J | 3.5 U | 3.5 U | 3.4 U | 3.8 U | 3.3 U | 3.3 U | 33 U | 3.3 U |
| Endrin ketone | 1.3 J | 1.3 J | 3.5 U | 3.5 U | 1.3 J | 3.8 U | NA | NA | NA | NA |
| gamma-Chlordane | 0.52 J | 1.9 J | 1.8 U | 0.52 J | 1.8 U | 1.9 U | NA | NA | NA | NA |
| Heptachlor | 0.76 J | 0.76 J | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U | 17 U | 1.7 U |
| | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | |
| 2,4,5-T | 5.2 J | 57 | NA | NA | NA | NA | 10 U | 10 U | 10 U | 10 U |
| 2,4,5-TP (Silvex) | 60 | 87 | NA | NA | NA | NA | 10 U | 10 U | 10 U | 10 U |
| 2,4-D | 14 J | 14 J | NA | NA | NA | NA | 40 U | 40 U | 40 U | 40 U |

**Notes:**

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R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 2 | SWMU 2 | SWMU 4 | | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW2SB01 | CGW2SB02 | CGW4SB01 | | CGW10SB05 | CGW10SB06 | CGW10SB07 | CGW10SB08 | CGW10SB09 |
| **Sample ID** | **Detected** | **Detected** | CGW2SB01-R01-10 | CGW2SB02-R01-5 | CGW4FD01P-R01-5 | CGW4SB01-R01-5 | CGW10SB05-R01-5 | CGW10SB06-R01-5 | CGW10SB07-R01-5 | CGW10SB08-R01-5 | CGW10SB09-R01-5 |
| **Sample Date** | **Concentration** | **Concentration** | 01/21/04 | 01/22/04 | 01/21/04 | 01/21/04 | 01/22/04 | 01/20/04 | 01/20/04 | 01/22/04 | 01/20/04 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | NA | NA | NA | NA | 44 U | 3.8 U | 3.9 U | 3.9 UJ | 3.8 U |
| 4,4'-DDE | 0.076 J | 540 | NA | NA | NA | NA | 140 J | 2.9 J | 12 J | 6.1 J | 13 J |
| 4,4'-DDT | 0.31 J | 950 | NA | NA | NA | NA | 44 U | 3.8 U | 3.9 U | 3.9 UJ | 3.8 U |
| beta-BHC | 0.77 J | 2.2 JN | NA | NA | NA | NA | 22 U | 2.0 U | 2.0 U | 2.0 UJ | 1.9 U |
| Endrin aldehyde | 1.5 J | 1.5 J | NA | NA | NA | NA | 44 U | 3.8 U | 3.9 U | 3.9 UJ | 3.8 U |
| Endrin ketone | 0.82 J | 0.82 J | NA | NA | NA | NA | 44 U | 3.8 U | 3.9 U | 3.9 UJ | 3.8 U |
| gamma-Chlordane | 0.45 J | 1.1 J | NA | NA | NA | NA | 22 U | 2.0 U | 2.0 U | 2.0 UJ | 1.9 U |
| Methoxychlor | 11 J | 11 J | NA | NA | NA | NA | 220 U | 20 U | 20 U | 20 UJ | 19 U |
| | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | |
| No Detections | -- | -- | ND | ND | ND | ND | ND | ND | ND | ND | ND |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | SWMU 10 | | SWMU 10 | SWMU 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW10SB10 | CGW10SB11 | CGW10SB12 | CGW10SB13 | CGW10SB14 | CGW10SB15 | CGW10SB16 | | CGW10SB17 | CGW10SB18 |
| **Sample ID** | **Detected** | **Detected** | CGW10SB10-R01-5 | CGW10SB11-R01-5 | CGW10SB12-R01-5 | CGW10SB13-R01-5 | CGW10SB14-R01-5 | CGW10SB15-R01-5 | CGW10FD02P-R01 | CGW10SB16-R01-5 | CGW10SB17-R01-5 | CGW10SB18-R01-5 |
| **Sample Date** | **Concentration** | **Concentration** | 01/20/04 | 01/20/04 | 01/20/04 | 01/20/04 | 01/20/04 | 01/20/04 | 01/22/04 | 01/22/04 | 01/22/04 | 01/22/04 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | 3.8 U | 3.7 U | 3.8 U | 4.0 U | 3.6 U | 3.7 U | 4.0 U | 41 U | 3.8 U | 3.7 U |
| 4,4'-DDE | 0.076 J | 540 | 18 J | 2.4 J | 9.4 J | 0.076 J | 2.0 J | 1.4 J | 0.21 J | 2.5 J | 4.6 J | 4.5 J |
| 4,4'-DDT | 0.31 J | 950 | 3.8 U | 3.7 U | 3.8 U | 4.0 U | 3.6 U | 3.7 U | 4.0 U | 41 U | 0.31 J | 3.7 U |
| beta-BHC | 0.77 J | 2.2 JN | 2.0 U | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 2.0 U | 21 U | 1.9 U | 1.9 U |
| Endrin aldehyde | 1.5 J | 1.5 J | 3.8 U | 3.7 U | 3.8 U | 4.0 U | 3.6 U | 3.7 U | 4.0 U | 41 U | 3.8 U | 3.7 U |
| Endrin ketone | 0.82 J | 0.82 J | 3.8 UJ | 3.7 U | 3.8 U | 4.0 U | 3.6 U | 3.7 U | 4.0 U | 41 U | 3.8 U | 3.7 U |
| gamma-Chlordane | 0.45 J | 1.1 J | 2.0 U | 1.9 U | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 2.0 U | 21 U | 1.9 U | 1.9 U |
| Methoxychlor | 11 J | 11 J | 20 U | 19 U | 20 U | 20 U | 19 U | 19 U | 20 U | 210 U | 19 U | 19 U |
| | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | |
| No Detections | -- | -- | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

**Notes:**

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J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | SWMU 10 | SWMU 10 | | PI 4 | PI 4 | PI 4 | PI 4 | PI 4 | PI 4 | PI 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | CGW10SB19 | CGW10SB20 | | EPI04-SO01 | EPI04-SO02 | EPI04-SO03 | EPI04-SO04 | EPI04-SO05 | EPI04-SO06 | EPI04-SO07 |
| **Sample ID** | **Detected** | **Detected** | CGW10SB19-R01-5 | CGW10FD04P-R01 | CGW10SB20-R01-5 | EPI04-SB01-0406 | EPI04-SB02-0406 | EPI04-SB03-0406 | EPI04-SB04-0406 | EPI04-SB05-0406 | EPI04-SB06-0406 | EPI04-SB07-0406 |
| **Sample Date** | **Concentration** | **Concentration** | 01/20/04 | 01/22/04 | 01/22/04 | 01/26/06 | 01/26/06 | 01/26/06 | 01/26/06 | 01/26/06 | 01/26/06 | 01/25/06 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | 3.7 U | 3.8 UJ | 3.8 U | 3.5 U | 3.4 U | 3.5 U | 3.8 U | 3.5 U | 3.7 U | 1.2 J |
| 4,4'-DDE | 0.076 J | 540 | 2.2 J | 1.5 J | 0.87 J | 3.5 U | 3.4 U | 1.5 J | 3.8 U | 3.5 U | 2.7 J | 1.1 J |
| 4,4'-DDT | 0.31 J | 950 | 3.7 U | 3.8 UJ | 3.8 U | 3.5 U | 3.4 U | 3.5 U | 3.8 U | 3.5 U | 2.2 J | 3.7 U |
| beta-BHC | 0.77 J | 2.2 JN | 1.9 U | 1.9 UJ | 2.0 U | 1.8 U | 1.8 U | 1.8 U | 2.0 U | 1.8 U | 1.9 U | 1.9 U |
| Endrin aldehyde | 1.5 J | 1.5 J | 3.7 U | 3.8 UJ | 3.8 U | 3.5 U | 3.4 U | 3.5 U | 3.8 U | 3.5 U | 3.7 U | 3.7 U |
| Endrin ketone | 0.82 J | 0.82 J | 3.7 U | 3.8 UJ | 3.8 U | 3.5 U | 3.4 U | 3.5 U | 3.8 U | 3.5 U | 3.7 U | 3.7 U |
| gamma-Chlordane | 0.45 J | 1.1 J | 1.9 U | 1.9 UJ | 2.0 U | 0.49 J | 0.45 J | 1.8 U | 2.0 U | 0.65 J | 0.50 J | 0.48 J |
| Methoxychlor | 11 J | 11 J | 19 U | 19 UJ | 20 U | 18 U | 18 U | 18 U | 20 U | 18 U | 19 U | 19 U |
| | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | |
| No Detections | -- | -- | ND | ND | ND | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

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NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PI 4 | | PI 4 | PI 4 | PI 4 | PI 4 | PI 4 | PI 6 | | PI 6 | PI 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPI04-SO08 | | EPI04-SO09 | EPI04-SO10 | EPI04-SO11 | EPI04-SO12 | EPI04-SO13 | VEP6-SO05 | | VEP6-SO06 | EPI07-SC |
| **Sample ID** | **Detected** | **Detected** | EPI04-SB08-0406 | EPI04-SB08P-0406 | EPI04-SB09-0406 | EPI04-SB10-0406 | EPI04-SB11-0406 | EPI04-SB12-0406 | EPI04-SB13-0406 | VEP6-SB05-46-0309 | VEP6-SB05P-46-030 | VEP6-SB06-46-0309 | EPI07-SB01 |
| **Sample Date** | **Concentration** | **Concentration** | 01/25/06 | 01/25/06 | 01/24/06 | 01/24/06 | 01/25/06 | 01/24/06 | 01/25/06 | 03/11/09 | 03/11/09 | 03/11/09 | 03/13/0 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | 3.5 U | 3.5 U | 0.89 J | 3.6 U | 3.8 U | 3.5 U | 3.8 U | NA | NA | NA | 3.6 |
| 4,4'-DDE | 0.076 J | 540 | 71 | 47 | 44 | 50 | 0.79 J | 220 | 3.8 U | NA | NA | NA | 3.6 |
| 4,4'-DDT | 0.31 J | 950 | 8.5 | 11 | 56 | 1.9 J | 3.8 U | 6.1 | 3.8 U | NA | NA | NA | 3.6 |
| beta-BHC | 0.77 J | 2.2 JN | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 2.0 U | NA | NA | NA | 1.9 |
| Endrin aldehyde | 1.5 J | 1.5 J | 1.5 J | 3.5 U | 3.5 U | 3.6 U | 3.8 U | 3.5 U | 3.8 U | NA | NA | NA | 3.6 |
| Endrin ketone | 0.82 J | 0.82 J | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.8 U | 3.5 U | 3.8 U | NA | NA | NA | 3.6 |
| gamma-Chlordane | 0.45 J | 1.1 J | 1.8 U | 1.8 U | 1.8 U | 1.1 J | 1.9 U | 1.8 U | 2.0 U | NA | NA | NA | 1.9 |
| Methoxychlor | 11 J | 11 J | 18 U | 18 U | 18 U | 18 U | 19 U | 18 U | 20 U | NA | NA | NA | 19 |
| | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | |
| No Detections | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | |
|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | )01 |
| **Sample ID** | **Detected** | **Detected** | -0406 |
| **Sample Date** | **Concentration** | **Concentration** | 6 |
| **Chemical Name** | | | |
| | | | |
| **Pesticides (UG/KG)** | | | |
| 4,4'-DDD | 0.89 J | 44 | U |
| 4,4'-DDE | 0.076 J | 540 | U |
| 4,4'-DDT | 0.31 J | 950 | U |
| beta-BHC | 0.77 J | 2.2 JN | U |
| Endrin aldehyde | 1.5 J | 1.5 J | U |
| Endrin ketone | 0.82 J | 0.82 J | U |
| gamma-Chlordane | 0.45 J | 1.1 J | U |
| Methoxychlor | 11 J | 11 J | U |
| | | | |
| **Herbicides (UG/KG)** | | | |
| No Detections | -- | -- | |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | | PI 7 | PI 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPI07-SO02 | EPI07-SO03 | EPI07-SO04 | EPI07-SO05 | EPI07-SO06 | EPI07-SO07 | EPI07-SO08 | EPI07-SO09 | | EPI07-SO10 | EPI07-S |
| **Sample ID** | **Detected** | **Detected** | EPI07-SB02-0406 | EPI07-SB03-0406 | EPI07-SB04-0406 | EPI07-SB05-0406 | EPI07-SB06-0406 | EPI07-SB07-0406 | EPI07-SB08-0406 | EPI07-SB09-0406 | EPI07-SB09P-0406 | EPI07-SB10-0406 | EPI07-SB1 |
| **Sample Date** | **Concentration** | **Concentration** | 03/13/06 | 03/13/06 | 03/13/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/06 | 03/14/ |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.6 U | 3.7 U | 3.4 |
| 4,4'-DDE | 0.076 J | 540 | 4.2 | 3.7 U | 3.6 U | 0.98 J | 3.7 U | 3.7 U | 130 | 0.76 J | 3.6 U | 3.7 U | 3.4 |
| 4,4'-DDT | 0.31 J | 950 | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.6 U | 3.7 U | 3.4 |
| beta-BHC | 0.77 J | 2.2 JN | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 |
| Endrin aldehyde | 1.5 J | 1.5 J | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.6 U | 3.7 U | 3.4 |
| Endrin ketone | 0.82 J | 0.82 J | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.6 U | 3.7 U | 3.4 |
| gamma-Chlordane | 0.45 J | 1.1 J | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 |
| Methoxychlor | 11 J | 11 J | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 18 U | 19 U | 18 |
| | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | |
| No Detections | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 7 | PI 8 | PI 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | D11 | EPI07-SO14 | EPI07-SO15 | EPI07-SO16 | EPI07-SO17 | EPI07-SO18 | EPI07-SO19 | EPI07-SO21 | VEP8-SO05 | VEP8-SO06 |
| **Sample ID** | **Detected** | **Detected** | L-0102 | EPI07-SB14-0406 | EPI07-SB15-0204 | EPI07-SB16-0204 | EPI07-SB17-0102 | EPI07-SB18-0204 | EPI07-SB19-0204 | EPI07-SB21-0103 | VEP8-SB05-46-0209 | VEP8-SB06-46-020 |
| **Sample Date** | **Concentration** | **Concentration** | 06 | 03/14/06 | 03/16/06 | 03/16/06 | 03/15/06 | 03/15/06 | 03/15/06 | 03/16/06 | 02/19/09 | 02/19/09 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | U | 3.5 U | 3.6 U | 3.7 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | NA | NA |
| 4,4'-DDE | 0.076 J | 540 | U | 3.5 U | 3.6 U | 3.7 U | 3.4 U | 19 | 3.4 U | 3.5 U | NA | NA |
| 4,4'-DDT | 0.31 J | 950 | U | 3.5 U | 3.6 U | 3.7 U | 3.4 U | 2.2 J | 3.4 U | 3.5 U | NA | NA |
| beta-BHC | 0.77 J | 2.2 JN | U | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U | 1.7 U | 1.8 U | NA | NA |
| Endrin aldehyde | 1.5 J | 1.5 J | U | 3.5 U | 3.6 U | 3.7 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | NA | NA |
| Endrin ketone | 0.82 J | 0.82 J | U | 3.5 U | 3.6 U | 3.7 U | 3.4 U | 3.4 U | 3.4 U | 3.5 U | NA | NA |
| gamma-Chlordane | 0.45 J | 1.1 J | U | 1.8 U | 1.8 U | 1.9 U | 1.7 U | 1.7 U | 1.7 U | 1.8 U | NA | NA |
| Methoxychlor | 11 J | 11 J | U | 18 U | 18 U | 19 U | 17 U | 17 U | 17 U | 18 U | NA | NA |
| | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | |
| No Detections | -- | -- | | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PI 8 | PI 8 | PI 8 | PAOC I | PAOC I | PAOC I | PAOC I | PAOC I | PAOC J | PAOC J | PAOC J | PAOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | VEP8-SO07 | VEP8-SO08 | VEP8-SO14 | VEPI-SO01 | VEPI-SO02 | VEPI-SO03 | VEPI-SO04 | VEPI-SO05 | EPAJ-SO01 | EPAJ-SO02 | EPAJ-SO03 | EPAJ-S |
| **Sample ID** | **Detected** | **Detected** | VEP8-SB07-46-020 | VEP8-SB08-46-020 | VEP8-SB14-46-020 | VEPI-SB01-46-020 | VEPI-SB02-46-020 | VEPI-SB03-46-020 | VEPI-SB04-46-020 | VEPI-SB05-46-020 | EPAJ-SB01-0405 | EPAJ-SB02-0406 | EPAJ-SB03-0406 | EPAJ-SB0 |
| **Sample Date** | **Concentration** | **Concentration** | 02/20/09 | 02/19/09 | 02/23/09 | 02/24/09 | 02/24/09 | 02/24/09 | 02/24/09 | 02/24/09 | 03/02/06 | 03/01/06 | 03/01/06 | 03/02/ |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | NA | NA | NA | NA | NA | NA | NA | NA | 3.4 U | 3.7 U | 3.5 U | 3.7 |
| 4,4'-DDE | 0.076 J | 540 | NA | NA | NA | NA | NA | NA | NA | NA | 3.1 J | 3.7 U | 2.1 J | 48 |
| 4,4'-DDT | 0.31 J | 950 | NA | NA | NA | NA | NA | NA | NA | NA | 1.7 J | 3.7 U | 3.5 U | 27 |
| beta-BHC | 0.77 J | 2.2 JN | NA | NA | NA | NA | NA | NA | NA | NA | 1.8 U | 1.9 U | 1.8 U | 1.9 |
| Endrin aldehyde | 1.5 J | 1.5 J | NA | NA | NA | NA | NA | NA | NA | NA | 3.4 U | 3.7 U | 3.5 U | 3.7 |
| Endrin ketone | 0.82 J | 0.82 J | NA | NA | NA | NA | NA | NA | NA | NA | 3.4 U | 3.7 U | 3.5 U | 3.7 |
| gamma-Chlordane | 0.45 J | 1.1 J | NA | NA | NA | NA | NA | NA | NA | NA | 1.8 U | 1.9 U | 1.8 U | 1.9 |
| Methoxychlor | 11 J | 11 J | NA | NA | NA | NA | NA | NA | NA | NA | 18 U | 19 U | 18 U | 19 |
| | | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | | |
| No Detections | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

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JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | J |
|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | 004 |
| **Sample ID** | **Detected** | **Detected** | -0406 |
| **Sample Date** | **Concentration** | **Concentration** | 06 |
| **Chemical Name** | | | |
| | | | |
| **Pesticides (UG/KG)** | | | |
| 4,4'-DDD | 0.89 J | 44 | U |
| 4,4'-DDE | 0.076 J | 540 | |
| 4,4'-DDT | 0.31 J | 950 | |
| beta-BHC | 0.77 J | 2.2 JN | U |
| Endrin aldehyde | 1.5 J | 1.5 J | U |
| Endrin ketone | 0.82 J | 0.82 J | U |
| gamma-Chlordane | 0.45 J | 1.1 J | U |
| Methoxychlor | 11 J | 11 J | U |
| | | | |
| **Herbicides (UG/KG)** | | | |
| No Detections | -- | -- | |

**Notes:**

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J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PAOC J | | PAOC J | PAOC K | PAOC K | PAOC K | PAOC K | PAOC K | PAOC S | PAOC S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPAJ-SO05 | | EPAJ-SO06 | EPAK-SO01 | EPAK-SO02 | EPAK-SO03 | EPAK-SO04 | EPAK-SO05 | EPAS-SO01 | EPAS-SO02 |
| **Sample ID** | **Detected** | **Detected** | EPAJ-SB05-0406 | EPAJ-SB05P-0406 | EPAJ-SB06-0406 | EPAK-SB01-0406 | EPAK-SB02-0406 | EPAK-SB03-0406 | EPAK-SB04-0406 | EPAK-SB05-0406 | EPAS-SB01-0406 | EPAS-SB02-0406 |
| **Sample Date** | **Concentration** | **Concentration** | 03/02/06 | 03/02/06 | 03/01/06 | 03/01/06 | 02/28/06 | 03/02/06 | 03/08/06 | 02/28/06 | 02/02/06 | 02/02/06 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | 3.7 U | 3.7 U | 3.4 U | 3.8 U | 3.6 U | 3.3 U | 44 | 4.3 U | 3.9 U | 3.5 U |
| 4,4'-DDE | 0.076 J | 540 | 2.5 J | 3.1 J | 1.3 J | 0.89 J | 3.6 U | 21 | 540 | 4.6 | 35 | 29 |
| 4,4'-DDT | 0.31 J | 950 | 1.3 J | 1.3 J | 27 | 3.8 U | 3.6 U | 7.5 | 950 | 4.3 U | 6.7 | 13 |
| beta-BHC | 0.77 J | 2.2 JN | 1.9 U | 2.2 JN | 1.8 U | 2.0 U | 1.9 U | 1.7 U | 1.8 U | 2.2 U | 2.0 U | 1.8 U |
| Endrin aldehyde | 1.5 J | 1.5 J | 3.7 U | 3.7 U | 3.4 U | 3.8 U | 3.6 U | 3.3 U | 3.6 U | 4.3 U | 3.9 U | 3.5 U |
| Endrin ketone | 0.82 J | 0.82 J | 3.7 U | 3.7 U | 3.4 U | 3.8 U | 3.6 U | 0.82 J | 3.6 U | 4.3 U | 3.9 U | 3.5 U |
| gamma-Chlordane | 0.45 J | 1.1 J | 1.9 U | 1.9 U | 1.8 U | 2.0 U | 1.9 U | 1.7 U | 0.76 J | 2.2 U | 2.0 U | 1.8 U |
| Methoxychlor | 11 J | 11 J | 19 U | 19 U | 18 U | 20 U | 19 U | 17 U | 18 U | 22 U | 20 U | 18 U |
| | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | |
| No Detections | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

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UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PAOC S | | PAOC S | PAOC S | PAOC U | PAOC U | PAOC U | PAOC U | PAOC U | PAOC U | PAOC U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPAS-SO03 | | EPAS-SO04 | EPAS-SO05 | EPAU-SO01 | EPAU-SO02 | EPAU-SO03 | EPAU-SO04 | EPAU-SO05 | EPAU-SO06 | EPAU-SO07 |
| **Sample ID** | **Detected** | **Detected** | EPAS-SB03-0406 | EPAS-SB03P-0406 | EPAS-SB04-0406 | EPAS-SB05-0406 | EPAU-SB01-0406 | EPAU-SB02-0406 | EPAU-SB03-0406 | EPAU-SB04-0406 | EPAU-SB05-0406 | EPAU-SB06-0406 | EPAU-SB07-0406 |
| **Sample Date** | **Concentration** | **Concentration** | 02/02/06 | 02/02/06 | 02/02/06 | 02/02/06 | 03/01/06 | 03/03/06 | 03/03/06 | 03/03/06 | 03/03/06 | 03/03/06 | 03/03/06 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticides (UG/KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 0.89 J | 44 | 3.8 U | 3.8 U | 3.8 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.8 U | 3.5 U |
| 4,4'-DDE | 0.076 J | 540 | 3.8 U | 3.8 U | 3.8 U | 2.8 J | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.8 U | 3.5 U |
| 4,4'-DDT | 0.31 J | 950 | 3.8 U | 3.8 U | 3.8 U | 1.8 J | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.8 U | 3.5 U |
| beta-BHC | 0.77 J | 2.2 JN | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 1.8 U | 0.77 J | 1.8 U | 1.8 U | 1.8 U | 2.0 U | 1.8 U |
| Endrin aldehyde | 1.5 J | 1.5 J | 3.8 U | 3.8 U | 3.8 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.8 U | 3.5 U |
| Endrin ketone | 0.82 J | 0.82 J | 3.8 U | 3.8 U | 3.8 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.8 U | 3.5 U |
| gamma-Chlordane | 0.45 J | 1.1 J | 2.0 U | 2.0 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 2.3 R | 1.8 U | 1.8 U | 2.0 U | 1.8 U |
| Methoxychlor | 11 J | 11 J | 20 U | 20 U | 19 U | 11 J | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 18 U |
| | | | | | | | | | | | | | |
| **Herbicides (UG/KG)** | | | | | | | | | | | | | |
| No Detections | -- | -- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 2**
East Vieques Subsurface Soil Pesticide and Herbicide Detections
Vieques, Puerto Rico

| **Site ID** | | | PAOC U | PAOC U | |
|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | EPAU-SO08 | EPAU-SO09 | |
| **Sample ID** | **Detected** | **Detected** | EPAU-SB08-0406 | EPAU-SB09-0406 | EPAU-SB09P-0406 |
| **Sample Date** | **Concentration** | **Concentration** | 03/01/06 | 03/03/06 | 03/03/06 |
| **Chemical Name** | | | | | |
| | | | | | |
| **Pesticides (UG/KG)** | | | | | |
| 4,4'-DDD | 0.89 J | 44 | 3.4 U | 3.5 U | 3.5 U |
| 4,4'-DDE | 0.076 J | 540 | 3.4 U | 3.5 U | 3.5 U |
| 4,4'-DDT | 0.31 J | 950 | 3.4 U | 3.5 U | 3.5 U |
| beta-BHC | 0.77 J | 2.2 JN | 1.8 U | 1.8 U | 1.8 U |
| Endrin aldehyde | 1.5 J | 1.5 J | 3.4 U | 3.5 U | 3.5 U |
| Endrin ketone | 0.82 J | 0.82 J | 3.4 U | 3.5 U | 3.5 U |
| gamma-Chlordane | 0.45 J | 1.1 J | 1.8 U | 1.8 U | 1.8 U |
| Methoxychlor | 11 J | 11 J | 18 U | 18 U | 18 U |
| | | | | | |
| **Herbicides (UG/KG)** | | | | | |
| No Detections | -- | -- | NA | NA | NA |

**Notes:**

Shading indicates detections

NA - Not Analyzed

J - Analyte present, value may or may not be accurate or precise

JN - Analyte present at approximate quantity

R - Unreliable Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - Micrograms per kilogram

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-B | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AB-SB05 | AB-SB06 | AB-SB07 | AB-SB08 | AB-SB09 | AB-SB10 | | AB-SB11 | AB-SB12 | AB-SB13 | AB-SB14 | AB-SB15 |
| **Sample ID** | **Detected** | **Detected** | NDE239 | NDE241 | NDE243 | NDE245 | NDE247 | NDE249 | NDE250 | NDE252 | NDE254 | NDE256 | NDE258 | NDE260 |
| **Sample Date** | **Concentration** | **Concentration** | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.33 J | 40 | 3.80 U | 4 U | 4 U | 4.30 U | 5.10 U | 4.10 U | 4.40 U | 4.40 U | 3.70 U | 4.40 U | 4 U | 3.90 U |
| 4,4'-DDE | 0.16 J | 3,990 J | 3.80 U | 4 U | 4 U | 4.30 U | 5.10 U | 4.10 U | 0.880 J | 1.80 J | 3.70 U | 0.570 J | 0.680 J | 0.900 J |
| 4,4'-DDT | 0.26 J | 2,190 J | 3.80 U | 4 U | 4 U | 4.30 U | 5.10 U | 4.10 U | 4.40 U | 4.40 U | 3.70 U | 4.40 U | 4 U | 3.90 U |
| Aldrin | 0.2 J | 0.87 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |
| Aroclor-1254 | 43 J | 56 | 38 U | 40 U | 40 U | 43 U | 51 U | 41 U | 44 U | 44 U | 37 U | 44 U | 40 U | 39 U |
| Aroclor-1260 | 10 J | 27 J | 38 U | 10 J | 14 J | 19 J | 51 U | 12 J | 12 J | 44 U | 37 U | 44 U | 40 U | 39 U |
| Dieldrin | 0.18 J | 3.90 | 3.90 | 4 U | 4 U | 4.30 U | 5.10 U | 4.10 U | 4.40 U | 1.80 J | 0.770 J | 4.40 U | 4 U | 3.90 U |
| Endosulfan I | 3.5 J | 3.5 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |
| Endosulfan II | 0.65 J | 0.65 J | 3.80 U | 4 U | 4 U | 4.30 U | 5.10 U | 4.10 U | 4.40 U | 4.40 U | 3.70 U | 4.40 U | 4 U | 3.90 U |
| Endosulfan sulfate | 0.22 J | 90 J | 3.80 U | 4 U | 4 U | 4.30 U | 5.10 U | 4.10 U | 4.40 U | 4.40 U | 3.70 U | 4.40 U | 4 U | 3.90 U |
| Endrin | 0.22 J | 16 JN | 3.80 U | 4 U | 4 U | 4.30 U | 5.10 U | 4.10 U | 4.40 U | 4.40 U | 3.70 U | 4.40 U | 4 U | 3.90 U |
| Endrin aldehyde | 0.21 J | 11 | 3.80 U | 4 U | 4 U | 4.30 U | 5.10 U | 4.10 U | 4.40 U | 4.40 U | 3.70 U | 4.40 U | 4 U | 3.90 U |
| Heptachlor | 0.43 J | 1.5 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |
| Heptachlor epoxide | 0.2 J | 1.7 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |
| Methoxychlor | 0.49 J | 240 J | 20 U | 21 U | 21 U | 22 U | 26 U | 21 U | 23 U | 23 U | 19 U | 23 U | 21 U | 20 U |
| alpha-Chlordane | 0.30 J | 4.6 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |
| beta-BHC | 0.59 J | 1.4 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |
| delta-BHC | 0.54 J | 0.59 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |
| gamma-BHC (Lindane) | 0.66 J | 0.66 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |
| gamma-Chlordane | 0.2 J | 270 J | 2 U | 2.10 U | 2.10 U | 2.20 U | 2.60 U | 2.10 U | 2.30 U | 2.30 U | 1.90 U | 2.30 U | 2.10 U | 2 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-B (continued) | | | | | |
|---|---|---|---|---|---|---|
| **Station ID** | AB-SB15 | AB-SB16 | WWTPSB001 | WWTPSB002 | WWTPSB003 | WWTPSB004 |
| **Sample ID** | NDE261 | NDE263 | NDE188 | NDE190 | NDE192 | NDE194 |
| **Sample Date** | 04/13/01 | 04/13/01 | 12/04/00 | 12/04/00 | 12/04/00 | 12/04/00 |
| **Chemical Name** | | | | | | |
| | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | |
| 4,4'-DDD | 4 U | 4 U | 3.70 UJ | 3.90 UJ | 3.80 UJ | 4.20 UJ |
| 4,4'-DDE | 1.10 J | 1.20 J | 3.70 UJ | 3.90 UJ | 3.80 UJ | 4.20 UJ |
| 4,4'-DDT | 4 U | 4 U | 3.70 UJ | 3.90 UJ | 3.80 UJ | 4.20 UJ |
| Aldrin | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |
| Aroclor-1254 | 40 U | 40 U | 37 UJ | 39 UJ | 38 UJ | 42 UJ |
| Aroclor-1260 | 40 U | 40 U | 37 UJ | 39 UJ | 38 UJ | 42 UJ |
| Dieldrin | 4 U | 4 U | 3.70 UJ | 3.90 UJ | 3.80 UJ | 4.20 UJ |
| Endosulfan I | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |
| Endosulfan II | 4 U | 4 U | 3.70 UJ | 3.90 UJ | 3.80 UJ | 4.20 UJ |
| Endosulfan sulfate | 4 U | 4 U | 3.70 UJ | 3.90 UJ | 3.80 UJ | 4.20 UJ |
| Endrin | 4 U | 4 U | 3.70 UJ | 3.90 UJ | 3.80 UJ | 4.20 UJ |
| Endrin aldehyde | 4 U | 4 U | 3.70 UJ | 3.90 UJ | 3.80 UJ | 4.20 UJ |
| Heptachlor | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |
| Heptachlor epoxide | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |
| Methoxychlor | 21 U | 21 U | 19 UJ | 20 UJ | 19 UJ | 22 UJ |
| alpha-Chlordane | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |
| beta-BHC | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |
| delta-BHC | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |
| gamma-BHC (Lindane) | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |
| gamma-Chlordane | 2.10 U | 2.10 U | 1.90 UJ | 2 UJ | 1.90 UJ | 2.20 UJ |

**Notes:**

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U - Analyte not detected
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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-C | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AC-SB01 | | AC-SB02 | AC-SB03 | AC-SB04 | AC-SB05 | AC-SB06 | AC-SB07 | AC-SB08 | | AC-SB09 | AC-SB10 |
| **Sample ID** | NDA196 | NDA197FD1 | NDA198 | NDA199 | NDA200 | NDA201 | NDA202 | NDA203 | NDA204 | NDA205FD1 | NDA206 | NDA207 |
| **Sample Date** | 04/10/00 | 04/10/00 | 04/10/00 | 04/10/00 | 04/10/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.6 U | 3.6 U | 4.3 U | 4.3 U | 3.5 U | 3.3 U | 3.8 U | 2.1 J | 4.3 UJ | 3.8 U | 3.4 U | 3.8 U |
| 4,4'-DDE | 3.6 U | 3.6 U | 4.3 U | 4.3 U | 0.53 J | 3.3 U | 0.58 J | 6.4 | 0.8 J | 0.84 J | 3.4 U | 0.48 J |
| 4,4'-DDT | 3.6 UJ | 3.6 UJ | 4.3 UJ | 4.3 UJ | 3.5 UJ | 3.3 U | 3.8 U | 16 | 4.3 U | 0.53 J | 3.4 U | 3.8 U |
| Aldrin | 1.8 U | 1.8 U | 2.2 U | 2.2 U | 1.8 U | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |
| Aroclor-1254 | 36 U | 35 U | 43 U | 33 U | 35 U | 33 U | 38 U | 41 U | 43 U | 37 U | 34 U | 37 U |
| Aroclor-1260 | 36 U | 35 U | 43 U | 33 U | 35 U | 33 U | 38 U | 41 U | 43 U | 37 U | 34 U | 37 U |
| Dieldrin | 3.6 U | 3.6 U | 4.3 U | 4.3 U | 3.5 U | 3.3 U | 3.8 U | 4.2 U | 4.3 U | 3.8 U | 3.4 U | 3.8 U |
| Endosulfan I | 1.8 U | 1.8 U | 2.2 U | 2.2 U | 1.8 U | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |
| Endosulfan II | 3.6 U | 3.6 U | 4.3 U | 4.3 U | 3.5 U | 3.3 U | 3.8 U | 4.2 U | 4.3 U | 3.8 U | 3.4 U | 3.8 U |
| Endosulfan sulfate | 3.6 U | 3.6 U | 4.3 U | 4.3 U | 3.5 U | 3.3 U | 3.8 U | 4.2 U | 4.3 U | 3.8 U | 3.4 U | 3.8 U |
| Endrin | 3.6 U | 3.6 U | 4.3 U | 4.3 U | 3.5 U | 3.3 U | 3.8 U | 4.2 U | 4.3 U | 3.8 U | 3.4 U | 3.8 U |
| Endrin aldehyde | 3.6 U | 3.6 U | 4.3 U | 4.3 U | 3.5 U | 3.3 U | 3.8 U | 4.2 U | 4.3 U | 3.8 U | 3.4 U | 3.8 U |
| Heptachlor | 1.8 U | 1.8 U | 2.2 U | 2.2 U | 1.8 U | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |
| Heptachlor epoxide | 1.8 U | 1.8 U | 2.2 U | 2.2 U | 1.8 U | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |
| Methoxychlor | 18 UJ | 18 UJ | 22 UJ | 22 UJ | 18 UJ | 17 U | 19 U | 21 U | 22 U | 19 U | 18 U | 19 U |
| alpha-Chlordane | 1.8 U | 1.8 U | 2.2 U | 2.2 U | 1.8 U | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |
| beta-BHC | 1.8 U | 1.8 U | 2.2 U | 2.2 U | 1.8 U | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |
| delta-BHC | 1.8 UJ | 1.8 UJ | 2.2 UJ | 2.2 UJ | 1.8 UJ | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |
| gamma-BHC (Lindane) | 1.8 UJ | 1.8 UJ | 2.2 UJ | 2.2 UJ | 1.8 UJ | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |
| gamma-Chlordane | 1.8 U | 1.8 U | 2.2 U | 2.2 U | 1.8 U | 1.7 U | 1.9 U | 2.1 U | 2.2 U | 1.9 U | 1.8 U | 1.9 U |

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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-C | | | | | W-AOC-E | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AC-SB11 | AC-SB12 | AC-SB13 | AC-SB14 | AC-SB15 | WAE-SO13 | WAE-SO14 | WAE-SO15 | WAE-SO16 | WAE-SO17 | |
| **Sample ID** | NDA208 | NDA209 | NDA210 | NDA211 | NDA212 | WAE-SS13-0002 | WAE-SS14-0002 | WAE-SS15-0002 | WAE-SS16-0002 | WAE-SS17-0002 | WAE-SS17P-0002 |
| **Sample Date** | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 11/30/05 | 11/30/05 | 12/01/05 | 12/01/05 | 11/30/05 | 11/30/05 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 3.4 U | 4.7 U | 3.4 U | 3.3 U | 3.7 U | 3.5 U | 3.6 U | 2.1 J | 3.7 U | 3.6 U | 3.6 U |
| 4,4'-DDE | 3.4 U | 1.4 J | 0.94 J | 0.58 J | 0.7 J | 3.5 U | 3.6 U | 3.6 U | 3.7 U | 8.4 | 8 |
| 4,4'-DDT | 0.47 J | 0.82 J | 0.81 J | 0.81 J | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.7 U | 3.5 J | 3.6 |
| Aldrin | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |
| Aroclor-1254 | 33 U | 46 U | 33 U | 33 U | 37 U | 35 U | 36 U | 36 U | 37 U | 36 U | 36 U |
| Aroclor-1260 | 33 U | 46 U | 33 U | 33 U | 37 U | 35 U | 36 U | 36 U | 37 U | 36 U | 36 U |
| Dieldrin | 3.4 U | 4.7 U | 3.4 U | 3.3 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.7 U | 3.6 U | 3.6 U |
| Endosulfan I | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |
| Endosulfan II | 3.4 U | 4.7 U | 3.4 U | 3.3 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.7 U | 3.6 U | 3.6 U |
| Endosulfan sulfate | 3.4 U | 4.7 U | 3.4 U | 3.3 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.7 U | 3.6 U | 3.6 U |
| Endrin | 3.4 U | 4.7 U | 3.4 U | 3.3 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.7 U | 3.6 U | 3.6 U |
| Endrin aldehyde | 3.4 U | 4.7 U | 3.4 U | 3.3 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.7 U | 3.6 U | 3.6 U |
| Heptachlor | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |
| Heptachlor epoxide | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |
| Methoxychlor | 17 U | 24 U | 17 U | 17 U | 19 U | 18 U | 18 U | 18 U | 19 U | 18 U | 18 U |
| alpha-Chlordane | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |
| beta-BHC | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |
| delta-BHC | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |
| gamma-BHC (Lindane) | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |
| gamma-Chlordane | 1.7 U | 2.4 U | 1.7 U | 1.7 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U |

**Notes:**

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J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-E | | W-AOC-H | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WAE-SO18 | WAE-SO19 | AOCHSB001 | | AOCHSB002 | AOCHSB003 | AOCHSB004 | AOCHSB005 | AOCHSB006 | AOCHSB007 | AOCHSB008 | AOCHSB009 |
| **Sample ID** | WAE-SS18-0002 | WAE-SS19-0002 | NDE004 | NDE005FD1 | NDE007 | NDE009 | NDE011 | NDE013 | NDE015 | NDE017 | NDE019 | NDE021 |
| **Sample Date** | 11/30/05 | 11/30/05 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.5 U | 3.7 U | 3.5 UJ | 3.6 UJ | 3.5 UJ | 2.4 J | 2.9 J | 3.4 UJ | 3.4 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ |
| 4,4'-DDE | 3.5 U | 3.7 U | 3,990 J | 3,440 J | 2,660 J | 50 J | 41 J | 14 J | 10 J | 126 J | 1.6 J | 7.8 J |
| 4,4'-DDT | 3.5 U | 3.7 U | 1,940 J | 2,190 J | 1,090 J | 14 UJ | 17 J | 10 J | 11 J | 75 J | 3.6 UJ | 6.7 J |
| Aldrin | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| Aroclor-1254 | 35 U | 37 U | 35 UJ | 36 UJ | 35 UJ | 38 UJ | 36 UJ | 34 UJ | 34 UJ | 36 UJ | 36 UJ | 37 UJ |
| Aroclor-1260 | 12 J | 37 U | 35 UJ | 36 UJ | 35 UJ | 38 UJ | 36 UJ | 34 UJ | 34 UJ | 36 UJ | 36 UJ | 37 UJ |
| Dieldrin | 3.5 U | 3.7 U | 3.5 UJ | 3.6 UJ | 3.5 UJ | 3.8 UJ | 3.6 UJ | 3.4 UJ | 3.4 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ |
| Endosulfan I | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| Endosulfan II | 3.5 U | 3.7 U | 3.5 UJ | 3.6 UJ | 3.5 UJ | 3.8 UJ | 3.6 UJ | 3.4 UJ | 3.4 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ |
| Endosulfan sulfate | 3.5 U | 3.7 U | 3.5 UJ | 3.6 UJ | 3.5 UJ | 3.8 UJ | 3.6 UJ | 3.4 UJ | 3.4 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ |
| Endrin | 3.5 U | 3.7 U | 3.5 UJ | 3.6 UJ | 3.5 UJ | 3.8 UJ | 3.6 UJ | 3.4 UJ | 3.4 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ |
| Endrin aldehyde | 3.5 U | 3.7 U | 3.5 UJ | 3.6 UJ | 3.5 UJ | 3.8 UJ | 3.6 UJ | 3.4 UJ | 3.4 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ |
| Heptachlor | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| Heptachlor epoxide | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| Methoxychlor | 18 U | 19 U | 18 UJ | 18 UJ | 18 UJ | 20 UJ | 18 UJ | 18 UJ | 18 UJ | 18 UJ | 19 UJ | 19 UJ |
| alpha-Chlordane | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| beta-BHC | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| delta-BHC | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| gamma-BHC (Lindane) | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| gamma-Chlordane | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |

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J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-H | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AOCHSB010 | | AOCHSB011 | AOCHSB012 | AOCHSB013 | AOCHSB014 | AOCHSB015 | AOCHSB016 | AOCHSS001 | AOCHSS002 | AOCHSS003 | AOCHSS004 |
| **Sample ID** | NDE023 | NDE024FD1 | NDE026 | NDE028 | NDE030 | NDE032 | NDE034 | NDE037 | NDE176 | NDE177 | NDE178 | NDE179 |
| **Sample Date** | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.5 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 3.9 UJ | 3.5 UJ | 4.8 J | 3.6 UJ | 3.6 UJ | 3.7 UJ | 3.5 UJ |
| 4,4'-DDE | 3.5 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 3.9 UJ | 3.5 UJ | 41 J | 3.6 UJ | 3.6 UJ | 3.7 UJ | 3.5 UJ |
| 4,4'-DDT | 3.5 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 3.9 UJ | 3.5 UJ | 29 J | 3.6 UJ | 3.6 UJ | 3.7 UJ | 3.5 UJ |
| Aldrin | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |
| Aroclor-1254 | 35 UJ | 38 UJ | 37 UJ | 37 UJ | 37 UJ | 39 UJ | 35 UJ | 35 UJ | 36 UJ | 36 UJ | 37 UJ | 35 UJ |
| Aroclor-1260 | 35 UJ | 38 UJ | 37 UJ | 37 UJ | 37 UJ | 39 UJ | 35 UJ | 35 UJ | 36 UJ | 36 UJ | 37 UJ | 35 UJ |
| Dieldrin | 3.5 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ | 3.5 UJ |
| Endosulfan I | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |
| Endosulfan II | 3.5 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ | 3.5 UJ |
| Endosulfan sulfate | 3.5 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ | 3.5 UJ |
| Endrin | 3.5 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ | 3.5 UJ |
| Endrin aldehyde | 3.5 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.6 UJ | 3.6 UJ | 3.7 UJ | 3.5 UJ |
| Heptachlor | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |
| Heptachlor epoxide | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |
| Methoxychlor | 18 UJ | 20 UJ | 19 UJ | 19 UJ | 19 UJ | 20 UJ | 18 UJ | 18 UJ | 18 UJ | 18 UJ | 19 UJ | 18 UJ |
| alpha-Chlordane | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |
| beta-BHC | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |
| delta-BHC | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |
| gamma-BHC (Lindane) | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |
| gamma-Chlordane | 1.8 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-H | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | NDAHSS17 | NDAHSS18 | NDAHSS19 | NDAHSS20 | NDAHSS20 | NDAHSS21 | NDAHSS22 | NDAHSS23 | NDAHSS24 | NDAHSS25 | NDAHSS26 | NDAHSS27 |
| **Sample ID** | NDAHSS17-R01 | NDAHSS18-R01 | NDAHSS19-R01 | NDAHFD04P-R01 | NDAHSS20-R01 | NDAHSS21-R01 | NDAHSS22-R01 | NDAHSS23-R01 | NDAHSS24-R01 | NDAHSS25-R01 | NDAHSS26-R01 | NDAHFD06P-R01 |
| **Sample Date** | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 0.52 J | 2.1 J | 20 R | 6.6 J | 3.5 R | 3.6 U | 10 J | 3.6 J | 3.6 U | 0.62 J | 2.3 J | 3 J |
| 4,4'-DDE | 40 | 95 J | 23 | 69 J | 3.5 R | 1.4 J | 190 | 16 J | 5 J | 2.5 J | 16 J | 7.5 |
| 4,4'-DDT | 18 J | 25 J | 8.6 J | 4.6 | 3.5 R | 3.6 U | 9.2 J | 8.3 J | 5.5 J | 1.3 J | 10 J | 2.2 J |
| Aldrin | 2 U | 1.8 U | 2.1 U | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| Aroclor-1254 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1260 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | 3.8 U | 3.5 U | 4.1 U | 3.5 U | 3.5 R | 3.6 U | 3.6 U | 3.6 UJ | 3.6 U | 3.6 U | 3.8 U | 3.6 U |
| Endosulfan I | 2 U | 1.8 U | 2.1 U | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| Endosulfan II | 3.8 U | 3.5 U | 4.1 U | 3.5 U | 0.073 R | 3.6 U | 3.6 U | 3.6 UJ | 3.6 U | 3.6 U | 3.8 U | 3.6 U |
| Endosulfan sulfate | 3.8 U | 3.5 U | 4.1 U | 3.5 U | 3.5 R | 3.6 U | 3.6 U | 3.6 UJ | 3.6 U | 3.6 U | 3.8 U | 3.6 U |
| Endrin | 3.8 U | 3.5 U | 4.1 U | 3.5 U | 3.5 R | 3.6 U | 3.6 U | 3.6 UJ | 3.6 U | 3.6 U | 3.8 U | 3.6 U |
| Endrin aldehyde | 3.8 U | 3.5 U | 4.1 U | 3.5 U | 3.5 R | 3.6 U | 3.6 U | 3.6 UJ | 3.6 U | 3.6 U | 3.8 U | 3.6 U |
| Heptachlor | 2 U | 1.8 U | 2.1 U | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| Heptachlor epoxide | 2 U | 1.8 U | 2.1 U | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| Methoxychlor | 20 U | 18 U | 0.74 J | 18 U | 18 R | 19 U | 18 U | 18 UJ | 18 U | 19 U | 19 U | 19 U |
| alpha-Chlordane | 2 U | 1.8 U | 2.1 U | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| beta-BHC | 2 U | 1.8 U | 2.1 U | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| delta-BHC | 2 UJ | 1.8 UJ | 2.1 UJ | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| gamma-BHC (Lindane) | 2 U | 1.8 U | 2.1 U | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| gamma-Chlordane | 2 U | 1.8 U | 2.1 U | 1.8 U | 1.8 R | 1.9 U | 1.8 U | 1.8 UJ | 1.8 U | 1.9 U | 1.9 U | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-H | | | W-AOC-I | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | NDAHSS27 | NDAHSS28 | NDAHSS29 | AOCISB001 | AOCISB002 | AOCISB003 | AOCISB004 | AOCISB005 | AOCISB006 | AOCISB007 | AOCISB008 |
| **Sample ID** | NDAHSS27-R01 | NDAHSS28-R01 | NDAHSS29-R01 | NDE043 | NDE045 | NDE047 | NDE049 | NDE051 | NDE053 | NDE055 | NDE057 |
| **Sample Date** | 08/26/03 | 08/26/03 | 08/26/03 | 11/29/00 | 11/29/00 | 11/29/00 | 11/29/00 | 11/29/00 | 11/30/00 | 11/30/00 | 11/30/00 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 1.9 J | 1.1 J | 4.4 | 3.6 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 3.6 U | 3.5 U |
| 4,4'-DDE | 8.8 J | 92 J | 35 | 3.6 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 3.6 U | 3.5 U |
| 4,4'-DDT | 11 J | 160 J | 7.7 J | 3.6 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 3.6 U | 3.5 U |
| Aldrin | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |
| Aroclor-1254 | NA | NA | NA | 36 U | 34 U | 35 U | 34 U | 34 U | 37 U | 36 U | 35 U |
| Aroclor-1260 | NA | NA | NA | 36 U | 34 U | 35 U | 34 U | 34 U | 37 U | 36 U | 35 U |
| Dieldrin | 3.6 U | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 3.6 U | 3.5 U |
| Endosulfan I | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |
| Endosulfan II | 3.6 U | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 3.6 U | 3.5 U |
| Endosulfan sulfate | 3.6 U | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 3.6 U | 3.5 U |
| Endrin | 3.6 U | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 3.6 U | 3.5 U |
| Endrin aldehyde | 3.6 U | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.7 U | 3.6 U | 3.5 U |
| Heptachlor | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |
| Heptachlor epoxide | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |
| Methoxychlor | 19 U | 19 U | 18 U | 19 U | 17 U | 18 U | 18 U | 18 U | 19 U | 19 U | 18 U |
| alpha-Chlordane | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |
| beta-BHC | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |
| delta-BHC | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |
| gamma-BHC (Lindane) | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |
| gamma-Chlordane | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-I | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AOCISB009 | AOCISB010 | AOCISB011 | | AOCISB012 | AOCISB013 | AOCISB014 | AOCISB015 | AOCISB016 | AOCISB017 | AOCISB018 |
| **Sample ID** | NDE059 | NDE061 | NDE062FD1 | NDE064 | NDE066 | NDE068 | NDE070 | NDE072 | NDE075 | NDE077 | NDE074FD1 |
| **Sample Date** | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 12/01/00 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| 4,4'-DDE | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| 4,4'-DDT | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 UJ | 3.7 UJ | 3.7 UJ | 3.6 UJ | 3.5 U | 3.5 U | 3.5 U |
| Aldrin | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Aroclor-1254 | 35 U | 35 U | 35 U | 35 U | 35 U | 37 U | 37 U | 36 U | 35 U | 35 U | 35 U |
| Aroclor-1260 | 35 U | 35 U | 35 U | 35 U | 35 U | 37 U | 37 U | 36 U | 35 U | 35 U | 35 U |
| Dieldrin | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| Endosulfan I | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Endosulfan II | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| Endosulfan sulfate | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| Endrin | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| Endrin aldehyde | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U | 3.5 U | 3.5 U |
| Heptachlor | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Heptachlor epoxide | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| Methoxychlor | 18 U | 18 U | 18 U | 18 U | 18 U | 19 U | 19 U | 18 U | 18 U | 18 U | 18 U |
| alpha-Chlordane | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| beta-BHC | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| delta-BHC | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| gamma-BHC (Lindane) | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |
| gamma-Chlordane | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-I | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AOCISB018 | AOCISB019 | AOCISB020 | | AOCISB021 | AOCISB022 | AOCISB023 | | AOCISB024 | AOCISB025 | AOCISB026 | |
| **Sample ID** | NDE079 | NDE081 | NDE083 | NDE084FD1 | NDE086 | NDE088 | NDE090 | NDE091FD1 | NDE093 | NDE095 | NDE097 | NDE099FD1 |
| **Sample Date** | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.5 U | 3.5 UJ | 4.1 UJ | 4.3 UJ | 3.6 UJ | 4 UJ | 3.7 U | 3.8 U | 3.4 U | 3.3 U | 3.3 U | 3.3 U |
| 4,4'-DDE | 3.5 U | 3.5 UJ | 4.1 UJ | 4.3 UJ | 3.6 UJ | 4 UJ | 3.7 U | 3.8 U | 3.4 U | 3.3 U | 3.3 U | 3.3 U |
| 4,4'-DDT | 3.5 U | 3.5 UJ | 4.1 UJ | 4.3 UJ | 3.6 UJ | 4 UJ | 3.7 U | 3.8 U | 3.4 U | 3.3 UJ | 3.3 UJ | 3.3 UJ |
| Aldrin | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |
| Aroclor-1254 | 35 U | 35 UJ | 41 UJ | 43 UJ | 36 UJ | 40 UJ | 37 U | 38 U | 34 U | 33 U | 33 U | 33 U |
| Aroclor-1260 | 35 U | 35 UJ | 41 UJ | 43 UJ | 36 UJ | 40 UJ | 37 U | 38 U | 34 U | 33 U | 33 U | 33 U |
| Dieldrin | 3.5 U | 3.5 UJ | 4.1 UJ | 4.3 UJ | 3.6 UJ | 4 UJ | 3.7 U | 3.8 U | 3.4 U | 3.3 U | 3.3 U | 3.3 U |
| Endosulfan I | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |
| Endosulfan II | 3.5 U | 3.5 UJ | 4.1 UJ | 4.3 UJ | 3.6 UJ | 4 UJ | 3.7 U | 3.8 U | 3.4 U | 3.3 U | 3.3 U | 3.3 U |
| Endosulfan sulfate | 3.5 U | 3.5 UJ | 4.1 UJ | 4.3 UJ | 3.6 UJ | 4 UJ | 3.7 U | 3.8 U | 3.4 U | 3.3 U | 3.3 U | 3.3 U |
| Endrin | 3.5 U | 3.5 UJ | 4.1 UJ | 4.3 UJ | 3.6 UJ | 4 UJ | 3.7 U | 3.8 U | 3.4 U | 3.3 U | 3.3 U | 3.3 U |
| Endrin aldehyde | 3.5 U | 3.5 UJ | 4.1 UJ | 4.3 UJ | 3.6 UJ | 4 UJ | 3.7 U | 3.8 U | 3.4 U | 3.3 U | 3.3 U | 3.3 U |
| Heptachlor | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |
| Heptachlor epoxide | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |
| Methoxychlor | 18 U | 18 UJ | 21 UJ | 22 UJ | 19 UJ | 20 UJ | 19 U | 20 U | 18 U | 17 UJ | 17 UJ | 17 UJ |
| alpha-Chlordane | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |
| beta-BHC | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |
| delta-BHC | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |
| gamma-BHC (Lindane) | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |
| gamma-Chlordane | 1.8 U | 1.8 UJ | 2.1 UJ | 2.2 UJ | 1.9 UJ | 2 UJ | 1.9 U | 2 U | 1.8 U | 1.7 U | 1.7 U | 1.7 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-J | | | | | | | | | | W-AOC-L | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AOCJSB001 | AOCJSB002 | AOCJSB003 | AOCJSB004 | AOCJSB005 | NDAJSS06 | NDAJSS07 | NDAJSS08 | NDAJSS09 | NDAJSS10 | AOCLSB001 | AOCLSB002 |
| **Sample ID** | NDE102 | NDE104 | NDE106 | NDE108 | NDE110 | NDAJSS06-R01 | NDAJSS07-R01 | NDAJSS08-R01 | NDAJSS09-R01 | NDAJSS10-R01 | NDE121 | NDE123 |
| **Sample Date** | 12/08/00 | 12/08/00 | 12/08/00 | 12/08/00 | 12/08/00 | 08/25/03 | 08/25/03 | 08/25/03 | 08/25/03 | 08/25/03 | 11/29/00 | 11/29/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.4 UJ | 3.4 UJ | 3.9 UJ | 4.9 UJ | 4.1 UJ | 4 U | 3.9 U | 3.9 UJ | 4.2 U | 3.8 UJ | 3.8 U | 3.8 U |
| 4,4'-DDE | 3.4 UJ | 3.4 UJ | 3.9 UJ | 4.9 UJ | 4.1 UJ | 4 U | 3.9 U | 3.9 UJ | 0.22 J | 3.8 UJ | 3.8 U | 1.6 J |
| 4,4'-DDT | 3.4 UJ | 3.4 UJ | 3.9 UJ | 4.9 UJ | 4.1 UJ | 4 U | 0.26 J | 3.9 UJ | 1.1 J | 3.8 UJ | 3.8 U | 9.1 |
| Aldrin | 1.8 UJ | 1.8 UJ | 0.73 J | 2.5 UJ | 2.1 UJ | 2.1 U | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |
| Aroclor-1254 | 34 UJ | 34 UJ | 39 UJ | 49 UJ | 41 UJ | 40 U | 39 U | 39 U | 42 U | 38 UJ | 38 U | 38 U |
| Aroclor-1260 | 34 UJ | 34 UJ | 39 UJ | 49 UJ | 41 UJ | 40 U | 39 U | 39 U | 42 U | 38 UJ | 38 U | 38 U |
| Dieldrin | 3.4 UJ | 3.4 UJ | 3.9 UJ | 4.9 UJ | 4.1 UJ | 4 U | 0.18 J | 3.9 UJ | 4.2 U | 3.8 UJ | 3.8 U | 3.8 U |
| Endosulfan I | 1.8 UJ | 1.8 UJ | 2 UJ | 2.5 UJ | 2.1 UJ | 2.1 U | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |
| Endosulfan II | 3.4 UJ | 3.4 UJ | 3.9 UJ | 4.9 UJ | 4.1 UJ | 4 U | 3.9 U | 3.9 UJ | 4.2 U | 3.8 UJ | 3.8 U | 3.8 U |
| Endosulfan sulfate | 3.4 UJ | 3.4 UJ | 3.9 UJ | 4.9 UJ | 4.1 UJ | 4 U | 3.9 U | 3.9 UJ | 4.2 U | 3.8 UJ | 3.8 U | 3.8 U |
| Endrin | 3.4 UJ | 3.4 UJ | 3.9 UJ | 4.9 UJ | 4.1 UJ | 4 U | 3.9 U | 3.9 UJ | 4.2 U | 3.8 UJ | 3.8 U | 3.8 U |
| Endrin aldehyde | 3.4 UJ | 3.4 UJ | 3.9 UJ | 4.9 UJ | 4.1 UJ | 4 U | 3.9 U | 3.9 UJ | 4.2 U | 3.8 UJ | 3.8 U | 3.8 U |
| Heptachlor | 1.8 UJ | 1.8 UJ | 2 UJ | 2.5 UJ | 2.1 UJ | 2.1 U | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |
| Heptachlor epoxide | 1.8 UJ | 1.8 UJ | 2 UJ | 2.5 UJ | 2.1 UJ | 2.1 U | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |
| Methoxychlor | 18 UJ | 18 UJ | 20 UJ | 25 UJ | 21 UJ | 21 U | 20 U | 20 UJ | 21 U | 20 UJ | 20 U | 19 U |
| alpha-Chlordane | 1.8 UJ | 1.8 UJ | 2 UJ | 2.5 UJ | 2.1 UJ | 2.1 U | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |
| beta-BHC | 1.8 UJ | 1.8 UJ | 2 UJ | 2.5 UJ | 2.1 UJ | 2.1 U | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |
| delta-BHC | 1.8 UJ | 1.8 UJ | 2 UJ | 2.5 UJ | 2.1 UJ | 2.1 U | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |
| gamma-BHC (Lindane) | 1.8 UJ | 1.8 UJ | 2 UJ | 2.5 UJ | 2.1 UJ | 2.1 UJ | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |
| gamma-Chlordane | 1.8 UJ | 1.8 UJ | 2 UJ | 2.5 UJ | 2.1 UJ | 2.1 U | 2 U | 2 UJ | 2.1 U | 2 UJ | 2 U | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-L | | |
|---|---|---|---|
| **Station ID** | AOCLSB003 | AOCLSB004 | |
| **Sample ID** | NDE125 | NDE127 | NDE128FD1 |
| **Sample Date** | 11/29/00 | 11/29/00 | 11/29/00 |
| **Chemical Name** | | | |
| | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | |
| 4,4'-DDD | 3.8 U | 3.7 U | 3.7 U |
| 4,4'-DDE | 3.8 U | 2.3 J | 0.74 J |
| 4,4'-DDT | 3.8 U | 1.2 J | 0.59 J |
| Aldrin | 2 U | 1.9 U | 1.9 U |
| Aroclor-1254 | 38 U | 37 U | 37 U |
| Aroclor-1260 | 38 U | 37 U | 37 U |
| Dieldrin | 3.8 U | 3.7 U | 3.7 U |
| Endosulfan I | 2 U | 1.9 U | 1.9 U |
| Endosulfan II | 3.8 U | 3.7 U | 3.7 U |
| Endosulfan sulfate | 3.8 U | 3.7 U | 3.7 U |
| Endrin | 3.8 U | 3.7 U | 3.7 U |
| Endrin aldehyde | 3.8 U | 3.7 U | 3.7 U |
| Heptachlor | 2 U | 1.9 U | 1.9 U |
| Heptachlor epoxide | 2 U | 1.9 U | 1.9 U |
| Methoxychlor | 20 U | 19 U | 19 U |
| alpha-Chlordane | 2 U | 1.9 U | 1.9 U |
| beta-BHC | 2 U | 1.9 U | 1.9 U |
| delta-BHC | 2 U | 1.9 U | 1.9 U |
| gamma-BHC (Lindane) | 2 U | 1.9 U | 1.9 U |
| gamma-Chlordane | 2 U | 1.9 U | 1.9 U |

**Notes:**
NA - Not analyzed
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R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-R | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AOCRSS001 | AOCRSS002 | AOCRSS003 | AOCRSS004 | AOCRSS005 | AOCRSS006 | AOCRSS007 | AOCRSS008 | AOCRSS009 | AOCRSS010 | |
| **Sample ID** | NDE133 | NDE134 | NDE135 | NDE136 | NDE137 | NDE138 | NDE139 | NDE140 | NDE141 | NDE142 | NDE143FD1 |
| **Sample Date** | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 12 J | 4 U | 4 U | 3.7 U | 7.4 J | 3.7 U | 4 U | 0.8 J | 2.1 J | 2.2 J | 2.6 J |
| 4,4'-DDE | 46 | 0.66 J | 4 U | 1.5 J | 43 | 3.7 U | 0.85 J | 1.1 J | 22 | 49 | 52 |
| 4,4'-DDT | 34 J | 4 UJ | 4 UJ | 0.7 J | 19 J | 3.7 UJ | 4 UJ | 0.5 J | 7.6 J | 9.2 J | 11 J |
| Aldrin | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |
| Aroclor-1254 | 37 U | 40 U | 40 U | 37 U | 38 U | 37 U | 40 U | 38 U | 38 U | 36 U | 37 U |
| Aroclor-1260 | 37 U | 40 U | 40 U | 37 U | 38 U | 37 U | 40 U | 38 U | 38 U | 36 U | 37 U |
| Dieldrin | 3.7 U | 4 U | 4 U | 3.7 U | 3.8 U | 3.7 U | 4 U | 3.8 U | 3.8 U | 3.6 U | 3.7 U |
| Endosulfan I | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |
| Endosulfan II | 3.7 U | 4 U | 4 U | 3.7 U | 3.8 U | 3.7 U | 4 U | 3.8 U | 3.8 U | 3.6 U | 3.7 U |
| Endosulfan sulfate | 3.7 U | 4 U | 4 U | 3.7 U | 3.8 U | 3.7 U | 4 U | 3.8 U | 3.8 U | 3.6 U | 3.7 U |
| Endrin | 3.7 U | 4 U | 4 U | 3.7 U | 3.8 U | 3.7 U | 4 U | 3.8 U | 3.8 U | 3.6 U | 3.7 U |
| Endrin aldehyde | 3.7 U | 4 U | 4 U | 3.7 U | 3.8 U | 3.7 U | 4 U | 3.8 U | 3.8 U | 3.6 U | 3.7 U |
| Heptachlor | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |
| Heptachlor epoxide | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |
| Methoxychlor | 19 UJ | 21 UJ | 21 UJ | 19 UJ | 20 UJ | 19 UJ | 21 UJ | 20 UJ | 20 UJ | 19 UJ | 19 UJ |
| alpha-Chlordane | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |
| beta-BHC | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |
| delta-BHC | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |
| gamma-BHC (Lindane) | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |
| gamma-Chlordane | 1.9 U | 2.1 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 2.1 U | 2 U | 2 U | 1.9 U | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-R | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AOCRSS011 | AOCRSS012 | AOCRSS013 | AOCRSS014 | AOCRSS015 | AOCRSS016 | AOCRSS017 | AOCRSS018 | AOCRSS019 | AOCRSS020 | |
| **Sample ID** | NDE144 | NDE145 | NDE146 | NDE147 | NDE148 | NDE149 | NDE150 | NDE151 | NDE152 | NDE153 | NDE154FD1 |
| **Sample Date** | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/28/00 | 11/29/00 | 11/29/00 | 11/29/00 | 11/29/00 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 3.5 J | 14 J | 6.4 J | 3.8 U | 9.4 J | 4 U | 3.8 U | 4 J | 3.7 U | 3.7 U | 3.7 U |
| 4,4'-DDE | 50 | 83 | 48 | 2.4 J | 57 | 54 | 10 | 70 | 18 | 48 J | 89 J |
| 4,4'-DDT | 22 J | 48 J | 44 J | 3.8 UJ | 32 | 19 J | 6.6 J | 34 | 12 | 32 J | 27 |
| Aldrin | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |
| Aroclor-1254 | 36 U | 35 U | 37 U | 38 U | 41 U | 40 U | 38 U | 37 U | 37 U | 37 U | 37 U |
| Aroclor-1260 | 36 U | 35 U | 37 U | 38 U | 41 U | 40 U | 38 U | 37 U | 37 U | 37 U | 37 U |
| Dieldrin | 3.6 U | 3.5 U | 3.7 U | 3.8 U | 4.1 U | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U |
| Endosulfan I | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |
| Endosulfan II | 3.6 U | 3.5 U | 3.7 U | 3.8 U | 4.1 U | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U |
| Endosulfan sulfate | 3.6 U | 3.5 U | 3.7 U | 3.8 U | 4.1 U | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U |
| Endrin | 3.6 U | 3.5 U | 3.7 U | 3.8 U | 4.1 U | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U |
| Endrin aldehyde | 3.6 U | 3.5 U | 3.7 U | 3.8 U | 4.1 U | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U |
| Heptachlor | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |
| Heptachlor epoxide | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |
| Methoxychlor | 19 UJ | 18 UJ | 19 UJ | 20 UJ | 21 UJ | 21 UJ | 19 UJ | 19 U | 19 U | 19 U | 19 U |
| alpha-Chlordane | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |
| beta-BHC | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |
| delta-BHC | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |
| gamma-BHC (Lindane) | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |
| gamma-Chlordane | 1.9 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-R | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AOCRSS021 | AOCRSS022 | AOCRSS023 | AOCRSS024 | AOCRSS025 | AOCRSS026 | AOCRSS027 | AOCRSS028 | AOCRSS029 | AOCRSS030 | |
| **Sample ID** | NDE155 | NDE156 | NDE157 | NDE158 | NDE159 | NDE160 | NDE161 | NDE162 | NDE163 | NDE164 | NDE165FD1 |
| **Sample Date** | 11/29/00 | 11/29/00 | 11/29/00 | 11/29/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 18 | 3.7 U | 3.5 U | 3.7 U | 3.6 U | 3.7 U | 7.7 UJ | 3.5 UJ | 4.2 U | 3.6 UJ | 3.8 UJ |
| 4,4'-DDE | 328 | 45 | 161 | 3.7 U | 3.6 U | 19 J | 9.4 J | 1 J | 4.2 U | 83 J | 85 J |
| 4,4'-DDT | 111 J | 46 | 42 | 3.7 U | 3.6 U | 8.9 J | 8.7 J | 3.5 J | 4.2 U | 82 J | 61 J |
| Aldrin | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |
| Aroclor-1254 | 37 U | 37 U | 35 U | 37 U | 36 U | 37 U | 77 UJ | 35 UJ | 42 U | 36 UJ | 38 UJ |
| Aroclor-1260 | 37 U | 37 U | 35 U | 37 U | 36 U | 37 U | 77 UJ | 35 UJ | 42 U | 36 UJ | 38 UJ |
| Dieldrin | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.6 U | 3.7 U | 7.7 UJ | 3.5 UJ | 4.2 U | 3.6 UJ | 3.8 UJ |
| Endosulfan I | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |
| Endosulfan II | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.6 U | 3.7 U | 7.7 UJ | 3.5 UJ | 4.2 U | 3.6 UJ | 3.8 UJ |
| Endosulfan sulfate | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.6 U | 3.7 U | 7.7 UJ | 3.5 UJ | 4.2 U | 3.6 UJ | 3.8 UJ |
| Endrin | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.6 U | 3.7 U | 7.7 UJ | 3.5 UJ | 4.2 U | 3.6 UJ | 3.8 UJ |
| Endrin aldehyde | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.6 U | 3.7 U | 7.7 UJ | 3.5 UJ | 4.2 U | 3.6 UJ | 3.8 UJ |
| Heptachlor | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |
| Heptachlor epoxide | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |
| Methoxychlor | 19 U | 19 U | 18 U | 19 U | 18 U | 19 U | 39 UJ | 18 UJ | 21 U | 19 UJ | 20 UJ |
| alpha-Chlordane | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |
| beta-BHC | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |
| delta-BHC | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |
| gamma-BHC (Lindane) | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |
| gamma-Chlordane | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.9 U | 3.9 UJ | 1.8 UJ | 2.1 U | 1.9 UJ | 2 UJ |

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NA - Not analyzed
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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-R | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | AOCRSS031 | AOCRSS032 | AOCRSS033 | AOCRSS034 | WAR-SO35 | | WAR-SO36 | WAR-SO37 | WAR-SO38 | WAR-SO39 | WAR-SO40 |
| **Sample ID** | NDE166 | NDE167 | NDE168 | NDE169 | WAR-SS35-0002 | WAR-SS35P-0002 | WAR-SS36-0002 | WAR-SS37-0002 | WAR-SS38-0002 | WAR-SS39-0002 | WAR-SS40-0002 |
| **Sample Date** | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 03/03/06 | 03/03/06 | 03/03/06 | 03/03/06 | 12/08/05 | 12/08/05 | 12/08/05 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 4 UJ | 3.9 UJ | 3.6 UJ | 3.9 UJ | 4 U | 3.8 U | 4 JN | 7.3 | 7.8 | 40 | 6.2 U |
| 4,4'-DDE | 76 J | 157 J | 4.9 J | 6 J | 4 U | 3.8 U | 13 | 8 J | 180 | 230 | 98 JN |
| 4,4'-DDT | 89 J | 54 J | 3.6 J | 3.9 UJ | 4 U | 3.8 U | 8.6 J | 51 J | 110 | 180 | 200 |
| Aldrin | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 3.2 U |
| Aroclor-1254 | 40 UJ | 39 UJ | 36 UJ | 39 UJ | 40 U | 38 U | 39 U | 38 U | 37 U | 38 U | 62 U |
| Aroclor-1260 | 40 UJ | 39 UJ | 36 UJ | 39 UJ | 40 U | 38 U | 39 U | 38 U | 37 U | 38 U | 62 U |
| Dieldrin | 4 UJ | 3.9 UJ | 3.6 UJ | 3.9 UJ | 4 U | 3.8 U | 3.9 U | 3.8 U | 3.7 U | 3.8 U | 6.2 U |
| Endosulfan I | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 3.2 U |
| Endosulfan II | 4 UJ | 3.9 UJ | 3.6 UJ | 3.9 UJ | 4 U | 3.8 U | 3.9 U | 3.8 U | 3.7 U | 3.8 U | 6.2 U |
| Endosulfan sulfate | 4 UJ | 3.9 UJ | 3.6 UJ | 3.9 UJ | 4 U | 3.8 U | 3.9 U | 3.8 U | 63 R | 61 R | 90 JN |
| Endrin | 4 UJ | 3.9 UJ | 3.6 UJ | 3.9 UJ | 4 U | 2.5 J | 3.9 U | 3.8 U | 26 R | 28 R | 16 JN |
| Endrin aldehyde | 4 UJ | 3.9 UJ | 3.6 UJ | 3.9 UJ | 4 U | 3.8 U | 12 R | 3.8 U | 3.7 U | 3.8 U | 6.2 U |
| Heptachlor | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 3.2 U |
| Heptachlor epoxide | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 3.2 U |
| Methoxychlor | 21 UJ | 20 UJ | 18 UJ | 20 UJ | 21 U | 19 U | 230 JN | 210 R | 140 R | 170 R | 240 J |
| alpha-Chlordane | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 3.2 U |
| beta-BHC | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 3.2 R | 2.7 R | 3.8 R | 6.8 R | 3.2 U |
| delta-BHC | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 3.2 U |
| gamma-BHC (Lindane) | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 3.2 U |
| gamma-Chlordane | 2.1 UJ | 2 UJ | 1.8 UJ | 2 UJ | 2.1 U | 1.9 U | 2 U | 1.9 U | 19 U | 270 | 270 J |

**Notes:**

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J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-R | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WAR-SO41 | WAR-SO42 | WAR-SO43 | WAR-SO44 | WAR-SO45 | | WAR-SO46 | WAR-SO47 | WAR-SO48 | WAR-SO49 | WAR-SO50 |
| **Sample ID** | WAR-SS41-0002 | WAR-SS42-0002 | WAR-SS43-0002 | WAR-SS44-0002 | WAR-SS45-0002 | WAR-SS45P-0002 | WAR-SS46-0002 | WAR-SS47-0002 | WAR-SS48-0002 | WAR-SS49-0002 | WAR-SS50-0002 |
| **Sample Date** | 12/07/05 | 12/07/05 | 12/05/05 | 12/07/05 | 12/07/05 | 12/07/05 | 12/15/05 | 12/16/05 | 12/15/05 | 12/15/05 | 12/15/05 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 3.7 U | 4 U | 2.6 J | 3.9 U | 3.6 U | 3.6 U | 3.6 U | 4.9 | 3.8 U | 3.8 U | 3.7 U |
| 4,4'-DDE | 13 | 4 U | 84 | 1.9 J | 8 J | 6.8 | 34 | 6.6 | 21 | 15 | 7.2 |
| 4,4'-DDT | 8 | 4 U | 76 | 3.9 U | 3.6 U | 2.3 J | 24 J | 4.6 | 8.8 | 3.9 | 5.5 |
| Aldrin | 1.9 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| Aroclor-1254 | 37 U | 40 U | 36 U | 39 U | 36 U | 36 U | 56 | 35 U | 38 U | 38 U | 37 U |
| Aroclor-1260 | 37 U | 40 U | 36 U | 39 U | 36 U | 36 U | 27 J | 35 U | 38 U | 38 U | 37 U |
| Dieldrin | 3.7 U | 4 U | 3.6 U | 3.9 U | 3.6 U | 3.6 U | 3.6 U | 3.5 U | 3.8 U | 3.8 U | 3.7 U |
| Endosulfan I | 1.9 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| Endosulfan II | 3.7 U | 4 U | 3.6 U | 3.9 U | 3.6 U | 3.6 U | 3.6 U | 3.5 U | 3.8 U | 3.8 U | 3.7 U |
| Endosulfan sulfate | 3.7 U | 4 U | 3.6 U | 3.9 U | 3.6 U | 3.6 U | 3.6 U | 3.5 U | 3.8 U | 3.8 U | 3.7 U |
| Endrin | 3.7 U | 4 U | 3.9 R | 3.9 U | 3.6 U | 3.6 U | 3.6 U | 3.5 U | 3.8 U | 3.8 U | 3.7 U |
| Endrin aldehyde | 3.7 U | 4 U | 3.6 U | 3.9 U | 3.6 U | 3.6 U | 3.6 U | 3.5 U | 3.8 U | 3.8 U | 3.7 U |
| Heptachlor | 1.9 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| Heptachlor epoxide | 1.9 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| Methoxychlor | 19 U | 21 U | 19 U | 20 U | 19 U | 19 U | 19 U | 18 U | 19 U | 19 U | 19 U |
| alpha-Chlordane | 1.9 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| beta-BHC | 1.8 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 0.64 J | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| delta-BHC | 1.9 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| gamma-BHC (Lindane) | 1.9 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U |
| gamma-Chlordane | 1.9 U | 2.1 U | 1.9 U | 2 U | 1.9 U | 0.38 J | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-R | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WAR-SO51 | WAR-SO52 | WAR-SO53 | WAR-SO54 | WAR-SO55 | | WAR-SO56 | WAR-SO57 | WAR-SO58 | WAR-SO59 | WAR-SO60 |
| **Sample ID** | WAR-SS51-0002 | WAR-SS52-0002 | WAR-SS53-0002 | WAR-SS54-0002 | WAR-SS55-0002 | WAR-SS55P-0002 | WAR-SS56-0002 | WAR-SS57-0002 | WAR-SS58-0002 | WAR-SS59-0002 | WAR-SS60-0002 |
| **Sample Date** | 12/15/05 | 12/15/05 | 12/15/05 | 12/16/05 | 12/16/05 | 12/16/05 | 12/16/05 | 12/16/05 | 12/16/05 | 12/16/05 | 12/15/05 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 3.7 U | 3.8 U | 3.8 U | 3.6 U | 3.8 U | 3.9 U | 3.6 U | 3.9 U | 2.1 J | 4 U | 3.9 U |
| 4,4'-DDE | 6.4 | 14 | 14 | 13 | 4.5 | 1.8 J | 3.6 U | 7.8 | 4.2 J | 4 U | 1.7 J |
| 4,4'-DDT | 3.8 | 11 | 5.7 | 4.7 | 2.9 J | 3.9 U | 3.6 U | 6.4 | 4.2 U | 4 U | 5.2 |
| Aldrin | 1.9 U | 2 U | 2 U | 1.9 U | 2 U | 2 U | 1.8 U | 2 U | 2.2 U | 2.1 U | 2 U |
| Aroclor-1254 | 37 U | 38 U | 38 U | 36 U | 38 U | 39 U | 36 U | 39 U | 42 U | 40 U | 39 U |
| Aroclor-1260 | 37 U | 38 U | 38 U | 36 U | 38 U | 39 U | 36 U | 39 U | 42 U | 40 U | 39 U |
| Dieldrin | 3.7 U | 3.8 U | 3.8 U | 3.6 U | 3.8 U | 3.9 U | 3.6 U | 3.9 U | 4.2 U | 4 U | 3.9 U |
| Endosulfan I | 1.9 U | 2 U | 2 U | 1.9 U | 2 U | 2 U | 1.8 U | 2 U | 2.2 U | 2.1 U | 2 U |
| Endosulfan II | 3.7 U | 3.8 U | 3.8 U | 3.6 U | 3.8 U | 3.9 U | 3.6 U | 3.9 U | 4.2 U | 4 U | 3.9 U |
| Endosulfan sulfate | 3.7 U | 3.8 U | 3.8 U | 3.6 U | 3.8 U | 3.9 U | 3.6 U | 3.9 U | 4.2 U | 4 U | 3.9 U |
| Endrin | 3.7 U | 3.8 U | 3.8 U | 3.6 U | 3.8 U | 3.9 U | 3.6 U | 3.9 U | 4.2 U | 4 U | 3.9 U |
| Endrin aldehyde | 3.7 U | 3.8 U | 3.8 U | 3.6 U | 3.8 U | 3.9 U | 3.6 U | 3.9 U | 4.2 U | 4 U | 3.9 U |
| Heptachlor | 1.9 U | 2 U | 2 U | 1.9 U | 2 U | 2 U | 1.8 U | 2 U | 2.2 U | 2.1 U | 2 U |
| Heptachlor epoxide | 1.9 U | 2 U | 2 U | 1.9 U | 2 U | 2 U | 1.8 U | 2 U | 2.2 U | 2.1 U | 2 U |
| Methoxychlor | 19 U | 20 U | 20 U | 19 U | 20 U | 20 U | 18 U | 20 U | 22 U | 21 U | 20 U |
| alpha-Chlordane | 1.9 U | 2 U | 2 U | 1.9 U | 2 U | 2 U | 3.3 | 2 U | 2.2 U | 2.1 U | 2 U |
| beta-BHC | 1.9 U | 2 U | 2 U | 1.9 U | 2 U | 2 U | 1.8 U | 0.59 J | 2.2 U | 2.1 U | 2 U |
| delta-BHC | 1.9 U | 2 U | 2 U | 1.9 U | 2 U | 2 U | 1.8 U | 2 U | 2.2 U | 2.1 U | 2 U |
| gamma-BHC (Lindane) | 1.9 U | 2 U | 2 U | 1.9 U | 2 U | 2 U | 1.8 U | 2 U | 2.2 U | 2.1 U | 2 U |
| gamma-Chlordane | 1.9 U | 0.51 J | 2 U | 1.9 U | 2 U | 2 U | 1.8 U | 2 U | 2.2 U | 2.1 U | 2 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-R | | | W-SWMU-10 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WAR-SO61 | WAR-SO62 | WAR-SO63 | W10-SB01 | W10-SB02 | | W10-SB03 | W10-SB04 | W10-SB05 | W10-SB06 | W10-SB07 | W10-SB08 | W10-SB09 |
| **Sample ID** | WAR-SS61-0002 | WAR-SS62-0002 | WAR-SS63-0002 | NDA125 | NDA127 | NDA128FD1 | NDA131 | NDA133 | NDA135 | NDA137 | NDA139 | NDA141 | NDA143 |
| **Sample Date** | 12/15/05 | 12/15/05 | 12/15/05 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 4 U | 3.8 U | 4.1 U | 3.9 U | 3.6 U | 4.2 U | 3.8 U | 3.9 U | 0.77 J | 0.8 J | 0.43 J | 4.2 U | 3.4 U |
| 4,4'-DDE | 4 U | 3.8 U | 4.1 U | 190 | 2.7 J | 3.8 J | 16 | 13 | 50 | 55 | 10 | 1.2 J | 14 |
| 4,4'-DDT | 4 U | 3.8 U | 4.1 U | 125 J | 4.4 | 4.2 | 10 J | 9.4 J | 44 | 26 | 5.7 J | 0.82 J | 7.1 J |
| Aldrin | 2 U | 2 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 2 U | 2.1 U | 1.8 U | 1.8 U | 2.1 U | 1.7 U |
| Aroclor-1254 | 40 U | 38 U | 41 U | 39 U | 36 U | 41 U | 37 U | 38 U | 40 U | 35 U | 35 U | 42 U | 34 U |
| Aroclor-1260 | 40 U | 38 U | 41 U | 39 U | 36 U | 41 U | 37 U | 38 U | 40 U | 35 U | 35 U | 42 U | 34 U |
| Dieldrin | 4 U | 3.8 U | 4.1 U | 3.9 U | 3.6 U | 4.2 U | 3.8 U | 3.9 U | 4.1 U | 3.5 U | 3.5 U | 4.2 U | 3.4 U |
| Endosulfan I | 2 U | 2 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 2 U | 2.1 U | 1.8 U | 1.8 U | 2.1 U | 1.7 U |
| Endosulfan II | 4 U | 3.8 U | 4.1 U | 3.9 U | 3.6 U | 4.2 U | 3.8 U | 3.9 U | 4.1 U | 3.5 U | 3.5 U | 4.2 U | 3.4 U |
| Endosulfan sulfate | 4 U | 3.8 U | 4.1 U | 3.9 U | 3.6 U | 4.2 U | 3.8 U | 3.9 U | 4.1 U | 3.5 U | 3.5 U | 4.2 U | 3.4 U |
| Endrin | 4 U | 3.8 U | 4.1 U | 3.9 U | 3.6 U | 4.2 U | 3.8 U | 3.9 U | 4.1 U | 3.5 U | 3.5 U | 4.2 U | 3.4 U |
| Endrin aldehyde | 4 U | 3.8 U | 4.1 U | 3.9 U | 3.6 U | 4.2 U | 3.8 U | 3.9 U | 4.1 U | 3.5 U | 3.5 U | 4.2 U | 3.4 U |
| Heptachlor | 2 U | 2 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 2 U | 2.1 U | 1.8 U | 1.8 U | 2.1 U | 1.7 U |
| Heptachlor epoxide | 2 U | 2 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 2 U | 2.1 U | 1.8 U | 1.8 U | 2.1 U | 1.7 U |
| Methoxychlor | 20 U | 20 U | 21 U | 20 UJ | 19 UJ | 21 UJ | 19 UJ | 20 UJ | 21 UJ | 18 UJ | 18 UJ | 21 UJ | 17 UJ |
| alpha-Chlordane | 2 U | 2 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 2 U | 2.1 U | 1.8 U | 1.8 U | 2.1 U | 1.7 U |
| beta-BHC | 2 U | 2 U | 0.79 J | 2 U | 1.9 U | 2.1 U | 1.9 U | 2 U | 2.1 U | 1.8 U | 1.8 U | 2.1 U | 1.7 U |
| delta-BHC | 2 U | 2 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 2 U | 2.1 U | 1.8 U | 1.8 U | 2.1 U | 1.7 U |
| gamma-BHC (Lindane) | 2 U | 2 U | 2.1 U | 2 UJ | 1.9 UJ | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 1.8 UJ | 1.8 UJ | 2.1 UJ | 1.7 UJ |
| gamma-Chlordane | 2 U | 2 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 2 U | 2.1 U | 1.8 U | 1.8 U | 2.1 U | 1.7 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-10 | W-SWMU-14 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | W10-SB10 | W14-SB01 | W14-SB02 | | W14-SB03 | W14-SB04 | W14-SB05 | W14-SB06 | W14-SB07 | W14-SB08 | W14-SB09 | W14-SB10 | W14-SB11 |
| **Sample ID** | NDA145 | NDA147 | NDA149 | NDA150FD1 | NDA153 | NDA155 | NDA157 | NDA159 | NDA161 | NDA164 | NDA166 | NDA168 | NDA170 |
| **Sample Date** | 04/04/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/06/00 | 04/06/00 | 04/06/00 | 04/06/00 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.8 U | 0.68 J | 3.4 U | 3.5 U | 4.1 UJ | 4.1 UJ | 3.9 UJ | 4 UJ |
| 4,4'-DDE | 4.9 | 0.5 J | 0.77 J | 0.64 J | 3.5 U | 3.8 U | 3 J | 3.4 U | 0.69 J | 4.1 UJ | 4.1 UJ | 3.9 UJ | 0.77 J |
| 4,4'-DDT | 4.9 | 3.5 UJ | 3.6 U | 3.4 U | 3.5 UJ | 3.8 U | 3.4 U | 3.4 U | 3.5 U | 4.1 UJ | 4.1 UJ | 3.9 UJ | 4 UJ |
| Aldrin | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |
| Aroclor-1254 | 36 U | 34 U | 36 U | 34 U | 35 U | 37 U | 33 U | 34 U | 34 U | 41 UJ | 41 UJ | 38 UJ | 40 UJ |
| Aroclor-1260 | 36 U | 34 U | 36 U | 34 U | 35 U | 37 U | 33 U | 34 U | 34 U | 41 UJ | 41 UJ | 38 UJ | 40 UJ |
| Dieldrin | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.8 U | 3.4 U | 3.4 U | 3.5 U | 4.1 UJ | 4.1 UJ | 0.45 UJ | 4 UJ |
| Endosulfan I | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |
| Endosulfan II | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.8 U | 3.4 U | 3.4 U | 3.5 U | 4.1 UJ | 4.1 UJ | 3.9 UJ | 4 UJ |
| Endosulfan sulfate | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.8 U | 3.4 U | 3.4 U | 3.5 U | 4.1 UJ | 4.1 UJ | 3.9 UJ | 4 UJ |
| Endrin | 3.7 U | 3.5 U | 3.6 UJ | 3.4 UJ | 3.5 U | 3.8 UJ | 3.4 UJ | 3.4 UJ | 3.5 UJ | 4.1 UJ | 4.1 UJ | 3.9 UJ | 4 UJ |
| Endrin aldehyde | 3.7 U | 3.5 U | 3.6 U | 3.4 U | 3.5 U | 3.8 U | 3.4 U | 3.4 U | 3.5 U | 4.1 UJ | 4.1 UJ | 3.9 UJ | 4 UJ |
| Heptachlor | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |
| Heptachlor epoxide | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |
| Methoxychlor | 19 UJ | 18 UJ | 1.2 J | 17 UJ | 18 UJ | 19 UJ | 17 UJ | 18 UJ | 18 UJ | 21 UJ | 21 UJ | 20 UJ | 20 UJ |
| alpha-Chlordane | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |
| beta-BHC | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |
| delta-BHC | 1.9 U | 1.8 UJ | 1.9 U | 1.7 U | 1.8 UJ | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |
| gamma-BHC (Lindane) | 1.9 UJ | 1.8 UJ | 1.9 UJ | 1.7 UJ | 1.8 UJ | 1.9 UJ | 1.7 UJ | 1.8 UJ | 1.8 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |
| gamma-Chlordane | 1.9 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.9 U | 1.7 U | 1.8 U | 1.8 U | 2.1 UJ | 2.1 UJ | 2 UJ | 2 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-14 | | | W-SWMU-15 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | W14-SB12 | W14-SB13 | W14-SB14 | W15-SB01 | W15-SB02 | W15-SB03 | W15-SB04 | W15-SB05 | W15-SB06 | | W15-SB07 | W15-SB08 |
| **Sample ID** | NDA172 | NDA174 | NDA176 | NDA178 | NDA179 | NDA180 | NDA181 | NDA182 | NDA183 | NDA184FD1 | NDA185 | NDA186 |
| **Sample Date** | 04/06/00 | 04/06/00 | 04/06/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/12/00 | 04/12/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.6 UJ | 3.5 UJ | 9.3 UJ | 3.40 U | 3.5 U | 3.40 U | 3.70 U | 3.90 U | 3.80 U | 3.70 U | 3.90 UJ | 3.70 UJ |
| 4,4'-DDE | 3.6 UJ | 1 J | 9.3 UJ | 3.40 U | 3.5 U | 0.620 J | 3.70 U | 3.90 U | 3.80 U | 3.70 U | 3.90 UJ | 0.420 J |
| 4,4'-DDT | 3.6 UJ | 3.5 UJ | 9.3 UJ | 3.40 U | 3.5 U | 3.40 U | 3.70 U | 3.90 U | 3.80 U | 3.70 U | 3.90 UJ | 3.70 UJ |
| Aldrin | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |
| Aroclor-1254 | 35 UJ | 34 UJ | 92 UJ | 33 U | 35 U | 34 U | 37 U | 39 U | 37 U | 37 U | 39 UJ | 37 UJ |
| Aroclor-1260 | 35 UJ | 34 UJ | 92 UJ | 33 U | 35 U | 21 J | 37 U | 39 U | 37 U | 37 U | 39 UJ | 37 UJ |
| Dieldrin | 3.6 UJ | 3.5 UJ | 9.3 UJ | 3.40 U | 3.5 U | 3.40 U | 3.70 U | 3.90 U | 3.80 U | 3.70 U | 3.90 UJ | 3.70 UJ |
| Endosulfan I | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |
| Endosulfan II | 3.6 UJ | 3.5 UJ | 9.3 UJ | 3.40 U | 3.5 U | 3.40 U | 3.70 U | 3.90 U | 3.80 U | 3.70 U | 3.90 UJ | 3.70 UJ |
| Endosulfan sulfate | 3.6 UJ | 3.5 UJ | 9.3 UJ | 3.40 U | 3.5 U | 3.40 U | 3.70 U | 3.90 U | 3.80 U | 3.70 U | 3.90 UJ | 3.70 UJ |
| Endrin | 3.6 UJ | 3.5 UJ | 9.3 UJ | 3.40 U | 3.5 U | 3.40 U | 3.70 U | 3.90 U | 3.80 U | 3.70 U | 3.90 UJ | 3.70 UJ |
| Endrin aldehyde | 3.6 UJ | 3.5 UJ | 9.3 UJ | 3.40 U | 3.5 U | 3.40 U | 3.70 U | 3.90 U | 3.80 U | 3.70 U | 3.90 UJ | 3.70 UJ |
| Heptachlor | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |
| Heptachlor epoxide | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |
| Methoxychlor | 18 UJ | 18 UJ | 48 UJ | 17 U | 18 U | 17 U | 19 U | 20 U | 19 U | 19 U | 20 UJ | 19 UJ |
| alpha-Chlordane | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |
| beta-BHC | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |
| delta-BHC | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |
| gamma-BHC (Lindane) | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |
| gamma-Chlordane | 1.8 UJ | 1.8 UJ | 4.8 UJ | 1.70 U | 1.80 U | 1.70 U | 1.90 U | 2 U | 1.90 U | 1.90 U | 2 UJ | 1.90 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-15 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | W15-SB09 | W15-SB10 | W15-SB11 | W15-SB12 | W15-SB13 | | W15-SB14 | W15-SB15 | W15-SB16 |
| **Sample ID** | NDA187 | NDA188 | NDA189 | NDA190 | NDA191 | NDA192FD1 | NDA193 | NDA194 | NDA195 |
| **Sample Date** | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 |
| **Chemical Name** | | | | | | | | | |
| | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | |
| 4,4'-DDD | 3.60 UJ | 4.60 UJ | 3.70 UJ | 3.80 UJ | 3.40 UJ | 3.90 UJ | 3.40 UJ | 4.10 UJ | 3.40 UJ |
| 4,4'-DDE | 3.60 UJ | 4.60 UJ | 3.70 UJ | 3.80 UJ | 3.40 UJ | 0.440 J | 1.10 J | 4.10 UJ | 3.40 UJ |
| 4,4'-DDT | 3.60 UJ | 4.60 UJ | 3.70 UJ | 3.80 UJ | 3.40 UJ | 3.90 UJ | 0.550 J | 4.10 UJ | 3.40 UJ |
| Aldrin | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |
| Aroclor-1254 | 35 UJ | 45 UJ | 37 UJ | 37 UJ | 34 UJ | 38 UJ | 34 UJ | 40 UJ | 34 UJ |
| Aroclor-1260 | 35 UJ | 45 UJ | 37 UJ | 37 UJ | 34 UJ | 38 UJ | 34 UJ | 40 UJ | 34 UJ |
| Dieldrin | 3.60 UJ | 4.60 UJ | 3.70 UJ | 3.80 UJ | 3.40 UJ | 3.90 UJ | 0.450 J | 4.10 UJ | 3.40 UJ |
| Endosulfan I | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |
| Endosulfan II | 3.60 UJ | 4.60 UJ | 3.70 UJ | 3.80 UJ | 3.40 UJ | 3.90 UJ | 3.40 UJ | 4.10 UJ | 3.40 UJ |
| Endosulfan sulfate | 3.60 UJ | 4.60 UJ | 3.70 UJ | 3.80 UJ | 3.40 UJ | 3.90 UJ | 3.40 UJ | 4.10 UJ | 3.40 UJ |
| Endrin | 3.60 UJ | 4.60 UJ | 3.70 UJ | 3.80 UJ | 3.40 UJ | 3.90 UJ | 3.40 UJ | 4.10 UJ | 3.40 UJ |
| Endrin aldehyde | 3.60 UJ | 4.60 UJ | 3.70 UJ | 3.80 UJ | 3.40 UJ | 3.90 UJ | 3.40 UJ | 4.10 UJ | 3.40 UJ |
| Heptachlor | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |
| Heptachlor epoxide | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |
| Methoxychlor | 18 UJ | 23 UJ | 19 UJ | 19 UJ | 17 UJ | 20 UJ | 18 UJ | 21 UJ | 17 UJ |
| alpha-Chlordane | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |
| beta-BHC | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |
| delta-BHC | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |
| gamma-BHC (Lindane) | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |
| gamma-Chlordane | 1.80 UJ | 2.30 UJ | 1.90 UJ | 1.90 UJ | 1.70 UJ | 2 UJ | 1.80 UJ | 2.10 UJ | 1.70 UJ |

**Notes:**

NA - Not analyzed
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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | SWMU4-MW05 | SWMU4-MW06 | | SWMU4-MW07 | SWMU4-MW08 | W4-SB01 | W4-SB02 | W4-SB03 | | W4-SB04 | W4-SB05 | W4-SB06 |
| **Sample ID** | NDB001 | NDB003 | NDB004FD1 | NDB006 | NDB008 | NDA057 | NDA059 | NDA061 | NDA062FD1 | NDA065 | NDA067 | NDA069 |
| **Sample Date** | 06/06/00 | 06/06/00 | 06/06/00 | 06/06/00 | 06/06/00 | 04/18/00 | 04/18/00 | 04/18/00 | 04/18/00 | 04/18/00 | 04/18/00 | 04/18/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.60 U | 3.5 U | 3.5 U | 3.5 U | 3.30 U | 4.10 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 4.20 UJ | 3.60 UJ | 3.40 UJ |
| 4,4'-DDE | 3.60 U | 3.5 U | 3.5 U | 3.5 U | 3.30 U | 4.10 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 4.20 UJ | 3.60 UJ | 3.40 UJ |
| 4,4'-DDT | 3.60 U | 3.5 U | 3.5 U | 3.5 U | 3.30 U | 4.10 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 4.20 UJ | 3.60 UJ | 3.40 UJ |
| Aldrin | 1.80 U | 1.80 U | 1.80 U | 1.80 U | 1.70 U | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |
| Aroclor-1254 | 36 U | 35 U | 35 U | 35 U | 33 U | 41 UJ | 35 UJ | 34 UJ | 35 UJ | 41 UJ | 36 UJ | 33 UJ |
| Aroclor-1260 | 36 U | 35 U | 35 U | 35 U | 33 U | 41 UJ | 35 UJ | 34 UJ | 35 UJ | 41 UJ | 36 UJ | 33 UJ |
| Dieldrin | 3.60 U | 3.5 U | 3.5 U | 3.5 U | 3.30 U | 4.10 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 4.20 UJ | 3.60 UJ | 3.40 UJ |
| Endosulfan I | 1.80 U | 1.80 U | 1.80 U | 1.80 U | 1.70 U | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |
| Endosulfan II | 3.60 U | 3.5 U | 3.5 U | 3.5 U | 3.30 U | 4.10 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 4.20 UJ | 3.60 UJ | 3.40 UJ |
| Endosulfan sulfate | 3.60 U | 3.5 U | 3.5 U | 3.5 U | 3.30 U | 4.10 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 4.20 UJ | 3.60 UJ | 3.40 UJ |
| Endrin | 3.60 U | 3.5 U | 3.5 U | 3.5 U | 3.30 U | 4.10 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 4.20 UJ | 3.60 UJ | 3.40 UJ |
| Endrin aldehyde | 3.60 U | 3.5 U | 3.5 U | 3.5 U | 3.30 U | 4.10 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 4.20 UJ | 3.60 UJ | 3.40 UJ |
| Heptachlor | 1.80 U | 1.80 U | 1.80 U | 1.80 U | 1.70 U | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |
| Heptachlor epoxide | 1.80 U | 1.80 U | 1.80 U | 1.80 U | 1.70 U | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |
| Methoxychlor | 18 U | 18 U | 18 U | 18 U | 17 U | 21 UJ | 18 UJ | 18 UJ | 18 UJ | 21 UJ | 18 UJ | 17 UJ |
| alpha-Chlordane | 1.80 U | 1.80 U | 1.80 U | 1.80 U | 1.70 U | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |
| beta-BHC | 1.80 U | 1.80 U | 1.80 U | 1.80 U | 1.70 U | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |
| delta-BHC | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.70 UJ | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |
| gamma-BHC (Lindane) | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.70 UJ | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |
| gamma-Chlordane | 1.80 U | 1.80 U | 1.80 U | 1.80 U | 1.70 U | 2.10 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 2.10 UJ | 1.80 UJ | 1.70 UJ |

**Notes:**

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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | W4-SB07 | | W4-SB08 | W4-SB09 | W4-SB10 | W4-SB11 | W4-SB12 | WW04-SO17 | WW04-SO18 | WW04-SO19 | |
| **Sample ID** | NDA071 | NDA072FD1 | NDA074 | NDA076 | NDA078 | NDA080 | NDA082 | WW04-SS17-01-07A | WW04-SS18-01-07A | WW04-SS19-01-07A | WW04-SS19P-01-07A |
| **Sample Date** | 04/19/00 | 04/19/00 | 04/19/00 | 04/19/00 | 04/19/00 | 04/19/00 | 04/19/00 | 02/02/07 | 02/07/07 | 02/05/07 | 02/05/07 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 4 UJ | 3.5 UJ | 0.350 UJ | 0.350 UJ | 0.350 UJ | 0.340 UJ | 0.340 UJ | 0.87 J | 3.5 U | 3.5 U | 3.6 U |
| 4,4'-DDE | 4 UJ | 3.5 UJ | 0.350 UJ | 0.350 UJ | 0.350 UJ | 0.340 UJ | 0.340 UJ | 3.4 U | 0.35 U | 0.89 U | 0.94 J |
| 4,4'-DDT | 4 UJ | 3.5 UJ | 0.350 UJ | 0.350 UJ | 0.350 UJ | 0.340 UJ | 0.340 UJ | 3.4 U | 0.55 U | 3.5 U | 3.6 U |
| Aldrin | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 1.8 U | 1.8 U | 0.61 U | 1.3 U |
| Aroclor-1254 | 39 UJ | 35 UJ | 35 UJ | 35 UJ | 35 UJ | 34 UJ | 33 UJ | 34 U | 35 U | 35 U | 36 U |
| Aroclor-1260 | 39 UJ | 35 UJ | 35 UJ | 35 UJ | 35 UJ | 34 UJ | 33 UJ | 34 U | 35 U | 35 U | 36 U |
| Dieldrin | 4 UJ | 3.5 UJ | 0.350 UJ | 0.350 UJ | 0.350 UJ | 0.340 UJ | 0.340 UJ | 0.069 U | 3.5 U | 1.3 U | 1.1 U |
| Endosulfan I | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 1.8 U | 1.8 U | 1.3 U | 3.5 J |
| Endosulfan II | 4 UJ | 3.5 UJ | 0.350 UJ | 0.350 UJ | 0.350 UJ | 0.340 UJ | 0.340 UJ | 0.25 U | 3.5 U | 0.33 U | 0.29 U |
| Endosulfan sulfate | 4 UJ | 3.5 UJ | 0.350 UJ | 0.350 UJ | 0.350 UJ | 0.340 UJ | 0.340 UJ | 3.4 U | 3.5 U | 3.5 U | 3.6 U |
| Endrin | 4 UJ | 3.5 UJ | 0.350 UJ | 0.350 UJ | 0.350 UJ | 0.340 UJ | 0.340 UJ | 3.4 U | 3.5 U | 0.25 U | 3.6 U |
| Endrin aldehyde | 4 UJ | 3.5 UJ | 0.350 UJ | 0.350 UJ | 0.350 UJ | 0.340 UJ | 0.340 UJ | 3.4 U | 0.34 J | 3.5 U | 3.6 U |
| Heptachlor | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 0.047 U | 1.8 UJ | 1.5 J | 1.5 J |
| Heptachlor epoxide | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 1.8 U | 1.8 U | 1.3 U | 1.7 J |
| Methoxychlor | 20 UJ | 18 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.70 UJ | 1.70 UJ | 18 U | 0.81 U | 18 U | 0.7 J |
| alpha-Chlordane | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 1.8 U | 1 J | 3.7 | 4.6 J |
| beta-BHC | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 1.8 U | 1.8 U | 0.51 U | 1.4 J |
| delta-BHC | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 1.8 U | 1.8 U | 0.97 U | 1.2 U |
| gamma-BHC (Lindane) | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 1.8 U | 1.8 U | 0.44 U | 0.66 J |
| gamma-Chlordane | 2 UJ | 1.80 UJ | 0.180 UJ | 0.180 UJ | 0.180 UJ | 0.170 UJ | 0.170 UJ | 0.11 U | 0.24 U | 1 U | 2.3 R |

**Notes:**

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R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WW04-SO20 | WW04-SO21 | WW04-SO22 | WW04-SO23 | WW04-SO24 | WW04-SO25 | WW04-SO26 | WW04-SO27 | |
| **Sample ID** | WW04-SS20-01-07A | WW04-SS21-01-07A | WW04-SS22-01-07A | WW04-SS23-02-07A | WW04-SS24-02-07A | WW04-SS25-02-07A | WW04-SS26-01-07A | WW04-SS27-01-07A | WW04-SS27P-01-07A |
| **Sample Date** | 02/08/07 | 02/08/07 | 02/08/07 | 01/30/07 | 01/31/07 | 01/30/07 | 01/30/07 | 01/26/07 | 01/26/07 |
| **Chemical Name** | | | | | | | | | |
| | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | |
| 4,4'-DDD | 3.5 U | 3.5 U | 3.4 U | 0.33 J | 4.6 U | 3.6 U | 3.5 U | 3.7 U | 3.7 U |
| 4,4'-DDE | 0.42 U | 0.45 J | 3.4 U | 3.7 U | 4.6 U | 3.6 U | 0.11 U | 3.7 U | 3.7 U |
| 4,4'-DDT | 3.5 U | 3.5 U | 3.4 U | 3.7 U | 4.6 U | 3.6 U | 3.5 U | 3.7 U | 3.7 U |
| Aldrin | 1.8 U | 0.2 J | 1.8 U | 1.9 U | 2.3 U | 1.9 U | 0.87 J | 1.9 U | 1.9 U |
| Aroclor-1254 | 35 U | 35 U | 34 U | 37 U | 46 U | 36 U | 35 U | 37 U | 37 U |
| Aroclor-1260 | 35 U | 35 U | 34 U | 37 U | 46 U | 36 U | 35 U | 37 U | 37 U |
| Dieldrin | 3.5 U | 3.5 U | 3.4 U | 0.56 J | 4.6 U | 3.6 U | 1.6 J | 3.7 U | 3.7 U |
| Endosulfan I | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 2.3 U | 1.9 U | 0.1 U | 1.9 U | 1.9 U |
| Endosulfan II | 3.5 U | 3.5 U | 3.4 U | 3.7 U | 4.6 U | 3.6 U | 1.1 U | 3.7 U | 3.7 U |
| Endosulfan sulfate | 3.5 U | 0.22 J | 3.4 U | 3.7 U | 4.6 U | 3.6 U | 3.5 U | 3.7 U | 3.7 U |
| Endrin | 3.5 U | 3.5 U | 3.4 U | 3.7 U | 4.6 U | 3.6 U | 0.34 J | 3.7 U | 3.7 U |
| Endrin aldehyde | 0.21 U | 0.46 U | 0.25 J | 3.7 U | 4.6 U | 3.6 U | 3.5 U | 3.7 U | 3.7 U |
| Heptachlor | 1.8 U | 1.8 U | 1.8 U | 0.1 U | 2.3 UJ | 1.9 UJ | 0.61 U | 1.9 UJ | 1.9 UJ |
| Heptachlor epoxide | 0.2 J | 1.8 U | 1.8 U | 1.9 U | 2.3 U | 1.9 U | 0.32 U | 1.9 U | 1.9 U |
| Methoxychlor | 0.65 U | 0.44 U | 0.26 U | 19 U | 23 U | 19 U | 18 U | 19 U | 19 U |
| alpha-Chlordane | 0.39 J | 0.48 U | 1.8 U | 1.9 U | 2.3 U | 1.9 U | 3 | 1.9 U | 1.9 U |
| beta-BHC | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 2.3 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U |
| delta-BHC | 1.8 U | 0.2 U | 1.8 U | 1.9 U | 2.3 U | 1.9 U | 0.54 J | 1.9 U | 1.9 U |
| gamma-BHC (Lindane) | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 2.3 U | 1.9 U | 0.28 U | 1.9 U | 1.9 U |
| gamma-Chlordane | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 2.3 U | 1.9 U | 0.58 U | 1.9 U | 1.9 U |

**Notes:**

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Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WW04-SO28 | WW04-SO29 | WW04-SO30 | WW04-SO31 | WW04-SO32 | WW04-SO33 | WW04-SO34 | WW04-SO35 | WW04-SO36 |
| **Sample ID** | WW04-SS28-01-07A | WW04-SS29-01-07A | WW04-SS30-01-07A | WW04-SS31-01-07A | WW04-SS32-01-07A | WW04-SS33-01-07A | WW04-SS34-01-07A | WW04-SS35-01-07A | WW04-SS36-01-07A |
| **Sample Date** | 01/31/07 | 01/23/07 | 01/25/07 | 01/31/07 | 01/24/07 | 02/01/07 | 01/25/07 | 02/01/07 | 02/13/07 |
| **Chemical Name** | | | | | | | | | |
| | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | |
| 4,4'-DDD | 3.8 U | 3.6 U | 3.4 U | 3.7 U | 3.6 U | 3.8 U | 3.5 U | 0.11 U | 3.6 U |
| 4,4'-DDE | 3.8 U | 3.6 U | 3.4 U | 3.7 U | 0.75 U | 0.091 U | 3.5 U | 0.24 U | 3.6 U |
| 4,4'-DDT | 3.8 U | 3.6 U | 3.4 U | 3.7 U | 3.6 U | 3.8 U | 3.5 U | 3.7 U | 3.6 U |
| Aldrin | 0.1 U | 1.8 U | 1.7 U | 0.089 U | 1.9 U | 2 U | 1.8 U | 0.41 U | 1.8 U |
| Aroclor-1254 | 38 U | 36 U | 34 U | 37 U | 36 U | 38 U | 35 U | 37 U | 36 U |
| Aroclor-1260 | 38 U | 36 U | 34 U | 37 U | 36 U | 38 U | 35 U | 37 U | 36 U |
| Dieldrin | 0.099 U | 3.6 U | 3.4 U | 3.7 U | 3.6 U | 3.8 U | 3.5 U | 0.89 U | 3.6 U |
| Endosulfan I | 0.43 U | 1.8 U | 1.7 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 0.29 U | 1.8 U |
| Endosulfan II | 3.8 U | 3.6 U | 3.4 U | 3.7 U | 3.6 U | 1.2 U | 3.5 U | 0.42 U | 0.18 U |
| Endosulfan sulfate | 3.8 U | 3.6 U | 3.4 U | 3.7 U | 3.6 U | 3.8 U | 3.5 U | 3.7 U | 3.6 R |
| Endrin | 0.18 U | 3.6 U | 3.4 U | 3.7 U | 3.6 U | 3.8 U | 3.5 U | 0.26 U | 3.6 U |
| Endrin aldehyde | 3.8 U | 0.32 J | 0.3 U | 3.7 U | 0.21 U | 3.8 U | 0.21 J | 0.12 U | 0.34 U |
| Heptachlor | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 UJ | 0.069 U | 1.8 UJ | 0.19 U | 1.8 UJ |
| Heptachlor epoxide | 1.9 U | 1.8 U | 1.7 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 0.079 U | 1.8 U |
| Methoxychlor | 0.49 J | 18 U | 17 U | 19 U | 19 U | 20 U | 0.32 U | 0.43 U | 18 U |
| alpha-Chlordane | 1.9 U | 1.8 U | 1.7 U | 1.9 U | 1.9 | 2 U | 1.8 U | 1.8 U | 0.26 U |
| beta-BHC | 1.9 U | 1.8 U | 1.7 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 0.39 U | 1.8 U |
| delta-BHC | 1.9 U | 1.8 U | 1.7 U | 1.9 U | 1.9 U | 2 U | 0.19 U | 0.62 U | 1.8 U |
| gamma-BHC (Lindane) | 1.9 U | 1.8 U | 1.7 U | 0.063 U | 1.9 U | 2 U | 1.8 U | 1.9 U | 1.8 U |
| gamma-Chlordane | 1.9 U | 1.8 U | 1.7 U | 1.9 U | 0.26 U | 2 U | 1.8 U | 0.96 U | 1.8 U |

**Notes:**

NA - Not analyzed
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JN - Analyte present at approximate quantity
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U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WW04-SO37 | | WW04-SO38 | WW04-SO39 | WW04-SO40 | WW04-SO41 | WW04-SO42 | WW04-SO44 | WW04-SO45 |
| **Sample ID** | WW04-SS37-01-07A | WW04-SS37P-01-07A | WW04-SS38-01-07A | WW04-SS39-01-07A | WW04-SS40-01-07A | WW04-SS41-01-07A | WW04-SS42-01-07A | WW04-SS44-01-07A | WW04-SS45-02-07A |
| **Sample Date** | 02/13/07 | 02/13/07 | 02/13/07 | 02/12/07 | 02/09/07 | 02/09/07 | 02/12/07 | 02/02/07 | 02/15/07 |
| **Chemical Name** | | | | | | | | | |
| | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | |
| 4,4'-DDD | 3.5 U | 3.5 U | 0.39 J | 3.6 U | 3.5 U | 3.6 U | 3.5 U | 4 U | 3.4 U |
| 4,4'-DDE | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.5 U | 3.6 U | 3.5 U | 4 U | 3.4 U |
| 4,4'-DDT | 3.5 U | 3.5 U | 0.71 J | 0.6 U | 3.5 U | 3.6 U | 3.5 U | 4 U | 3.4 U |
| Aldrin | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 2.1 U | 0.67 J |
| Aroclor-1254 | 35 U | 35 U | 37 U | 36 U | 35 U | 36 U | 35 U | 40 U | 34 U |
| Aroclor-1260 | 35 U | 35 U | 37 U | 36 U | 35 U | 36 U | 35 U | 40 U | 34 U |
| Dieldrin | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.5 U | 3.6 U | 3.5 U | 0.12 U | 3.4 U |
| Endosulfan I | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 2.1 U | 1.8 U |
| Endosulfan II | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 3.5 U | 3.6 U | 3.5 U | 4 U | 3.4 U |
| Endosulfan sulfate | 3.5 U | 3.5 U | 0.26 J | 0.18 U | 3.5 U | 0.27 U | 3.5 U | 0.3 U | 0.28 U |
| Endrin | 3.5 U | 3.5 U | 3.7 U | 3.6 U | 0.22 J | 3.6 U | 3.5 U | 4 U | 0.31 U |
| Endrin aldehyde | 3.5 U | 0.2 U | 3.7 U | 0.18 U | 0.25 U | 0.26 U | 1.5 J | 4 U | 1.8 U |
| Heptachlor | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 1.8 U | 1.9 U | 1.8 UJ | 0.066 U | 1.8 UJ |
| Heptachlor epoxide | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.1 J | 1.8 U |
| Methoxychlor | 0.35 U | 18 U | 19 U | 1.1 U | 18 U | 19 U | 18 U | 21 U | 0.56 U |
| alpha-Chlordane | 1.8 U | 1.8 U | 0.3 J | 0.59 J | 0.49 J | 1.8 J | 1.1 J | 2.1 U | 2.2 J |
| beta-BHC | 1.8 U | 1.8 U | 1.9 U | 0.39 U | 1.8 U | 1.9 U | 1.8 U | 2.1 U | 1.8 U |
| delta-BHC | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 2.1 U | 1.8 U |
| gamma-BHC (Lindane) | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.8 U | 2.1 U | 1.8 U |
| gamma-Chlordane | 0.2 J | 0.22 U | 0.29 U | 0.42 J | 0.19 U | 0.22 U | 0.2 J | 2.1 U | 0.6 U |

**Notes:**

NA - Not analyzed
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JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WW04-SO46 | WW04-SO47 | WW04-SO48 | WW04-SO49 | WW04-SO50 | WW04-SO51 | WW04-SO54 | WW04-SO55 | WW04-SO55 |
| **Sample ID** | WW04-SS46-01-07A | WW04-SS47-01-07A | WW04-SS48-01-07A | WW04-SS49-01-07A | WW04-SS50-02-07A | WW04-SS51-02-07A | WW04-SS54-01-07A | WW04-SS55-01-07A | WW04-SS55P-01-07A |
| **Sample Date** | 01/26/07 | 01/29/07 | 01/29/07 | 01/23/07 | 02/09/07 | 02/15/07 | 02/14/07 | 02/14/07 | 02/14/07 |
| **Chemical Name** | | | | | | | | | |
| | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | |
| 4,4'-DDD | 3.7 U | 3.7 U | 3.7 U | 3.5 U | 4 U | 3.5 U | 3.9 U | 0.2 U | 0.51 U |
| 4,4'-DDE | 3.7 U | 3.7 U | 3.7 U | 3.5 U | 4 U | 3.5 U | 3.9 U | 0.35 U | 0.31 U |
| 4,4'-DDT | 3.7 U | 3.7 U | 3.7 U | 3.5 U | 4 U | 3.5 U | 3.9 U | 0.19 U | 0.25 U |
| Aldrin | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 0.22 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| Aroclor-1254 | 37 U | 37 U | 37 U | 35 U | 40 U | 35 U | 39 U | 34 U | 35 U |
| Aroclor-1260 | 37 U | 37 U | 37 U | 35 U | 40 U | 35 U | 39 U | 34 U | 35 U |
| Dieldrin | 3.7 U | 3.7 U | 0.062 U | 3.5 U | 4 U | 3.5 U | 3.9 U | 0.74 U | 0.9 U |
| Endosulfan I | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 2 U | 1.8 U | 2 U | 0.18 U | 1.8 U |
| Endosulfan II | 3.7 U | 0.65 J | 3.7 U | 3.5 U | 4 U | 3.5 U | 3.9 U | 1.7 U | 1.8 U |
| Endosulfan sulfate | 3.7 U | 0.66 U | 3.7 U | 3.5 U | 4 U | 3.5 U | 3.9 U | 0.8 J | 0.67 J |
| Endrin | 3.7 U | 3.7 U | 3.7 U | 3.5 U | 4 U | 3.5 U | 3.9 U | 0.39 U | 0.4 U |
| Endrin aldehyde | 3.7 U | 3.7 U | 3.7 U | 0.33 U | 4 U | 3.5 U | 0.8 J | 0.54 U | 0.59 U |
| Heptachlor | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.8 UJ | 2 U | 1.8 UJ | 2 UJ | 1.8 UJ | 1.8 UJ |
| Heptachlor epoxide | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 2 U | 1.8 U | 0.39 J | 0.26 U | 0.24 U |
| Methoxychlor | 19 U | 0.39 U | 19 U | 1.2 J | 0.39 U | 1.1 U | 20 U | 18 U | 0.3 U |
| alpha-Chlordane | 0.27 J | 1.9 U | 1.9 U | 1.1 J | 2 U | 1.8 U | 2 U | 0.82 U | 0.82 U |
| beta-BHC | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 2 U | 1.8 U | 2 U | 0.82 U | 0.67 U |
| delta-BHC | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 2 U | 1.8 U | 2 U | 0.18 U | 0.59 J |
| gamma-BHC (Lindane) | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 2 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| gamma-Chlordane | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 2 U | 1.8 U | 2 U | 0.45 U | 0.51 U |

**Notes:**

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UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-6 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | NDW06SS09 | | NDW06SS10 | NDW06SS11 | NDW06SS12 | NDW06SS13 | NDW06SS14 | NDW06SS15 | NDW06SS16 | NDW06SS17 | NDW06SS18 |
| **Sample ID** | NDW06SS09-R01 | NDW06SS09-R01 | NDW06SS10-R01 | NDW06SS11-R01 | NDW06SS12-R01 | NDW06SS13-R01 | NDW06SS14-R01 | NDW06SS15-R01 | NDW06SS16-R01 | NDW06SS17-R01 | NDW06SS18-R01 |
| **Sample Date** | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 4.3 U | 4.4 U | 4.4 U | 4.3 UJ | 4.8 U | 28 J | 5.8 U | 2.5 J | 5.8 U | 5.6 U | 5.7 U |
| 4,4'-DDE | 0.16 J | 4.4 U | 4.4 U | 4.3 UJ | 2.8 J | 23 J | 5.8 U | 6 U | 5.8 U | 5.6 U | 5.7 U |
| 4,4'-DDT | 4.3 U | 4.4 U | 4.4 U | 4.3 UJ | 4.8 U | 9.2 J | 5.8 U | 6 U | 5.8 U | 5.6 U | 5.7 U |
| Aldrin | 2.2 U | 2.3 U | 2.3 U | 2.2 UJ | 2.4 U | 2.2 U | 3 U | 3.1 U | 3 U | 2.9 U | 2.9 U |
| Aroclor-1254 | 43 U | 44 U | 44 U | 43 U | 48 U | 42 U | 58 U | 60 U | 58 U | 56 U | 57 U |
| Aroclor-1260 | 43 U | 44 U | 44 U | 43 U | 48 U | 42 U | 58 U | 60 U | 58 U | 56 U | 57 U |
| Dieldrin | 4.3 U | 4.4 U | 4.4 U | 4.3 UJ | 4.8 U | 4.2 U | 5.8 U | 6 U | 5.8 U | 5.6 U | 5.7 U |
| Endosulfan I | 2.2 U | 2.3 U | 2.3 U | 2.2 UJ | 2.4 U | 2.2 U | 3 U | 3.1 U | 3 U | 2.9 U | 2.9 U |
| Endosulfan II | 4.3 U | 4.4 U | 4.4 U | 4.3 UJ | 4.8 U | 4.2 U | 5.8 U | 6 U | 5.8 U | 5.6 U | 5.7 U |
| Endosulfan sulfate | 4.3 U | 4.4 U | 4.4 U | 4.3 UJ | 4.8 U | 4.2 U | 5.8 U | 6 U | 5.8 U | 5.6 U | 5.7 U |
| Endrin | 4.3 U | 4.4 U | 4.4 U | 4.3 UJ | 4.8 U | 4.2 U | 5.8 U | 6 U | 5.8 U | 5.6 U | 5.7 U |
| Endrin aldehyde | 4.3 U | 4.4 U | 4.4 U | 4.3 UJ | 4.8 U | 4.2 U | 5.8 U | 6 U | 5.8 U | 5.6 U | 5.7 U |
| Heptachlor | 2.2 U | 2.3 U | 2.3 U | 2.2 UJ | 2.4 U | 2.2 U | 3 U | 3.1 U | 3 U | 2.9 U | 2.9 U |
| Heptachlor epoxide | 2.2 U | 2.3 U | 2.3 U | 2.2 UJ | 2.4 U | 2.2 U | 3 U | 3.1 U | 3 U | 2.9 U | 2.9 U |
| Methoxychlor | 22 U | 23 U | 23 U | 22 UJ | 24 U | 22 U | 30 U | 31 U | 30 U | 29 U | 29 U |
| alpha-Chlordane | 2.2 U | 2.3 U | 2.3 U | 2.2 UJ | 2.4 U | 2.2 U | 3 U | 3.1 U | 3 U | 2.9 U | 2.9 U |
| beta-BHC | 2.2 U | 2.3 U | 2.3 U | 2.2 UJ | 2.4 U | 2.2 U | 3 U | 3.1 U | 3 U | 2.9 U | 2.9 U |
| delta-BHC | 2.2 U | 2.3 UJ | 2.3 UJ | 2.2 UJ | 2.4 UJ | 2.2 UJ | 3 UJ | 3.1 UJ | 3 UJ | 2.9 UJ | 2.9 UJ |
| gamma-BHC (Lindane) | 2.2 U | 2.3 U | 2.3 U | 2.2 UJ | 2.4 U | 2.2 U | 3 U | 3.1 U | 3 U | 2.9 U | 2.9 U |
| gamma-Chlordane | 2.2 U | 2.3 U | 2.3 U | 2.2 UJ | 2.4 U | 2.2 U | 3 U | 3.1 U | 3 U | 2.9 U | 2.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-6 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | NDW06SS19 | NDW06SS20 | NDW06SS21 | NDW06SS22 | NDW06SS23 | W6-SB01 | W6-SB02 | | W6-SB03 | W6-SB04 | W6-SB05 | W6-SB06 |
| **Sample ID** | NDW06SS19-R01 | NDW06SS20-R01 | NDW06SS21-R01 | NDW06SS22-R01 | NDW06SS23-R01 | NDA101 | NDA103 | NDA104FD1 | NDA107 | NDA109 | NDA111 | NDA113 |
| **Sample Date** | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 08/28/03 | 04/24/00 | 04/24/00 | 04/24/00 | 04/24/00 | 04/24/00 | 04/24/00 | 04/20/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 56 U | 48 U | 44 U | 4.3 U | 4.2 J | 11 J | 4.5 UJ | 4.70 UJ | 4.20 UJ | 0.620 J | 2 J | 4.10 UJ |
| 4,4'-DDE | 56 U | 48 U | 44 U | 0.37 J | 18 J | 29 J | 3.80 J | 3 J | 6.70 J | 1.20 J | 7.5 J | 74 J |
| 4,4'-DDT | 56 U | 48 U | 44 U | 4.3 U | 44 U | 7.20 J | 4.5 UJ | 4.70 UJ | 3 J | 4.30 UJ | 4.40 UJ | 17 J |
| Aldrin | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ |
| Aroclor-1254 | 560 U | 480 U | 440 U | 43 U | 43 J | 44 UJ | 45 UJ | 46 UJ | 41 UJ | 43 UJ | 44 UJ | 41 UJ |
| Aroclor-1260 | 560 U | 480 U | 440 U | 43 U | 440 U | 44 UJ | 45 UJ | 46 UJ | 41 UJ | 43 UJ | 44 UJ | 41 UJ |
| Dieldrin | 56 U | 48 U | 44 U | 4.3 U | 44 U | 4.40 UJ | 4.5 UJ | 4.70 UJ | 4.20 UJ | 4.30 UJ | 4.40 UJ | 4.10 UJ |
| Endosulfan I | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ |
| Endosulfan II | 56 U | 48 U | 44 U | 4.3 U | 44 U | 4.40 UJ | 4.5 UJ | 4.70 UJ | 4.20 UJ | 4.30 UJ | 4.40 UJ | 4.10 UJ |
| Endosulfan sulfate | 56 U | 48 U | 44 U | 4.3 U | 44 U | 4.40 UJ | 4.5 UJ | 4.70 UJ | 4.20 UJ | 4.30 UJ | 4.40 UJ | 4.10 UJ |
| Endrin | 56 U | 48 U | 44 U | 4.3 U | 44 U | 4.40 UJ | 4.5 UJ | 4.70 UJ | 4.20 UJ | 4.30 UJ | 4.40 UJ | 4.10 UJ |
| Endrin aldehyde | 11 J | 48 U | 44 U | 4.3 U | 44 U | 4.40 UJ | 4.5 UJ | 4.70 UJ | 4.20 UJ | 4.30 UJ | 4.40 UJ | 4.10 UJ |
| Heptachlor | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ |
| Heptachlor epoxide | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ |
| Methoxychlor | 290 U | 250 U | 220 U | 22 U | 230 U | 23 UJ | 23 UJ | 24 UJ | 21 UJ | 22 UJ | 22 UJ | 21 UJ |
| alpha-Chlordane | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 0.610 J |
| beta-BHC | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ |
| delta-BHC | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ |
| gamma-BHC (Lindane) | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ |
| gamma-Chlordane | 29 U | 25 U | 22 U | 2.2 U | 23 U | 2.30 UJ | 2.30 UJ | 2.40 UJ | 2.10 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-6 | | W-SWMU-7 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | W6-SB07 | W6-SB08 | NDW07SS07 | | NDW07SS08 | NDW07SS09 | NDW07SS10 | NDW07SS11 | NDW07SS12 | NDW07SS13 | NDW07SS14 |
| **Sample ID** | NDA115 | NDA117 | NDW07FD02P-R01 | NDW07SS07-R01 | NDW07SS08-R01 | NDW07SS09-R01 | NDW07SS10-R01 | NDW07SS11-R01 | NDW07SS12-R01 | NDW07SS13-R01 | NDW07SS14-R01 |
| **Sample Date** | 04/20/00 | 04/20/00 | 08/26/03 | 08/26/03 | 08/27/03 | 08/26/03 | 08/27/03 | 08/27/03 | 08/27/03 | 08/27/03 | 08/26/03 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 3.80 UJ | 13 J | 3.8 U | 3.7 U | 3.9 U | 3.9 U | 4 U | 4 U | 4.3 U | 4.2 U | 3.8 U |
| 4,4'-DDE | 1.80 J | 46 J | 3.8 U | 0.31 J | 3.9 U | 0.97 J | 4 U | 4 U | 4.3 U | 4.2 U | 3.8 U |
| 4,4'-DDT | 3.80 UJ | 7 J | 0.64 J | 0.43 J | 3.9 U | 3.9 U | 4 U | 4 U | 4.3 U | 4.2 U | 3.8 U |
| Aldrin | 1.90 UJ | 2.10 UJ | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 U |
| Aroclor-1254 | 38 UJ | 42 UJ | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aroclor-1260 | 38 UJ | 42 UJ | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | 3.80 UJ | 4.20 UJ | 3.8 U | 3.7 U | 3.9 U | 3.9 U | 4 U | 4 U | 4.3 U | 4.2 U | 3.8 U |
| Endosulfan I | 1.90 UJ | 2.10 UJ | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 U |
| Endosulfan II | 3.80 UJ | 4.20 UJ | 3.8 U | 3.7 U | 3.9 U | 3.9 U | 4 U | 4 U | 4.3 U | 4.2 U | 3.8 U |
| Endosulfan sulfate | 3.80 UJ | 4.20 UJ | 3.8 U | 3.7 U | 3.9 U | 3.9 U | 4 U | 4 U | 4.3 U | 4.2 U | 3.8 U |
| Endrin | 3.80 UJ | 4.20 UJ | 3.8 U | 3.7 U | 3.9 U | 3.9 U | 4 U | 4 U | 4.3 U | 4.2 U | 3.8 U |
| Endrin aldehyde | 3.80 UJ | 4.20 UJ | 3.8 U | 3.7 U | 3.9 U | 3.9 U | 4 U | 4 U | 4.3 U | 4.2 U | 3.8 U |
| Heptachlor | 1.90 UJ | 2.10 UJ | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 U |
| Heptachlor epoxide | 1.90 UJ | 2.10 UJ | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 U |
| Methoxychlor | 19 UJ | 21 UJ | 19 U | 19 U | 20 U | 20 U | 20 U | 21 U | 22 U | 22 U | 19 U |
| alpha-Chlordane | 1.90 UJ | 2.10 UJ | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 U |
| beta-BHC | 1.90 UJ | 2.10 UJ | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 U |
| delta-BHC | 1.90 UJ | 2.10 UJ | 1.9 UJ | 1.9 U | 2 U | 2 UJ | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 UJ |
| gamma-BHC (Lindane) | 1.90 UJ | 2.10 UJ | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 U |
| gamma-Chlordane | 1.90 UJ | 2.10 UJ | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 2.1 U | 2.2 U | 2.2 U | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-7 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | NDW07SS15 | NDW07SS16 | NDW07SS17 | | NDW07SS18 | NDW07SS19 | NDW07SS20 | NDW07SS21 | W7-SB01 | W7-SB02 | W7-SB03 |
| **Sample ID** | NDW07SS15-R01 | NDW07SS16-R01 | NDW07SS17-R01 | NDW07SS17-R01FD | NDW07SS18-R01 | NDW07SS19-R01 | NDW07SS20-R01 | NDW07SS21-R01 | NDA119 | NDA120 | NDA121 |
| **Sample Date** | 08/27/03 | 08/25/03 | 08/25/03 | 08/25/03 | 08/27/03 | 08/27/03 | 08/27/03 | 08/27/03 | 04/18/00 | 04/18/00 | 04/18/00 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 3.9 UJ | 3.8 U | 4.2 U | 4.1 U | 3.7 UJ | 4 U | 3.5 U | 3.5 U | 3.70 UJ | 4.40 UJ | 3.60 UJ |
| 4,4'-DDE | 3.9 UJ | 3.8 U | 4.2 U | 4.1 U | 3.7 UJ | 4 U | 3.5 U | 3.5 U | 3.70 UJ | 4.40 UJ | 3.60 UJ |
| 4,4'-DDT | 3.9 UJ | 3.8 UJ | 4.2 UJ | 4.1 U | 3.7 UJ | 4 U | 3.5 U | 3.5 U | 2 J | 0.700 J | 3.60 UJ |
| Aldrin | 2 UJ | 1.9 U | 2.1 U | 2.1 U | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |
| Aroclor-1254 | NA | NA | NA | NA | NA | NA | NA | NA | 37 UJ | 44 UJ | 36 UJ |
| Aroclor-1260 | NA | NA | NA | NA | NA | NA | NA | NA | 37 UJ | 44 UJ | 36 UJ |
| Dieldrin | 3.9 UJ | 3.8 U | 4.2 U | 4.1 U | 3.7 UJ | 4 U | 3.5 U | 3.5 U | 3.70 UJ | 4.40 UJ | 3.60 UJ |
| Endosulfan I | 2 UJ | 1.9 U | 2.1 U | 2.1 U | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |
| Endosulfan II | 3.9 UJ | 3.8 U | 4.2 U | 4.1 U | 3.7 UJ | 4 U | 3.5 U | 3.5 U | 3.70 UJ | 4.40 UJ | 3.60 UJ |
| Endosulfan sulfate | 3.9 UJ | 3.8 U | 4.2 U | 4.1 U | 3.7 UJ | 4 U | 3.5 U | 3.5 U | 3.70 UJ | 4.40 UJ | 3.60 UJ |
| Endrin | 3.9 UJ | 3.8 U | 4.2 U | 4.1 U | 3.7 UJ | 4 U | 3.5 U | 3.5 U | 3.70 UJ | 4.40 UJ | 3.60 UJ |
| Endrin aldehyde | 3.9 UJ | 3.8 U | 4.2 U | 4.1 U | 3.7 UJ | 4 U | 3.5 U | 3.5 U | 3.70 UJ | 4.40 UJ | 3.60 UJ |
| Heptachlor | 2 UJ | 0.51 J | 0.43 J | 2.1 U | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |
| Heptachlor epoxide | 2 UJ | 1.9 U | 2.1 U | 2.1 U | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |
| Methoxychlor | 20 UJ | 19 UJ | 21 UJ | 21 U | 19 UJ | 20 U | 18 U | 18 U | 19 UJ | 22 UJ | 19 UJ |
| alpha-Chlordane | 2 UJ | 1.9 U | 2.1 U | 2.1 U | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |
| beta-BHC | 2 UJ | 1.9 U | 2.1 U | 2.1 U | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |
| delta-BHC | 2 UJ | 1.9 U | 2.1 U | 2.1 UJ | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |
| gamma-BHC (Lindane) | 2 UJ | 1.9 U | 2.1 U | 2.1 U | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |
| gamma-Chlordane | 2 UJ | 1.9 U | 2.1 U | 2.1 U | 1.9 UJ | 2 U | 1.8 U | 1.8 U | 1.90 UJ | 2.20 UJ | 1.90 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 3**
West Vieques Surface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-7 | | |
|---|---|---|---|
| **Station ID** | W7-SB04 | W7-SB05 | W7-SB06 |
| **Sample ID** | NDA122 | NDA123 | NDA124 |
| **Sample Date** | 04/18/00 | 04/18/00 | 04/18/00 |
| **Chemical Name** | | | |
| | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | |
| 4,4'-DDD | 3.70 UJ | 3.70 UJ | 3.70 UJ |
| 4,4'-DDE | 9.90 J | 2.30 J | 0.400 J |
| 4,4'-DDT | 23 J | 16 J | 3.60 J |
| Aldrin | 1.90 UJ | 1.90 UJ | 1.90 UJ |
| Aroclor-1254 | 37 UJ | 37 UJ | 37 UJ |
| Aroclor-1260 | 37 UJ | 37 UJ | 37 UJ |
| Dieldrin | 3.70 UJ | 3.70 UJ | 3.70 UJ |
| Endosulfan I | 1.90 UJ | 1.90 UJ | 1.90 UJ |
| Endosulfan II | 3.70 UJ | 3.70 UJ | 3.70 UJ |
| Endosulfan sulfate | 3.70 UJ | 3.70 UJ | 3.70 UJ |
| Endrin | 3.70 UJ | 3.70 UJ | 3.70 UJ |
| Endrin aldehyde | 3.70 UJ | 3.70 UJ | 3.70 UJ |
| Heptachlor | 1.90 UJ | 1.90 UJ | 1.90 UJ |
| Heptachlor epoxide | 1.90 UJ | 1.90 UJ | 1.90 UJ |
| Methoxychlor | 19 UJ | 19 UJ | 19 UJ |
| alpha-Chlordane | 1.90 UJ | 1.90 UJ | 1.90 UJ |
| beta-BHC | 1.90 UJ | 1.90 UJ | 1.90 UJ |
| delta-BHC | 1.90 UJ | 1.90 UJ | 1.90 UJ |
| gamma-BHC (Lindane) | 1.90 UJ | 1.90 UJ | 1.90 UJ |
| gamma-Chlordane | 1.90 UJ | 1.90 UJ | 1.90 UJ |

**Notes:**
NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
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U - Analyte not detected
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Shading Indicates Detection

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**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-B | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AB-SB05 | AB-SB06 | AB-SB07 | AB-SB08 | AB-SB09 | AB-SB10 | AB-SB11 | AB-SB12 | AB-SB13 | AB-SB14 | AB-SB15 |
| **Sample ID** | **Detected** | **Detected** | NDE240 | NDE242 | NDE244 | NDE246 | NDE248 | NDE251 | NDE253 | NDE255 | NDE257 | NDE259 | NDE262 |
| **Sample Date** | **Concentration** | **Concentration** | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 | 04/13/01 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.5 U | 3.90 U | 4 U | 4.20 U | 3.80 U | 3.90 U | 3.90 U | 3.5 U | 3.80 U | 3.70 U | 4.10 U |
| 4,4'-DDE | 0.1 J | 764 | 3.5 U | 3.90 U | 4 U | 4.20 U | 3.80 U | 3.90 U | 3.90 U | 3.5 U | 3.80 U | 3.70 U | 4.10 U |
| 4,4'-DDT | 0.25 J | 928 | 3.5 U | 3.90 U | 4 U | 4.20 U | 3.80 U | 3.90 U | 3.90 U | 3.5 U | 3.80 U | 3.70 U | 4.10 U |
| Aldrin | 0.550 J | 1.1 J | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 0.550 J | 2.10 U |
| Aroclor-1254 | 15 J | 230 J | 35 U | 39 U | 40 U | 42 U | 38 U | 39 U | 39 U | 35 U | 38 U | 37 U | 41 U |
| Dieldrin | 0.26 J | 1.3 J | 3.5 U | 3.90 U | 4 U | 4.20 U | 3.80 U | 3.90 U | 3.90 U | 3.5 U | 3.80 U | 3.70 U | 4.10 U |
| Endosulfan I | 0.29 J | 0.67 J | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 1.90 U | 2.10 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.5 U | 3.90 U | 4 U | 4.20 U | 3.80 U | 3.90 U | 3.90 U | 3.5 U | 3.80 U | 3.70 U | 4.10 U |
| Endrin | 0.26 J | 0.26 J | 3.5 U | 3.90 U | 4 U | 4.20 U | 3.80 U | 3.90 U | 3.90 U | 3.5 U | 3.80 U | 3.70 U | 4.10 U |
| Endrin aldehyde | 0.2 J | 13 | 3.5 U | 3.90 U | 4 U | 4.20 U | 3.80 U | 3.90 U | 3.90 U | 3.5 U | 3.80 U | 3.70 U | 4.10 U |
| Endrin ketone | 1.4 J | 1.4 J | 3.5 U | 3.90 U | 4 U | 4.20 U | 3.80 U | 3.90 U | 3.90 U | 3.5 U | 3.80 U | 3.70 U | 4.10 U |
| Heptachlor | 0.2 J | 0.66 J | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 1.90 U | 2.10 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 1.90 U | 2.10 U |
| alpha-BHC | 4.1 J | 5.3 JN | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 1.90 U | 2.10 U |
| alpha-Chlordane | 0.22 J | 3 | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 1.90 U | 2.10 U |
| beta-BHC | 0.76 J | 0.76 J | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 1.90 U | 2.10 U |
| delta-BHC | 0.22 J | 0.22 J | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 1.90 U | 2.10 U |
| gamma-Chlordane | 0.20 J | 8.3 | 1.80 U | 2 U | 2.10 U | 2.20 U | 2 U | 2 U | 2 U | 1.80 U | 2 U | 1.90 U | 2.10 U |

**Notes:**

NA - Not analyzed
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JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-B | | | | | | W-AOC-C | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AB-SB16 | WWTPSB001 | WWTPSB002 | WWTPSB003 | WWTPSB004 | | AC-SB16 | | | AC-SB16 | | |
| **Sample ID** | **Detected** | **Detected** | NDE264 | NDE189 | NDE191 | NDE193 | NDE195FD1 | NDE196 | NDA213 | NDA214FD1 | NDA215 | NDA216 | NDA217 | NDA218 |
| **Sample Date** | **Concentration** | **Concentration** | 04/13/01 | 12/04/00 | 12/04/00 | 12/04/00 | 12/04/00 | 12/04/00 | 04/07/00 | 04/07/00 | 04/07/00 | 04/07/00 | 04/07/00 | 04/07/00 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.60 U | 3.70 UJ | 3.80 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ | 3.8 UJ | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.8 UJ | 3.7 UJ |
| 4,4'-DDE | 0.1 J | 764 | 3.60 U | 3.70 UJ | 3.80 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ | 3.8 UJ | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.8 UJ | 3.7 UJ |
| 4,4'-DDT | 0.25 J | 928 | 3.60 U | 3.70 UJ | 3.80 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ | 3.8 UJ | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.8 UJ | 3.7 UJ |
| Aldrin | 0.550 J | 1.1 J | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| Aroclor-1254 | 15 J | 230 J | 36 U | 37 UJ | 38 UJ | 37 UJ | 36 UJ | 36 UJ | 38 UJ | 37 UJ | 38 UJ | 36 UJ | 38 UJ | 36 UJ |
| Dieldrin | 0.26 J | 1.3 J | 3.60 U | 3.70 UJ | 3.80 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ | 3.8 UJ | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.8 UJ | 3.7 UJ |
| Endosulfan I | 0.29 J | 0.67 J | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.60 U | 3.70 UJ | 3.80 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ | 3.8 UJ | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.8 UJ | 3.7 UJ |
| Endrin | 0.26 J | 0.26 J | 3.60 U | 3.70 UJ | 3.80 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ | 3.8 UJ | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.8 UJ | 3.7 UJ |
| Endrin aldehyde | 0.2 J | 13 | 3.60 U | 3.70 UJ | 3.80 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ | 3.8 UJ | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.8 UJ | 3.7 UJ |
| Endrin ketone | 1.4 J | 1.4 J | 3.60 U | 3.70 UJ | 3.80 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ | 3.8 UJ | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.8 UJ | 3.7 UJ |
| Heptachlor | 0.2 J | 0.66 J | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| alpha-BHC | 4.1 J | 5.3 JN | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| alpha-Chlordane | 0.22 J | 3 | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| beta-BHC | 0.76 J | 0.76 J | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| delta-BHC | 0.22 J | 0.22 J | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| gamma-Chlordane | 0.20 J | 8.3 | 1.90 U | 1.90 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.90 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |

**Notes:**
NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-C | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AC-SB17 | | | AC-SB17 | | AC-SB18 | | | | | | AC-SB19 |
| **Sample ID** | **Detected** | **Detected** | NDA219 | NDA220 | NDA221 | NDA222 | NDA223 | NDA224 | NDA225 | NDA226 | NDA227FD1 | NDA228 | NDA229 | NDA230 |
| **Sample Date** | **Concentration** | **Concentration** | 04/07/00 | 04/07/00 | 04/07/00 | 04/07/00 | 04/07/00 | 04/10/00 | 04/10/00 | 04/10/00 | 04/10/00 | 04/10/00 | 04/10/00 | 04/10/00 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.3 UJ | 3.8 UJ | 3.8 U | 4.1 U | 3.9 U | 3.8 U | 4 U | 4.3 U | 3.6 U |
| 4,4'-DDE | 0.1 J | 764 | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.3 UJ | 3.8 UJ | 3.8 U | 4.1 U | 3.9 U | 3.8 U | 4 U | 4.3 U | 3.6 U |
| 4,4'-DDT | 0.25 J | 928 | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.3 UJ | 3.8 UJ | 3.8 UJ | 4.1 UJ | 3.9 UJ | 3.8 UJ | 4 UJ | 4.3 UJ | 3.6 UJ |
| Aldrin | 0.550 J | 1.1 J | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 U | 2.1 U | 2 U | 1.9 U | 2 U | 2.2 U | 1.8 U |
| Aroclor-1254 | 15 J | 230 J | 37 UJ | 38 UJ | 35 UJ | 33 UJ | 38 UJ | 38 U | 41 U | 39 U | 38 U | 40 U | 43 U | 36 U |
| Dieldrin | 0.26 J | 1.3 J | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.3 UJ | 3.8 UJ | 3.8 U | 4.1 U | 3.9 U | 3.8 U | 4 U | 4.3 U | 3.6 U |
| Endosulfan I | 0.29 J | 0.67 J | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 U | 2.1 U | 2 U | 1.9 U | 2 U | 2.2 U | 1.8 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.3 UJ | 3.8 UJ | 3.8 U | 4.1 U | 3.9 U | 3.8 U | 4 U | 4.3 U | 3.6 U |
| Endrin | 0.26 J | 0.26 J | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.3 UJ | 3.8 UJ | 3.8 U | 4.1 U | 3.9 U | 3.8 U | 4 U | 4.3 U | 3.6 U |
| Endrin aldehyde | 0.2 J | 13 | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.3 UJ | 3.8 UJ | 3.8 U | 4.1 U | 3.9 U | 3.8 U | 4 U | 4.3 U | 3.6 U |
| Endrin ketone | 1.4 J | 1.4 J | 3.7 UJ | 3.8 UJ | 3.6 UJ | 3.3 UJ | 3.8 UJ | 3.8 U | 4.1 U | 3.9 U | 3.8 U | 4 U | 4.3 U | 3.6 U |
| Heptachlor | 0.2 J | 0.66 J | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 U | 2.1 U | 2 U | 1.9 U | 2 U | 2.2 U | 1.8 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 U | 2.1 U | 2 U | 1.9 U | 2 U | 2.2 U | 1.8 U |
| alpha-BHC | 4.1 J | 5.3 JN | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.2 UJ | 1.8 UJ |
| alpha-Chlordane | 0.22 J | 3 | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 U | 2.1 U | 2 U | 1.9 U | 2 U | 2.2 U | 1.8 U |
| beta-BHC | 0.76 J | 0.76 J | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 U | 2.1 U | 2 U | 1.9 U | 2 U | 2.2 U | 1.8 U |
| delta-BHC | 0.22 J | 0.22 J | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.2 UJ | 1.8 UJ |
| gamma-Chlordane | 0.20 J | 8.3 | 1.9 UJ | 1.9 UJ | 1.8 UJ | 1.7 UJ | 1.9 UJ | 1.9 U | 2.1 U | 2 U | 1.9 U | 2 U | 2.2 U | 1.8 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-C | | | |
|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AC-SB19 | | | |
| **Sample ID** | **Detected** | **Detected** | NDA231 | NDA232 | NDA233 | NDA234 |
| **Sample Date** | **Concentration** | **Concentration** | 04/10/00 | 04/10/00 | 04/10/00 | 04/10/00 |
| **Chemical Name** | | | | | | |
| | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.6 U | 3.7 U | 3.5 U | 3.8 U |
| 4,4'-DDE | 0.1 J | 764 | 3.6 U | 3.7 U | 3.5 U | 3.8 U |
| 4,4'-DDT | 0.25 J | 928 | 3.6 UJ | 3.7 UJ | 3.5 UJ | 3.8 UJ |
| Aldrin | 0.550 J | 1.1 J | 1.8 U | 1.9 U | 1.8 U | 1.9 U |
| Aroclor-1254 | 15 J | 230 J | 35 U | 36 U | 35 U | 38 U |
| Dieldrin | 0.26 J | 1.3 J | 3.6 U | 3.7 U | 3.5 U | 3.8 U |
| Endosulfan I | 0.29 J | 0.67 J | 1.8 U | 1.9 U | 1.8 U | 1.9 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.6 U | 3.7 U | 3.5 U | 3.8 U |
| Endrin | 0.26 J | 0.26 J | 3.6 U | 3.7 U | 3.5 U | 3.8 U |
| Endrin aldehyde | 0.2 J | 13 | 3.6 U | 3.7 U | 3.5 U | 3.8 U |
| Endrin ketone | 1.4 J | 1.4 J | 3.6 U | 3.7 U | 3.5 U | 3.8 U |
| Heptachlor | 0.2 J | 0.66 J | 1.8 U | 1.9 U | 1.8 U | 1.9 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.8 U | 1.9 U | 1.8 U | 1.9 U |
| alpha-BHC | 4.1 J | 5.3 JN | 1.8 UJ | 1.9 UJ | 1.8 UJ | 1.9 UJ |
| alpha-Chlordane | 0.22 J | 3 | 1.8 U | 1.9 U | 1.8 U | 1.9 U |
| beta-BHC | 0.76 J | 0.76 J | 1.8 U | 1.9 U | 1.8 U | 1.9 U |
| delta-BHC | 0.22 J | 0.22 J | 1.8 UJ | 1.9 UJ | 1.8 UJ | 1.9 UJ |
| gamma-Chlordane | 0.20 J | 8.3 | 1.8 U | 1.9 U | 1.8 U | 1.9 U |

**Notes:**
NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-E | | | | | | | | | | W-AOC-F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | NDAEMW01 | WAE-SO13 | | | | WAE-SO14 | | | WAE-SO15 | WAE-SO16 | AF-SB01 |
| **Sample ID** | **Detected** | **Detected** | NDAEGW01-FP1 | WAE-SB13-0406R | WAE-SB13P-0406R | WAE-SB13-3234 | WAE-SB13-3436 | WAE-SB14-0406 | WAE-SB14-4244 | WAE-SB14-4446 | WAE-SB15-0406R | WAE-SB16-0406 | NDA235 |
| **Sample Date** | **Concentration** | **Concentration** | 09/01/04 | 12/12/05 | 12/12/05 | 12/14/05 | 12/14/05 | 12/01/05 | 12/12/05 | 12/12/05 | 12/05/05 | 12/05/05 | 04/11/00 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 21,000 U | 3.6 U | 3.6 U | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 3.6 U | 3.8 U | 3.8 U | 4.4 UJ |
| 4,4'-DDE | 0.1 J | 764 | 21,000 U | 3.6 U | 1.5 J | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 7.8 | 3.8 U | 3.8 U | 4.4 UJ |
| 4,4'-DDT | 0.25 J | 928 | 21,000 U | 3.6 U | 3.6 U | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 9.2 | 3.8 U | 3.8 U | 4.4 UJ |
| Aldrin | 0.550 J | 1.1 J | 11,000 U | 1.9 U | 1.9 U | 2 U | 1.1 J | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 2 U | 2.2 UJ |
| Aroclor-1254 | 15 J | 230 J | 210,000 U | 36 U | 36 U | 38 U | 36 U | 15 J | 38 U | 36 U | 38 U | 38 U | 43 UJ |
| Dieldrin | 0.26 J | 1.3 J | 21,000 U | 3.6 U | 3.6 U | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 3.6 U | 3.8 U | 3.8 U | 4.4 UJ |
| Endosulfan I | 0.29 J | 0.67 J | 11,000 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 2 U | 2.2 UJ |
| Endosulfan sulfate | 0.26 J | 0.29 J | 21,000 U | 3.6 U | 3.6 U | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 3.6 U | 3.8 U | 3.8 U | 4.4 UJ |
| Endrin | 0.26 J | 0.26 J | 21,000 U | 3.6 U | 3.6 U | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 3.6 U | 3.8 U | 3.8 U | 4.4 UJ |
| Endrin aldehyde | 0.2 J | 13 | 21,000 U | 3.6 U | 3.6 U | 2.1 J | 3.6 U | 3.7 U | 3.8 U | 3.6 U | 3.8 U | 3.8 U | 4.4 UJ |
| Endrin ketone | 1.4 J | 1.4 J | 21,000 U | 3.6 U | 3.6 U | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 4 R | 3.8 U | 3.8 U | 4.4 UJ |
| Heptachlor | 0.2 J | 0.66 J | 11,000 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 2 U | 2.2 UJ |
| Heptachlor epoxide | 0.31 J | 0.31 J | 11,000 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 2 U | 2.2 UJ |
| alpha-BHC | 4.1 J | 5.3 JN | 11,000 U | 1.9 U | 1.9 U | 5.3 JN | 4.1 J | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 2 U | 2.2 UJ |
| alpha-Chlordane | 0.22 J | 3 | 11,000 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 2 U | 2.2 UJ |
| beta-BHC | 0.76 J | 0.76 J | 11,000 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 2 U | 2.2 UJ |
| delta-BHC | 0.22 J | 0.22 J | 11,000 U | 1.9 U | 1.9 U | 2 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 2 U | 2.2 UJ |
| gamma-Chlordane | 0.20 J | 8.3 | 11,000 U | 1.9 U | 5 | 2 U | 1.8 U | 1.9 U | 1.9 U | 8.3 | 1.9 U | 2 U | 2.2 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise

Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AF-SB01 | | | | | AF-SB02 | | | | | AF-SB03 | |
| **Sample ID** | **Detected** | **Detected** | NDA236 | NDA237FD1 | NDA238 | NDA239 | NDA240 | NDA241 | NDA242 | NDA243 | NDA244 | NDA245 | NDA246 | NDA247FD1 |
| **Sample Date** | **Concentration** | **Concentration** | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/11/00 | 04/12/00 | 04/12/00 | 04/12/00 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 4 UJ | 3.7 UJ | 4.2 UJ | 3.9 UJ | 3.7 UJ | 3.8 UJ | 4.1 UJ | 3.8 UJ |
| 4,4'-DDE | 0.1 J | 764 | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 4 UJ | 3.7 UJ | 4.2 UJ | 3.9 UJ | 3.7 UJ | 3.8 UJ | 0.47 J | 3.8 UJ |
| 4,4'-DDT | 0.25 J | 928 | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 4 UJ | 3.7 UJ | 4.2 UJ | 3.9 UJ | 3.7 UJ | 3.8 UJ | 4.1 UJ | 3.8 UJ |
| Aldrin | 0.550 J | 1.1 J | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |
| Aroclor-1254 | 15 J | 230 J | 37 UJ | 37 UJ | 37 UJ | 37 UJ | 40 UJ | 37 UJ | 41 UJ | 39 UJ | 36 UJ | 38 UJ | 40 UJ | 38 UJ |
| Dieldrin | 0.26 J | 1.3 J | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 4 UJ | 3.7 UJ | 4.2 UJ | 3.9 UJ | 3.7 UJ | 3.8 UJ | 4.1 UJ | 3.8 UJ |
| Endosulfan I | 0.29 J | 0.67 J | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 4 UJ | 3.7 UJ | 4.2 UJ | 3.9 UJ | 3.7 UJ | 3.8 UJ | 4.1 UJ | 3.8 UJ |
| Endrin | 0.26 J | 0.26 J | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 4 UJ | 3.7 UJ | 4.2 UJ | 3.9 UJ | 3.7 UJ | 3.8 UJ | 4.1 UJ | 3.8 UJ |
| Endrin aldehyde | 0.2 J | 13 | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 4 UJ | 3.7 UJ | 4.2 UJ | 3.9 UJ | 3.7 UJ | 3.8 UJ | 4.1 UJ | 3.8 UJ |
| Endrin ketone | 1.4 J | 1.4 J | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ | 4 UJ | 3.7 UJ | 4.2 UJ | 3.9 UJ | 3.7 UJ | 3.8 UJ | 4.1 UJ | 3.8 UJ |
| Heptachlor | 0.2 J | 0.66 J | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |
| alpha-BHC | 4.1 J | 5.3 JN | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |
| alpha-Chlordane | 0.22 J | 3 | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |
| beta-BHC | 0.76 J | 0.76 J | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |
| delta-BHC | 0.22 J | 0.22 J | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |
| gamma-Chlordane | 0.20 J | 8.3 | 1.9 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise

Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-F | | | | | | W-AOC-H | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AF-SB03 | | AF-SB04 | | | | AOCHSB001 | AOCHSB002 | AOCHSB003 | AOCHSB004 | AOCHSB005 | AOCHSB006 | AOCHSB007 |
| **Sample ID** | **Detected** | **Detected** | NDA248 | NDA249 | NDA252 | NDA253 | NDA254 | NDA255 | NDE006 | NDE008 | NDE010 | NDE012 | NDE014 | NDE016 | NDE018 |
| **Sample Date** | **Concentration** | **Concentration** | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 | 04/12/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/05/00 | 12/06/00 | 12/06/00 |
| **Chemical Name** | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 4 UJ | 3.7 UJ | 3.9 UJ | 4.2 UJ | 4.2 UJ | 4.1 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 U | 3.5 U |
| 4,4'-DDE | 0.1 J | 764 | 4 UJ | 3.7 UJ | 3.9 UJ | 4.2 UJ | 4.2 UJ | 4.1 UJ | 764 J | 124 J | 3.9 J | 1.6 J | 8.7 J | 2 J | 4.5 |
| 4,4'-DDT | 0.25 J | 928 | 4 UJ | 3.7 UJ | 3.9 UJ | 4.2 UJ | 4.2 UJ | 4.1 UJ | 928 J | 22 J | 3.5 UJ | 3.5 UJ | 7.6 J | 1.5 J | 2.5 J |
| Aldrin | 0.550 J | 1.1 J | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |
| Aroclor-1254 | 15 J | 230 J | 40 UJ | 37 UJ | 39 UJ | 33 UJ | 41 UJ | 41 UJ | 39 UJ | 35 UJ | 35 UJ | 35 UJ | 35 UJ | 35 U | 35 U |
| Dieldrin | 0.26 J | 1.3 J | 4 UJ | 3.7 UJ | 3.9 UJ | 4.2 UJ | 4.2 UJ | 4.1 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 U | 3.5 U |
| Endosulfan I | 0.29 J | 0.67 J | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 4 UJ | 3.7 UJ | 3.9 UJ | 4.2 UJ | 4.2 UJ | 4.1 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 U | 3.5 U |
| Endrin | 0.26 J | 0.26 J | 4 UJ | 3.7 UJ | 3.9 UJ | 4.2 UJ | 4.2 UJ | 4.1 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 U | 3.5 U |
| Endrin aldehyde | 0.2 J | 13 | 4 UJ | 3.7 UJ | 3.9 UJ | 4.2 UJ | 4.2 UJ | 4.1 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 U | 3.5 U |
| Endrin ketone | 1.4 J | 1.4 J | 4 UJ | 3.7 UJ | 3.9 UJ | 4.2 UJ | 4.2 UJ | 4.1 UJ | 3.9 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.5 U | 3.5 U |
| Heptachlor | 0.2 J | 0.66 J | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |
| alpha-BHC | 4.1 J | 5.3 JN | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |
| alpha-Chlordane | 0.22 J | 3 | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |
| beta-BHC | 0.76 J | 0.76 J | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |
| delta-BHC | 0.22 J | 0.22 J | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |
| gamma-Chlordane | 0.20 J | 8.3 | 2.1 UJ | 1.9 UJ | 2 UJ | 2.1 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 UJ | 1.8 U | 1.8 U |

**Notes:**

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J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise

Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-H | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AOCHSB008 | AOCHSB009 | | | AOCHSB010 | AOCHSB011 | AOCHSB012 | AOCHSB013 | AOCHSB014 | AOCHSB015 | | AOCHSB016 | |
| **Sample ID** | **Detected** | **Detected** | NDE020 | NDE022 | NDE203 | NDE204 | NDE025 | NDE027 | NDE029 | NDE031 | NDE033 | NDE035 | NDE036FD1 | NDE038 | NDE039FD1 |
| **Sample Date** | **Concentration** | **Concentration** | 12/06/00 | 12/06/00 | 12/06/00 | 12/06/00 | 12/06/00 | 12/06/00 | 12/06/00 | 12/06/00 | 12/07/00 | 12/07/00 | 12/07/00 | 12/07/00 | 12/07/00 |
| **Chemical Name** | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.7 U | 3.6 U | 3.9 U | 3.9 U | 3.8 U | 4.9 | 13 | 2.5 J | 3.7 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ |
| 4,4'-DDE | 0.1 J | 764 | 3.7 U | 3.6 U | 3.9 U | 3.9 U | 1.5 J | 419 | 24 | 1.7 J | 3.7 UJ | 3.8 UJ | 3.7 UJ | 3.8 J | 3.7 UJ |
| 4,4'-DDT | 0.25 J | 928 | 3.7 U | 3.6 UJ | 3.9 UJ | 3.9 UJ | 0.9 J | 3.7 U | 3.8 U | 3.6 U | 3.7 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ |
| Aldrin | 0.550 J | 1.1 J | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |
| Aroclor-1254 | 15 J | 230 J | 37 U | 36 U | 39 U | 39 U | 38 U | 37 U | 38 U | 36 U | 37 UJ | 38 UJ | 37 UJ | 37 UJ | 37 UJ |
| Dieldrin | 0.26 J | 1.3 J | 3.7 U | 3.6 U | 3.9 U | 3.9 U | 3.8 U | 3.7 U | 3.8 U | 3.6 U | 3.7 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ |
| Endosulfan I | 0.29 J | 0.67 J | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.7 U | 3.6 U | 3.9 U | 3.9 U | 3.8 U | 3.7 U | 3.8 U | 3.6 U | 3.7 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ |
| Endrin | 0.26 J | 0.26 J | 3.7 U | 3.6 U | 3.9 U | 3.9 U | 3.8 U | 3.7 U | 3.8 U | 3.6 U | 3.7 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ |
| Endrin aldehyde | 0.2 J | 13 | 3.7 U | 3.6 U | 3.9 U | 3.9 U | 3.8 U | 3.7 U | 3.8 U | 3.6 U | 3.7 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ |
| Endrin ketone | 1.4 J | 1.4 J | 3.7 U | 3.6 U | 3.9 U | 3.9 U | 3.8 U | 3.7 U | 3.8 U | 3.6 U | 3.7 UJ | 3.8 UJ | 3.7 UJ | 3.7 UJ | 3.7 UJ |
| Heptachlor | 0.2 J | 0.66 J | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |
| alpha-BHC | 4.1 J | 5.3 JN | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |
| alpha-Chlordane | 0.22 J | 3 | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |
| beta-BHC | 0.76 J | 0.76 J | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |
| delta-BHC | 0.22 J | 0.22 J | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |
| gamma-Chlordane | 0.20 J | 8.3 | 1.9 U | 1.9 U | 2 U | 2 U | 2 U | 1.9 U | 2 U | 1.8 U | 1.9 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.9 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise

Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-H | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | NDAHSB17 | NDAHSB18 | NDAHSB19 | NDAHSB20 | | NDAHSB21 | NDAHSB22 | NDAHSB23 | NDAHSB24 | NDAHSB25 | NDAHSB26 |
| **Sample ID** | **Detected** | **Detected** | NDAHSB17-R01 | NDAHSB18-R01 | NDAHSB19-R01 | NDAHFD05P-R01 | NDAHSB20-R01 | NDAHSB21-R01 | NDAHSB22-R01 | NDAHSB23-R01 | NDAHSB24-R01 | NDAHSB25-R01 | NDAHSB26-R01 |
| **Sample Date** | **Concentration** | **Concentration** | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 | 08/26/03 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.5 UJ | 3.9 UJ | 3.4 UJ | 3.4 U | 3.5 UJ | 3.4 UJ | 3.4 UJ | 3.4 UJ | 3.4 UJ | 3.6 U | 3.6 U |
| 4,4'-DDE | 0.1 J | 764 | 3.5 U | 0.2 J | 3.4 U | 0.1 J | 0.14 J | 3.4 U | 3.4 U | 3.4 U | 3.4 U | 3.6 U | 3.6 U |
| 4,4'-DDT | 0.25 J | 928 | 3.5 U | 3.9 U | 3.4 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.4 U | 3.6 U | 3.6 U |
| Aldrin | 0.550 J | 1.1 J | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |
| Aroclor-1254 | 15 J | 230 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | 0.26 J | 1.3 J | 3.5 U | 3.9 U | 3.4 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.4 U | 3.6 U | 3.6 U |
| Endosulfan I | 0.29 J | 0.67 J | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.5 U | 3.9 U | 3.4 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.4 U | 3.6 U | 3.6 U |
| Endrin | 0.26 J | 0.26 J | 3.5 U | 3.9 U | 3.4 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.4 U | 3.6 U | 3.6 U |
| Endrin aldehyde | 0.2 J | 13 | 3.5 U | 3.9 U | 3.4 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.4 U | 3.6 U | 3.6 U |
| Endrin ketone | 1.4 J | 1.4 J | 3.5 U | 3.9 U | 3.4 U | 3.4 U | 3.5 U | 3.4 U | 3.4 U | 3.4 U | 3.4 U | 3.6 U | 3.6 U |
| Heptachlor | 0.2 J | 0.66 J | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |
| alpha-BHC | 4.1 J | 5.3 JN | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |
| alpha-Chlordane | 0.22 J | 3 | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |
| beta-BHC | 0.76 J | 0.76 J | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |
| delta-BHC | 0.22 J | 0.22 J | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |
| gamma-Chlordane | 0.20 J | 8.3 | 1.8 U | 2 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise

Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-H | | | W-AOC-I | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | NDAHSB27 | NDAHSB28 | NDAHSB29 | AOCISB001 | AOCISB002 | AOCISB003 | AOCISB004 | AOCISB005 | AOCISB006 | AOCISB007 | AOCISB008 | AOCISB009 | AOCISB010 |
| **Sample ID** | **Detected** | **Detected** | NDAHSB27-R01 | NDAHSB28-R01 | NDAHSB29-R01 | NDE044 | NDE046 | NDE048 | NDE050 | NDE052 | NDE054 | NDE056 | NDE058 | NDE060 | NDE063 |
| **Sample Date** | **Concentration** | **Concentration** | 08/26/03 | 08/26/03 | 08/26/03 | 11/29/00 | 11/29/00 | 11/29/00 | 11/29/00 | 11/29/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 |
| **Chemical Name** | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 10 J | 0.19 J | 3.5 R | 4 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.9 U | 3.5 U | 3.5 U |
| 4,4'-DDE | 0.1 J | 764 | 2.7 J | 0.61 J | 3.2 J | 4 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.9 U | 3.5 U | 3.5 U |
| 4,4'-DDT | 0.25 J | 928 | 37 U | 0.48 J | 0.82 J | 4 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.9 U | 3.5 U | 3.5 U |
| Aldrin | 0.550 J | 1.1 J | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| Aroclor-1254 | 15 J | 230 J | NA | NA | NA | 40 U | 37 U | 35 U | 36 U | 36 U | 35 U | 35 U | 39 U | 35 U | 35 U |
| Dieldrin | 0.26 J | 1.3 J | 37 U | 4 U | 3.5 R | 4 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.9 U | 3.5 U | 3.5 U |
| Endosulfan I | 0.29 J | 0.67 J | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 37 U | 4 U | 3.5 R | 4 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.9 U | 3.5 U | 3.5 U |
| Endrin | 0.26 J | 0.26 J | 37 U | 4 U | 3.5 R | 4 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.9 U | 3.5 U | 3.5 U |
| Endrin aldehyde | 0.2 J | 13 | 37 U | 4 U | 3.5 R | 4 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.9 U | 3.5 U | 3.5 U |
| Endrin ketone | 1.4 J | 1.4 J | 37 U | 4 U | 3.5 R | 4 U | 3.7 U | 3.5 U | 3.6 U | 3.6 U | 3.5 U | 3.5 U | 3.9 U | 3.5 U | 3.5 U |
| Heptachlor | 0.2 J | 0.66 J | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| alpha-BHC | 4.1 J | 5.3 JN | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| alpha-Chlordane | 0.22 J | 3 | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| beta-BHC | 0.76 J | 0.76 J | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| delta-BHC | 0.22 J | 0.22 J | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |
| gamma-Chlordane | 0.20 J | 8.3 | 19 U | 2 U | 1.8 R | 2.1 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.8 U | 2 U | 1.8 U | 1.8 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise

Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-I | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AOCISB011 | AOCISB012 | AOCISB013 | AOCISB014 | AOCISB015 | AOCISB016 | AOCISB017 | AOCISB018 | AOCISB019 | AOCISB020 | AOCISB021 | AOCISB022 |
| **Sample ID** | **Detected** | **Detected** | NDE065 | NDE067 | NDE069 | NDE071 | NDE073 | NDE076 | NDE078 | NDE080 | NDE082 | NDE085 | NDE087 | NDE089 |
| **Sample Date** | **Concentration** | **Concentration** | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 11/30/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 4.2 UJ | 3.5 UJ | 3.6 UJ | 3.5 UJ | 4 UJ |
| 4,4'-DDE | 0.1 J | 764 | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 4.2 UJ | 3.5 UJ | 3.6 UJ | 3.5 UJ | 4 UJ |
| 4,4'-DDT | 0.25 J | 928 | 3.5 U | 3.5 UJ | 3.5 UJ | 3.5 UJ | 3.6 UJ | 3.5 U | 3.5 U | 4.2 UJ | 3.5 UJ | 3.6 UJ | 3.5 UJ | 4 UJ |
| Aldrin | 0.550 J | 1.1 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |
| Aroclor-1254 | 15 J | 230 J | 35 U | 35 U | 35 U | 35 U | 36 U | 35 U | 35 U | 42 UJ | 35 UJ | 36 UJ | 35 UJ | 40 UJ |
| Dieldrin | 0.26 J | 1.3 J | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 4.2 UJ | 3.5 UJ | 3.6 UJ | 3.5 UJ | 4 UJ |
| Endosulfan I | 0.29 J | 0.67 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 4.2 UJ | 3.5 UJ | 3.6 UJ | 3.5 UJ | 4 UJ |
| Endrin | 0.26 J | 0.26 J | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 4.2 UJ | 3.5 UJ | 3.6 UJ | 3.5 UJ | 4 UJ |
| Endrin aldehyde | 0.2 J | 13 | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 4.2 UJ | 3.5 UJ | 3.6 UJ | 3.5 UJ | 4 UJ |
| Endrin ketone | 1.4 J | 1.4 J | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 4.2 UJ | 3.5 UJ | 3.6 UJ | 3.5 UJ | 4 UJ |
| Heptachlor | 0.2 J | 0.66 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |
| alpha-BHC | 4.1 J | 5.3 JN | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |
| alpha-Chlordane | 0.22 J | 3 | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |
| beta-BHC | 0.76 J | 0.76 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |
| delta-BHC | 0.22 J | 0.22 J | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |
| gamma-Chlordane | 0.20 J | 8.3 | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.2 UJ | 1.8 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise

Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-I | | | | W-AOC-J | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | AOCISB023 | AOCISB024 | AOCISB025 | AOCISB026 | AOCJSB001 | AOCJSB002 | AOCJSB003 | AOCJSB004 | AOCJSB005 | | NDAJSB06 | | NDAJSB07 |
| **Sample ID** | **Detected** | **Detected** | NDE092 | NDE094 | NDE096 | NDE098 | NDE103 | NDE105 | NDE107 | NDE109 | NDE111FD1 | NDE112 | NDAJFD04P-R01 | NDAJSB06-R01 | NDAJSB07-R01 |
| **Sample Date** | **Concentration** | **Concentration** | 12/01/00 | 12/01/00 | 12/01/00 | 12/01/00 | 12/12/00 | 12/12/00 | 12/12/00 | 12/12/00 | 12/12/00 | 12/12/00 | 08/25/03 | 08/25/03 | 08/25/03 |
| **Chemical Name** | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.6 U | 3.6 U | 3.3 U | 3.5 U | 4.3 U | 3.8 U | 3.7 U | 3.8 U | 3.3 U | 3.3 U | 4 U | 4.1 U | 3.7 U |
| 4,4'-DDE | 0.1 J | 764 | 3.6 U | 3.6 U | 3.3 U | 3.5 U | 4.3 U | 3.8 U | 3.7 U | 3.8 U | 3.3 U | 3.3 U | 4 U | 4.1 U | 3.7 U |
| 4,4'-DDT | 0.25 J | 928 | 3.6 U | 3.6 U | 3.3 UJ | 3.5 U | 4.3 U | 3.8 U | 3.7 U | 3.8 U | 3.3 U | 3.3 U | 4 U | 4.1 U | 3.7 U |
| Aldrin | 0.550 J | 1.1 J | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 U | 2 U | 1.9 U | 1.9 U | 1.7 U | 1.7 U | 2 U | 2.1 U | 1.9 U |
| Aroclor-1254 | 15 J | 230 J | 36 U | 36 U | 33 U | 35 U | 43 U | 38 U | 37 U | 38 U | 33 U | 33 U | 40 U | 41 U | 37 U |
| Dieldrin | 0.26 J | 1.3 J | 3.6 U | 3.6 U | 3.3 U | 3.5 U | 4.3 U | 3.8 U | 3.7 U | 3.8 U | 3.3 U | 3.3 U | 4 U | 4.1 U | 3.7 U |
| Endosulfan I | 0.29 J | 0.67 J | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 U | 2 U | 1.9 U | 1.9 U | 1.7 U | 1.7 U | 2 U | 2.1 U | 1.9 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.6 U | 3.6 U | 3.3 U | 3.5 U | 4.3 U | 3.8 U | 3.7 U | 3.8 U | 3.3 U | 3.3 U | 4 U | 4.1 U | 3.7 U |
| Endrin | 0.26 J | 0.26 J | 3.6 U | 3.6 U | 3.3 U | 3.5 U | 4.3 U | 3.8 U | 3.7 U | 3.8 U | 3.3 U | 3.3 U | 4 U | 4.1 U | 3.7 U |
| Endrin aldehyde | 0.2 J | 13 | 3.6 U | 3.6 U | 3.3 U | 3.5 U | 4.3 U | 3.8 U | 3.7 U | 3.8 U | 3.3 U | 3.3 U | 4 U | 4.1 U | 3.7 U |
| Endrin ketone | 1.4 J | 1.4 J | 3.6 U | 3.6 U | 3.3 U | 3.5 U | 4.3 U | 3.8 U | 3.7 U | 3.8 U | 3.3 U | 3.3 U | 4 U | 4.1 U | 3.7 U |
| Heptachlor | 0.2 J | 0.66 J | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 U | 2 U | 1.9 U | 1.9 U | 1.7 U | 1.7 U | 2 U | 2.1 U | 1.9 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 U | 2 U | 1.9 U | 1.9 U | 1.7 U | 1.7 U | 2 U | 2.1 U | 1.9 U |
| alpha-BHC | 4.1 J | 5.3 JN | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 1.7 UJ | 1.7 UJ | 2 U | 2.1 U | 1.9 U |
| alpha-Chlordane | 0.22 J | 3 | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 U | 2 U | 1.9 U | 1.9 U | 1.7 U | 1.7 U | 2 U | 2.1 U | 1.9 U |
| beta-BHC | 0.76 J | 0.76 J | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 U | 2 U | 1.9 U | 1.9 U | 1.7 U | 1.7 U | 2 U | 2.1 U | 1.9 U |
| delta-BHC | 0.22 J | 0.22 J | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 U | 2 U | 1.9 U | 1.9 U | 1.7 U | 1.7 U | 2 U | 2.1 U | 1.9 U |
| gamma-Chlordane | 0.20 J | 8.3 | 1.9 U | 1.8 U | 1.7 U | 1.8 U | 2.2 U | 2 U | 1.9 U | 1.9 U | 1.7 U | 1.7 U | 2 U | 2.1 U | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise

Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-J | | | W-AOC-L | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | NDAJSB08 | NDAJSB09 | NDAJSB10 | AOCLSB001 | AOCLSB002 | AOCLSB003 | AOCLSB004 |
| **Sample ID** | **Detected** | **Detected** | NDAJSB08-R01 | NDAJSB09-R01 | NDAJSB10-R01 | NDE122 | NDE124 | NDE126 | NDE129 |
| **Sample Date** | **Concentration** | **Concentration** | 08/25/03 | 08/25/03 | 08/25/03 | 11/29/00 | 11/29/00 | 11/29/00 | 11/29/00 |
| **Chemical Name** | | | | | | | | | |
| | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 4.4 U | 4.7 U | 3.8 U | 4.2 U | 3.6 U | 3.6 U | 3.9 U |
| 4,4'-DDE | 0.1 J | 764 | 4.4 U | 4.7 U | 3.8 U | 4.2 U | 3.6 U | 3.6 U | 3.9 U |
| 4,4'-DDT | 0.25 J | 928 | 4.4 U | 4.7 U | 3.8 U | 4.2 U | 3.6 U | 3.6 U | 3.9 U |
| Aldrin | 0.550 J | 1.1 J | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |
| Aroclor-1254 | 15 J | 230 J | 44 U | 47 U | 38 U | 42 U | 36 U | 36 U | 39 U |
| Dieldrin | 0.26 J | 1.3 J | 4.4 U | 4.7 U | 3.8 U | 4.2 U | 3.6 U | 3.6 U | 3.9 U |
| Endosulfan I | 0.29 J | 0.67 J | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 4.4 U | 4.7 U | 3.8 U | 4.2 U | 3.6 U | 3.6 U | 3.9 U |
| Endrin | 0.26 J | 0.26 J | 4.4 U | 4.7 U | 3.8 U | 4.2 U | 3.6 U | 3.6 U | 3.9 U |
| Endrin aldehyde | 0.2 J | 13 | 4.4 U | 4.7 U | 3.8 U | 4.2 U | 3.6 U | 3.6 U | 3.9 U |
| Endrin ketone | 1.4 J | 1.4 J | 4.4 U | 4.7 U | 3.8 U | 4.2 U | 3.6 U | 3.6 U | 3.9 U |
| Heptachlor | 0.2 J | 0.66 J | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |
| alpha-BHC | 4.1 J | 5.3 JN | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |
| alpha-Chlordane | 0.22 J | 3 | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |
| beta-BHC | 0.76 J | 0.76 J | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |
| delta-BHC | 0.22 J | 0.22 J | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |
| gamma-Chlordane | 0.20 J | 8.3 | 2.2 U | 2.4 U | 1.9 U | 2.2 U | 1.8 U | 1.9 U | 2 U |

**Notes:**

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Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | | | W-AOC-R | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Lowest** | **Highest** | WAR-SO49 | WAR-SO50 | | WAR-SO51 | WAR-SO52 | WAR-SO53 | WAR-SO54 | WAR-SO55 | WAR-SO56 | WAR-SO57 | WAR-SO58 | WAR-SO59 |
| **Sample ID** | **Detected** | **Detected** | WAR-SB49-0406 | WAR-SB50-0406 | WAR-SB50P-0406 | WAR-SB51-0406 | WAR-SB52-0406 | WAR-SB53-0406 | WAR-SB54-0406 | WAR-SB55-0406 | WAR-SB56-0406 | WAR-SB57-0406 | WAR-SB58-0406 | WAR-SB59-0406 |
| **Sample Date** | **Concentration** | **Concentration** | 12/15/05 | 12/15/05 | 12/15/05 | 12/15/05 | 12/15/05 | 12/15/05 | 12/16/05 | 12/16/05 | 12/16/05 | 12/16/05 | 12/16/05 | 12/16/05 |
| **Chemical Name** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.19 J | 24 | 3.8 U | 3.8 U | 3.4 U | 3.7 U | 3.8 U | 4 U | 4 U | 3.8 U | 3.8 U | 4.1 U | 3.7 U | 3.7 U |
| 4,4'-DDE | 0.1 J | 764 | 1.1 J | 3.8 U | 1.3 J | 3.2 J | 1.7 J | 1.7 J | 4 U | 3.8 U | 3.8 U | 0.98 J | 3.7 U | 3.7 U |
| 4,4'-DDT | 0.25 J | 928 | 3.8 U | 3.8 U | 3.4 U | 2.6 J | 3.8 U | 4 U | 4 U | 3.8 U | 3.8 U | 4.1 U | 3.7 U | 3.7 U |
| Aldrin | 0.550 J | 1.1 J | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |
| Aroclor-1254 | 15 J | 230 J | 38 U | 38 U | 34 U | 37 U | 38 U | 40 U | 40 U | 38 U | 38 U | 41 U | 37 U | 37 U |
| Dieldrin | 0.26 J | 1.3 J | 3.8 U | 3.8 U | 3.4 U | 3.7 U | 3.8 U | 4 U | 4 U | 3.8 U | 3.8 U | 4.1 U | 3.7 U | 3.7 U |
| Endosulfan I | 0.29 J | 0.67 J | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |
| Endosulfan sulfate | 0.26 J | 0.29 J | 3.8 U | 3.8 U | 3.4 U | 3.7 U | 3.8 U | 4 U | 4 U | 3.8 U | 3.8 U | 4.1 U | 3.7 U | 3.7 U |
| Endrin | 0.26 J | 0.26 J | 3.8 U | 3.8 U | 3.4 U | 3.7 U | 3.8 U | 4 U | 4 U | 3.8 U | 3.8 U | 4.1 U | 3.7 U | 3.7 U |
| Endrin aldehyde | 0.2 J | 13 | 3.8 U | 3.8 U | 3.4 U | 3.7 U | 3.8 U | 4 U | 4 U | 3.8 U | 3.8 U | 4.1 U | 3.7 U | 3.7 U |
| Endrin ketone | 1.4 J | 1.4 J | 3.8 U | 3.8 U | 3.4 U | 3.7 U | 3.8 U | 4 U | 4 U | 3.8 U | 3.8 U | 4.1 U | 3.7 U | 3.7 U |
| Heptachlor | 0.2 J | 0.66 J | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |
| Heptachlor epoxide | 0.31 J | 0.31 J | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |
| alpha-BHC | 4.1 J | 5.3 JN | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |
| alpha-Chlordane | 0.22 J | 3 | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |
| beta-BHC | 0.76 J | 0.76 J | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |
| delta-BHC | 0.22 J | 0.22 J | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |
| gamma-Chlordane | 0.20 J | 8.3 | 2 U | 2 U | 1.8 U | 1.9 U | 2 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 2.1 U | 1.9 U | 1.9 U |

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JN - Analyte present at approximate quantity
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Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-AOC-R | | | | | W-SWMU-4 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WAR-SO60 | | WAR-SO61 | WAR-SO62 | WAR-SO63 | SWMU4-MW05 | SWMU4-MW06 | SWMU4-MW07 | SWMU4-MW08 | W4-SB01 | W4-SB02 | W4-SB03 | |
| **Sample ID** | WAR-SB60-0406 | WAR-SB60P-0406 | WAR-SB61-0406 | WAR-SB62-0406 | WAR-SB63-0406 | NDB002 | NDB005 | NDB007 | NDB009 | NDA058 | NDA060 | NDA063 | NDA064FD1 |
| **Sample Date** | 12/15/05 | 12/15/05 | 12/15/05 | 12/15/05 | 12/15/05 | 06/06/00 | 06/06/00 | 06/06/00 | 06/06/00 | 04/18/00 | 04/18/00 | 04/18/00 | 04/18/00 |
| **Chemical Name** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | |
| 4,4'-DDD | 3.8 U | 4 U | 4 U | 4.1 U | 4.1 U | 3.80 U | 3.5 U | 3.40 U | 4 U | 3.70 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ |
| 4,4'-DDE | 3.8 U | 4 U | 4.5 | 0.94 J | 1.9 J | 3.80 U | 3.5 U | 3.40 U | 4 U | 3.70 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ |
| 4,4'-DDT | 3.8 U | 4 U | 7.9 | 1.8 J | 3.2 J | 3.80 U | 3.5 U | 3.40 U | 4 U | 3.70 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ |
| Aldrin | 2 U | 2 U | 2.1 U | 2.1 U | 2.1 U | 1.90 U | 1.80 U | 1.80 U | 2 U | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |
| Aroclor-1254 | 38 U | 40 U | 40 U | 41 U | 41 U | 38 U | 35 U | 34 U | 40 U | 37 UJ | 36 UJ | 35 UJ | 35 UJ |
| Dieldrin | 3.8 U | 4 U | 4 U | 4.1 U | 4.1 U | 3.80 U | 3.5 U | 3.40 U | 4 U | 3.70 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ |
| Endosulfan I | 2 U | 2 U | 2.1 U | 2.1 U | 2.1 U | 1.90 U | 1.80 U | 1.80 U | 2 U | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |
| Endosulfan sulfate | 3.8 U | 4 U | 4 U | 4.1 U | 4.1 U | 3.80 U | 3.5 U | 3.40 U | 4 U | 3.70 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ |
| Endrin | 3.8 U | 4 U | 4 U | 4.1 U | 4.1 U | 3.80 U | 3.5 U | 3.40 U | 4 U | 3.70 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ |
| Endrin aldehyde | 3.8 U | 4 U | 4 U | 4.1 U | 4.1 U | 3.80 U | 3.5 U | 3.40 U | 4 U | 3.70 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ |
| Endrin ketone | 3.8 U | 4 U | 1.4 J | 4.1 U | 4.1 U | 3.80 U | 3.5 U | 3.40 U | 4 U | 3.70 UJ | 3.70 UJ | 3.60 UJ | 3.60 UJ |
| Heptachlor | 2 U | 2 U | 2.1 U | 2.1 U | 2.1 U | 1.90 U | 1.80 U | 1.80 U | 2 U | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |
| Heptachlor epoxide | 2 U | 2 U | 2.1 U | 2.1 U | 2.1 U | 1.90 U | 1.80 U | 1.80 U | 2 U | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |
| alpha-BHC | 2 U | 2 U | 2.1 U | 2.1 U | 2.1 U | 1.90 UJ | 1.80 UJ | 1.80 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |
| alpha-Chlordane | 2 U | 2 U | 0.92 J | 2.1 U | 2.1 U | 1.90 U | 1.80 U | 1.80 U | 2 U | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |
| beta-BHC | 2 U | 2 U | 2.1 U | 2.1 U | 2.1 U | 1.90 U | 1.80 U | 1.80 U | 2 U | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |
| delta-BHC | 2 U | 2 U | 2.1 U | 2.1 U | 2.1 U | 1.90 UJ | 1.80 UJ | 1.80 UJ | 2 UJ | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |
| gamma-Chlordane | 2 U | 2 U | 2.1 U | 2.1 U | 2.1 U | 1.90 U | 1.80 U | 1.80 U | 2 U | 1.90 UJ | 1.90 UJ | 1.80 UJ | 1.80 UJ |

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JN - Analyte present at approximate quantity
R - Unreliable result
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Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | W4-SB04 | W4-SB05 | W4-SB06 | W4-SB07 | W4-SB08 | W4-SB09 | W4-SB10 | W4-SB11 | W4-SB12 | WW04-SO17 | WW04-SO18 | WW04-SO19 |
| **Sample ID** | NDA066 | NDA068 | NDA070 | NDA073 | NDA075 | NDA077 | NDA079 | NDA081 | NDA083 | WW04-SB17-12-07A | WW04-SB18-13-07A | WW04-SB19-13-07A |
| **Sample Date** | 04/18/00 | 04/18/00 | 04/19/00 | 04/19/00 | 04/19/00 | 04/19/00 | 04/19/00 | 04/19/00 | 04/19/00 | 02/06/07 | 02/09/07 | 02/06/07 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.5 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 0.350 UJ | 0.400 UJ | 0.380 UJ | 0.350 UJ | 0.340 UJ | 3.5 U | 3.4 U | 0.068 U |
| 4,4'-DDE | 3.5 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 0.350 UJ | 0.400 UJ | 0.380 UJ | 0.350 UJ | 0.340 UJ | 3.5 U | 3.4 U | 0.34 J |
| 4,4'-DDT | 3.5 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 0.350 UJ | 0.400 UJ | 0.380 UJ | 0.350 UJ | 0.340 UJ | 3.5 U | 3.4 U | 3.5 U |
| Aldrin | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 1.8 U | 1.8 U | 0.8 U |
| Aroclor-1254 | 35 UJ | 36 UJ | 35 UJ | 35 UJ | 34 UJ | 39 UJ | 38 UJ | 34 UJ | 34 UJ | 35 U | 34 U | 35 U |
| Dieldrin | 3.5 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 0.350 UJ | 0.400 UJ | 0.380 UJ | 0.350 UJ | 0.340 UJ | 3.5 U | 3.4 U | 1.3 J |
| Endosulfan I | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 0.062 U | 1.8 U | 1 U |
| Endosulfan sulfate | 3.5 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 0.350 UJ | 0.400 UJ | 0.380 UJ | 0.350 UJ | 0.340 UJ | 0.29 J | 3.4 U | 3.5 U |
| Endrin | 3.5 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 0.350 UJ | 0.400 UJ | 0.380 UJ | 0.350 UJ | 0.340 UJ | 3.5 U | 0.18 U | 3.5 U |
| Endrin aldehyde | 3.5 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 0.350 UJ | 0.400 UJ | 0.380 UJ | 0.350 UJ | 0.340 UJ | 0.2 U | 3.4 U | 3.5 U |
| Endrin ketone | 3.5 UJ | 3.60 UJ | 3.5 UJ | 3.5 UJ | 0.350 UJ | 0.400 UJ | 0.380 UJ | 0.350 UJ | 0.340 UJ | 3.5 U | 3.4 U | 0.32 U |
| Heptachlor | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 0.096 U | 1.8 U | 0.53 U |
| Heptachlor epoxide | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 1.8 U | 1.8 U | 0.59 U |
| alpha-BHC | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 1.8 U | 1.8 U | 1.8 U |
| alpha-Chlordane | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 1.8 U | 1.6 J | 3 |
| beta-BHC | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 1.8 U | 1.8 U | 0.76 J |
| delta-BHC | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 0.096 U | 0.22 J | 0.43 U |
| gamma-Chlordane | 1.80 UJ | 1.80 UJ | 1.80 UJ | 1.80 UJ | 0.180 UJ | 0.200 UJ | 0.190 UJ | 0.180 UJ | 0.170 UJ | 0.088 U | 0.25 U | 5 |

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Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WW04-SO20 | WW04-SO21 | | WW04-SO25 | WW04-SO26 | | WW04-SO27 | WW04-SO28 | WW04-SO29 | WW04-SO30 |
| **Sample ID** | WW04-SB20-12-07A | WW04-SB21-13-07A | WW04-SB21P-13-07A | WW04-SB25-46-07A | WW04-SB26-46-07A | WW04-SB26P-46-07A | WW04-SB27-46-07A | WW04-SB28-46-07A | WW04-SB29-46-07A | WW04-SB30-46-07A |
| **Sample Date** | 02/08/07 | 02/08/07 | 02/08/07 | 01/30/07 | 01/30/07 | 01/30/07 | 01/26/07 | 01/31/07 | 01/23/07 | 01/25/07 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | |
| 4,4'-DDD | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 3.8 U | 3.6 U | 3.6 U | 3.7 U |
| 4,4'-DDE | 3.4 U | 0.5 U | 0.24 U | 3.6 U | 3.5 U | 3.5 U | 3.8 U | 3.6 U | 3.6 U | 3.7 U |
| 4,4'-DDT | 3.4 U | 3.4 U | 3.5 U | 0.25 J | 3.5 U | 3.5 U | 3.8 U | 3.6 U | 3.6 U | 3.7 U |
| Aldrin | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U |
| Aroclor-1254 | 34 U | 34 U | 35 U | 36 U | 35 U | 35 U | 38 U | 36 U | 36 U | 37 U |
| Dieldrin | 3.4 U | 3.4 U | 3.5 U | 0.26 J | 3.5 U | 3.5 U | 3.8 U | 3.6 U | 3.6 U | 3.7 U |
| Endosulfan I | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 0.38 J | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U |
| Endosulfan sulfate | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 3.8 U | 3.6 U | 3.6 U | 3.7 U |
| Endrin | 3.4 U | 3.4 U | 3.5 U | 0.26 J | 3.5 U | 3.5 U | 3.8 U | 3.6 U | 3.6 U | 3.7 U |
| Endrin aldehyde | 0.2 J | 0.29 U | 0.21 U | 3.6 U | 3.5 U | 3.5 U | 3.8 U | 3.6 U | 3.6 U | 13 |
| Endrin ketone | 3.4 U | 3.4 U | 3.5 U | 3.6 U | 3.5 U | 3.5 U | 3.8 U | 3.6 U | 3.6 U | 3.7 U |
| Heptachlor | 1.8 U | 0.2 J | 1.8 U | 0.22 U | 0.17 U | 0.13 U | 1.9 UJ | 0.16 U | 1.8 UJ | 1.9 UJ |
| Heptachlor epoxide | 1.8 U | 0.31 J | 1.8 U | 1.8 U | 0.082 U | 0.07 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U |
| alpha-BHC | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U |
| alpha-Chlordane | 1.8 U | 1.1 J | 0.27 J | 1.8 U | 0.47 J | 0.49 J | 1.9 U | 1.9 U | 1.8 U | 1.9 U |
| beta-BHC | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U |
| delta-BHC | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U |
| gamma-Chlordane | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1 J | 0.77 J | 1.9 U | 1.9 U | 0.2 J | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WW04-SO31 | | WW04-SO32 | WW04-SO33 | WW04-SO34 | WW04-SO35 | | WW04-SO36 | WW04-SO37 | WW04-SO38 |
| **Sample ID** | WW04-SB31-46-07A | WW04-SB31-68-07A | WW04-SB32-46-07A | WW04-SB33-46-07A | WW04-SB34-46-07A | WW04-SB35-46-07A | WW04-SB35-68-07A | WW04-SB36-46-07A | WW04-SB37-46-07A | WW04-SB38-12-07A |
| **Sample Date** | 01/31/07 | 01/31/07 | 01/24/07 | 02/01/07 | 01/25/07 | 02/01/07 | 02/02/07 | 02/13/07 | 02/13/07 | 02/13/07 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | |
| 4,4'-DDD | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U |
| 4,4'-DDE | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U | 3.6 U | 0.42 J |
| 4,4'-DDT | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 0.11 U | 3.7 U | 3.6 U | 3.5 U |
| Aldrin | 0.11 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 0.069 U | 0.21 U | 1.9 U | 1.9 U | 1.8 U |
| Aroclor-1254 | 37 U | 37 U | 36 U | 37 U | 37 U | 37 U | 37 U | 37 U | 36 U | 35 U |
| Dieldrin | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 0.084 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U |
| Endosulfan I | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 0.67 J | 1.9 U | 1.9 U | 1.8 U |
| Endosulfan sulfate | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U | 3.7 R | 3.6 U | 0.26 J |
| Endrin | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U |
| Endrin aldehyde | 3.7 U | 3.7 U | 3.6 U | 3.7 U | 3.7 U | 3.7 U | 3.7 U | 0.48 U | 3.6 U | 0.31 U |
| Endrin ketone | 3.7 U | 3.7 U | 3.6 U | 0.15 U | 3.7 U | 0.14 U | 3.7 U | 3.7 U | 3.6 U | 3.5 U |
| Heptachlor | 0.079 U | 0.13 U | 1.9 UJ | 0.075 U | 1.9 UJ | 0.09 U | 0.29 U | 1.9 UJ | 1.9 UJ | 1.8 UJ |
| Heptachlor epoxide | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 0.072 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U |
| alpha-BHC | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U |
| alpha-Chlordane | 1.9 U | 1.9 U | 0.22 J | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U |
| beta-BHC | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U |
| delta-BHC | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U |
| gamma-Chlordane | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 0.23 U | 1.9 U | 1.8 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WW04-SO38 | WW04-SO39 | | | WW04-SO40 | WW04-SO41 | WW04-SO42 | WW04-SO46 | WW04-SO47 | WW04-SO48 |
| **Sample ID** | WW04-SB38P-12-07A | WW04-SB39-46-07A | WW04-SB39P-46-07A | WW04-SB39-67-07A | WW04-SB40-46-07A | WW04-SB41-46-07A | WW04-SB42-46-07A | WW04-SB46-46-07A | WW04-SB47-46-07A | WW04-SB48-46-07A |
| **Sample Date** | 02/13/07 | 02/12/07 | 02/12/07 | 02/12/07 | 02/09/07 | 02/09/07 | 02/12/07 | 01/26/07 | 01/29/07 | 01/29/07 |
| **Chemical Name** | | | | | | | | | | |
| | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | |
| 4,4'-DDD | 24 | 3.6 U | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.5 U | 3.5 U | 3.8 U | 3.8 U |
| 4,4'-DDE | 6.9 NJ | 3.6 U | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.5 U | 3.5 U | 3.8 U | 3.8 U |
| 4,4'-DDT | 4.5 R | 3.6 U | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.5 U | 3.5 U | 3.8 U | 3.8 U |
| Aldrin | 0.42 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U |
| Aroclor-1254 | 230 J | 36 U | 37 U | 37 U | 35 U | 37 U | 35 U | 35 U | 38 U | 38 U |
| Dieldrin | 2.4 U | 3.6 U | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.5 U | 3.5 U | 0.24 U | 0.11 U |
| Endosulfan I | 1.3 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U |
| Endosulfan sulfate | 0.19 U | 3.6 U | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.5 U | 3.5 U | 3.8 U | 3.8 U |
| Endrin | 1.1 U | 3.6 U | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.5 U | 3.5 U | 3.8 U | 3.8 U |
| Endrin aldehyde | 2.5 J | 0.21 U | 0.81 U | 0.25 U | 0.48 U | 0.19 U | 3.5 U | 3.5 U | 3.8 U | 3.8 U |
| Endrin ketone | 0.18 U | 3.6 U | 3.7 U | 3.7 U | 3.5 U | 3.7 U | 3.5 U | 3.5 U | 3.8 U | 3.8 U |
| Heptachlor | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ | 1.8 U | 1.9 U | 1.8 UJ | 1.8 UJ | 1.9 UJ | 1.9 UJ |
| Heptachlor epoxide | 3.5 R | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U |
| alpha-BHC | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U |
| alpha-Chlordane | 0.73 U | 1.8 U | 1.9 U | 1.9 U | 0.97 J | 0.33 J | 0.31 J | 1.8 U | 1.9 U | 1.9 U |
| beta-BHC | 1.8 R | 1.8 U | 0.25 U | 0.21 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U |
| delta-BHC | 1.8 U | 1.8 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.8 U | 1.8 U | 1.9 U | 1.9 U |
| gamma-Chlordane | 0.59 U | 0.3 U | 0.23 J | 0.26 J | 0.2 J | 0.23 J | 1.8 U | 1.8 U | 1.9 U | 1.9 U |

**Notes:**

NA - Not analyzed
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JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-4 | | | W-SWMU-6 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | WW04-SO49 | WW04-SO54 | WW04-SO55 | W6-SB01 | W6-SB02 | W6-SB02 | W6-SB03 | W6-SB04 | W6-SB05 | W6-SB06 | W6-SB07 | W6-SB08 |
| **Sample ID** | WW04-SB49-46-07A | WW04-SB54-35-07A | WW04-SB55-24-07A | NDA102 | NDA105 | NDA106FD1 | NDA108 | NDA110 | NDA112 | NDA114 | NDA116 | NDA118 |
| **Sample Date** | 01/23/07 | 02/14/07 | 02/14/07 | 04/24/00 | 04/24/00 | 04/24/00 | 04/24/00 | 04/24/00 | 04/24/00 | 04/20/00 | 04/20/00 | 04/20/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.5 U | 3.6 U | 3.6 U | 13 J | 0.840 J | 0.970 J | 1 J | 4.40 UJ | 0.320 J | 12 J | 4.20 UJ | 4.30 UJ |
| 4,4'-DDE | 3.5 U | 3.6 U | 0.35 U | 30 J | 11 J | 5.30 J | 5.80 J | 0.880 J | 2 J | 316 J | 4.20 UJ | 4.30 UJ |
| 4,4'-DDT | 3.5 U | 3.6 U | 3.6 U | 5.20 UJ | 5.30 UJ | 5.30 UJ | 1.80 J | 4.40 UJ | 4.30 UJ | 19 J | 4.20 UJ | 4.30 UJ |
| Aldrin | 1.8 U | 1.8 U | 1.8 U | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |
| Aroclor-1254 | 35 U | 36 U | 36 U | 51 UJ | 52 UJ | 52 UJ | 44 UJ | 44 UJ | 43 UJ | 43 UJ | 41 UJ | 42 UJ |
| Dieldrin | 3.5 U | 3.6 U | 3.6 U | 5.20 UJ | 5.30 UJ | 5.30 UJ | 4.40 UJ | 4.40 UJ | 4.30 UJ | 4.30 UJ | 4.20 UJ | 4.30 UJ |
| Endosulfan I | 1.8 U | 1.8 U | 0.29 J | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |
| Endosulfan sulfate | 3.5 U | 3.6 U | 3.6 U | 5.20 UJ | 5.30 UJ | 5.30 UJ | 4.40 UJ | 4.40 UJ | 4.30 UJ | 4.30 UJ | 4.20 UJ | 4.30 UJ |
| Endrin | 3.5 U | 3.6 U | 3.6 U | 5.20 UJ | 5.30 UJ | 5.30 UJ | 4.40 UJ | 4.40 UJ | 4.30 UJ | 4.30 UJ | 4.20 UJ | 4.30 UJ |
| Endrin aldehyde | 3.5 U | 3.6 U | 0.43 J | 5.20 UJ | 5.30 UJ | 5.30 UJ | 4.40 UJ | 4.40 UJ | 4.30 UJ | 4.30 UJ | 4.20 UJ | 4.30 UJ |
| Endrin ketone | 3.5 U | 3.6 U | 3.6 U | 5.20 UJ | 5.30 UJ | 5.30 UJ | 4.40 UJ | 4.40 UJ | 4.30 UJ | 4.30 UJ | 4.20 UJ | 4.30 UJ |
| Heptachlor | 1.8 UJ | 1.8 UJ | 1.8 UJ | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |
| Heptachlor epoxide | 1.8 U | 1.8 U | 0.43 U | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |
| alpha-BHC | 1.8 U | 1.8 U | 1.8 U | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |
| alpha-Chlordane | 0.45 J | 1.8 U | 0.91 J | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |
| beta-BHC | 1.8 U | 1.8 U | 1.8 U | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |
| delta-BHC | 1.8 U | 1.8 U | 1.8 U | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |
| gamma-Chlordane | 1.8 U | 1.8 U | 1.8 U | 2.60 UJ | 2.70 UJ | 2.70 UJ | 2.30 UJ | 2.30 UJ | 2.20 UJ | 2.20 UJ | 2.10 UJ | 2.20 UJ |

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JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-7 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | NDW07SB07 | NDW07SB08 | NDW07SB09 | NDW07SB10 | NDW07SB11 | NDW07SB12 | NDW07SB13 | NDW07SB14 | NDW07SB15 | NDW07SB16 | NDW07SB17 |
| **Sample ID** | NDW07SB07-R01 | NDW07SB08-R01 | NDW07SB09-R01 | NDW07SB10-R01 | NDW07SB11-R01 | NDW07SB12-R01 | NDW07SB13-R01 | NDW07SB14-R01 | NDW07SB15-R01 | NDW07SB16-R01 | NDW07SB17-R01 |
| **Sample Date** | 08/26/03 | 08/27/03 | 08/26/03 | 08/27/03 | 08/27/03 | 08/27/03 | 08/27/03 | 08/26/03 | 08/27/03 | 08/25/03 | 08/25/03 |
| **Chemical Name** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | |
| 4,4'-DDD | 3.8 U | 4 U | 3.7 U | 3.7 UJ | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.5 U | 3.8 U | 4.1 UJ |
| 4,4'-DDE | 3.8 U | 4 U | 3.7 U | 3.7 UJ | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.5 U | 3.8 U | 4.1 UJ |
| 4,4'-DDT | 3.8 U | 4 U | 3.7 U | 3.7 UJ | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.5 U | 3.8 UJ | 4.1 UJ |
| Aldrin | 1.9 U | 2 U | 1.9 U | 1.9 UJ | 2 U | 2 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.1 R |
| Aroclor-1254 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dieldrin | 3.8 U | 4 U | 3.7 U | 3.7 UJ | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.5 U | 3.8 U | 4.1 R |
| Endosulfan I | 1.9 U | 2 U | 1.9 U | 1.9 UJ | 2 U | 2 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.1 UJ |
| Endosulfan sulfate | 3.8 U | 4 U | 3.7 U | 3.7 UJ | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.5 U | 3.8 U | 4.1 UJ |
| Endrin | 3.8 U | 4 U | 3.7 U | 3.7 UJ | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.5 U | 3.8 U | 4.1 UJ |
| Endrin aldehyde | 3.8 U | 4 U | 3.7 U | 3.7 UJ | 4 U | 3.8 U | 3.7 U | 3.7 U | 3.5 U | 3.8 U | 4.1 UJ |
| Endrin ketone | 3.8 UJ | 4 U | 3.7 UJ | 3.7 UJ | 4 U | 3.8 U | 3.7 U | 3.7 UJ | 3.5 U | 3.8 U | 4.1 UJ |
| Heptachlor | 1.9 U | 2 U | 0.22 J | 1.9 UJ | 2 U | 2 U | 1.9 U | 0.66 J | 1.8 U | 1.9 U | 0.54 J |
| Heptachlor epoxide | 1.9 U | 2 U | 1.9 U | 1.9 UJ | 2 U | 2 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.1 UJ |
| alpha-BHC | 1.9 U | 2 U | 1.9 U | 1.9 UJ | 2 U | 2 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.1 UJ |
| alpha-Chlordane | 1.9 U | 2 U | 1.9 U | 1.9 UJ | 2 U | 2 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 0.24 J |
| beta-BHC | 1.9 U | 2 U | 1.9 U | 1.9 UJ | 2 U | 2 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.1 UJ |
| delta-BHC | 1.9 U | 2 U | 1.9 U | 1.9 UJ | 2 U | 2 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.1 UJ |
| gamma-Chlordane | 1.9 U | 2 U | 1.9 U | 1.9 UJ | 2 U | 2 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 2.1 UJ |

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J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SMMU-10 | W-SMMU-10 | | | | | | | | | | W-SWMU-14 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | W10-SB01 | W10-SB02 | | W10-SB03 | W10-SB04 | W10-SB05 | W10-SB06 | W10-SB07 | W10-SB08 | W10-SB09 | W10-SB10 | W14-SB01 | W14-SB02 | | W14-SB03 |
| **Sample ID** | NDA126 | NDA129 | NDA130FD1 | NDA132 | NDA134 | NDA136 | NDA138 | NDA140 | NDA142 | NDA144 | NDA146 | NDA148 | NDA151 | NDA152FD1 | NDA154 |
| **Sample Date** | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/04/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/05/00 |
| **Chemical Name** | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | | | | |
| 4,4'-DDD | 3.6 U | 3.7 U | 3.6 U | 4.1 U | 4.1 U | 3.9 U | 3.6 U | 3.7 U | 3.9 U | 0.67 J | 3.6 U | 4.1 U | 3.8 U | 4.7 U | 3.7 U |
| 4,4'-DDE | 21 | 3.7 U | 3.6 U | 4.1 U | 4.1 U | 3.9 U | 1.2 J | 3.7 U | 0.8 J | 15 | 1.3 J | 4.1 U | 3.8 U | 4.7 U | 3.7 U |
| 4,4'-DDT | 11 | 3.7 U | 3.6 U | 4.1 U | 4.1 U | 3.9 U | 1 J | 3.7 U | 3.9 U | 7.6 J | 1 J | 4.1 U | 3.8 U | 4.7 U | 3.7 U |
| Aldrin | 1.9 U | 1.9 U | 1.8 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 1.9 U | 2 U | 1.9 U | 1.8 U | 2.1 U | 1.9 U | 2.4 U | 1.9 U |
| Aroclor-1254 | 36 U | 37 U | 36 U | 41 U | 40 U | 39 U | 36 U | 36 U | 38 U | 36 U | 35 U | 40 U | 37 U | 47 U | 37 U |
| Dieldrin | 3.6 U | 3.7 U | 3.6 U | 4.1 U | 4.1 U | 3.9 U | 3.6 U | 3.7 U | 3.9 U | 3.7 U | 3.6 U | 4.1 U | 3.8 U | 4.7 U | 3.7 U |
| Endosulfan I | 1.9 U | 1.9 U | 1.8 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 1.9 U | 2 U | 1.9 U | 1.8 U | 2.1 U | 1.9 U | 2.4 U | 1.9 U |
| Endosulfan sulfate | 3.6 U | 3.7 U | 3.6 U | 4.1 U | 4.1 U | 3.9 U | 3.6 U | 3.7 U | 3.9 U | 3.7 U | 3.6 U | 4.1 U | 3.8 U | 4.7 U | 3.7 U |
| Endrin | 3.6 U | 3.7 U | 3.6 U | 4.1 U | 4.1 U | 3.9 U | 3.6 U | 3.7 U | 3.9 U | 3.7 U | 3.6 U | 4.1 UJ | 3.8 UJ | 4.7 UJ | 3.7 UJ |
| Endrin aldehyde | 3.6 U | 3.7 U | 3.6 U | 4.1 U | 4.1 U | 3.9 U | 3.6 U | 3.7 U | 3.9 U | 3.7 U | 3.6 U | 4.1 U | 3.8 U | 4.7 U | 3.7 U |
| Endrin ketone | 3.6 U | 3.7 U | 3.6 U | 4.1 U | 4.1 U | 3.9 U | 3.6 U | 3.7 U | 3.9 U | 3.7 U | 3.6 U | 4.1 U | 3.8 U | 4.7 U | 3.7 U |
| Heptachlor | 1.9 U | 1.9 U | 1.8 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 1.9 U | 2 U | 1.9 U | 1.8 U | 2.1 U | 1.9 U | 2.4 U | 1.9 U |
| Heptachlor epoxide | 1.9 U | 1.9 U | 1.8 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 1.9 U | 2 U | 1.9 U | 1.8 U | 2.1 U | 1.9 U | 2.4 U | 1.9 U |
| alpha-BHC | 1.9 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ | 2.1 UJ | 2 UJ | 1.9 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 1.8 UJ | 2.1 UJ | 1.9 UJ | 2.4 UJ | 1.9 UJ |
| alpha-Chlordane | 1.9 U | 1.9 U | 1.8 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 1.9 U | 2 U | 1.9 U | 1.8 U | 2.1 U | 1.9 U | 2.4 U | 1.9 U |
| beta-BHC | 1.9 U | 1.9 U | 1.8 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 1.9 U | 2 U | 1.9 U | 1.8 U | 2.1 U | 1.9 U | 2.4 U | 1.9 U |
| delta-BHC | 1.9 U | 1.9 U | 1.8 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 1.9 U | 2 U | 1.9 U | 1.8 U | 2.1 U | 1.9 U | 2.4 U | 1.9 U |
| gamma-Chlordane | 1.9 U | 1.9 U | 1.8 U | 2.1 U | 2.1 U | 2 U | 1.9 U | 1.9 U | 2 U | 1.9 U | 1.8 U | 2.1 U | 1.9 U | 2.4 U | 1.9 U |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

**Table 4**
West Vieques Subsurface Soil Pesticide Detections
*Vieques, Puerto Rico*

| **Site ID** | W-SWMU-14 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | W14-SB04 | W14-SB05 | W14-SB06 | W14-SB07 | | W14-SB08 | W14-SB09 | W14-SB10 | W14-SB11 | W14-SB12 | W14-SB13 | W14-SB14 |
| **Sample ID** | NDA156 | NDA158 | NDA160 | NDA162 | NDA163FD1 | NDA165 | NDA167 | NDA169 | NDA171 | NDA173 | NDA175 | NDA177 |
| **Sample Date** | 04/05/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/05/00 | 04/06/00 | 04/06/00 | 04/06/00 | 04/06/00 | 04/06/00 | 04/06/00 | 04/06/00 |
| **Chemical Name** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Pesticide/Polychlorinated Biphenyls (UG_KG)** | | | | | | | | | | | | |
| 4,4'-DDD | 3.6 U | 1.2 J | 4 U | 3.8 U | 3.9 U | 3.8 UJ | 4.1 UJ | 4 UJ | 3.6 UJ | 4.2 UJ | 3.7 UJ | 3.9 UJ |
| 4,4'-DDE | 3.6 U | 3.6 U | 4 U | 3.8 U | 3.9 U | 3.8 UJ | 4.1 UJ | 4 UJ | 3.6 UJ | 4.2 UJ | 3.7 UJ | 3.9 UJ |
| 4,4'-DDT | 3.6 U | 38 | 4 U | 3.8 U | 3.9 U | 3.8 UJ | 4.1 UJ | 4 UJ | 3.6 UJ | 4.2 UJ | 3.7 UJ | 3.9 UJ |
| Aldrin | 1.8 U | 1.8 U | 2 U | 1.9 U | 2 U | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |
| Aroclor-1254 | 35 U | 36 U | 40 U | 38 U | 39 U | 37 UJ | 40 UJ | 39 UJ | 36 UJ | 42 UJ | 37 UJ | 38 UJ |
| Dieldrin | 3.6 U | 3.6 U | 4 U | 3.8 U | 3.9 U | 3.8 UJ | 4.1 UJ | 4 UJ | 3.6 UJ | 4.2 UJ | 3.7 UJ | 3.9 UJ |
| Endosulfan I | 1.8 U | 1.8 U | 2 U | 1.9 U | 2 U | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |
| Endosulfan sulfate | 3.6 U | 3.6 U | 4 U | 3.8 U | 3.9 U | 3.8 UJ | 4.1 UJ | 4 UJ | 3.6 UJ | 4.2 UJ | 3.7 UJ | 3.9 UJ |
| Endrin | 3.6 UJ | 3.6 UJ | 4 UJ | 3.8 UJ | 3.9 UJ | 3.8 UJ | 4.1 UJ | 4 UJ | 3.6 UJ | 4.2 UJ | 3.7 UJ | 3.9 UJ |
| Endrin aldehyde | 3.6 U | 3.6 U | 4 U | 3.8 U | 3.9 U | 3.8 UJ | 4.1 UJ | 4 UJ | 3.6 UJ | 4.2 UJ | 3.7 UJ | 3.9 UJ |
| Endrin ketone | 3.6 U | 3.6 U | 4 U | 3.8 U | 3.9 U | 3.8 UJ | 4.1 UJ | 4 UJ | 3.6 UJ | 4.2 UJ | 3.7 UJ | 3.9 UJ |
| Heptachlor | 1.8 U | 1.8 U | 2 U | 1.9 U | 2 U | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |
| Heptachlor epoxide | 1.8 U | 1.8 U | 2 U | 1.9 U | 2 U | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |
| alpha-BHC | 1.8 UJ | 1.8 UJ | 2 UJ | 1.9 UJ | 2 UJ | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |
| alpha-Chlordane | 1.8 U | 1.8 U | 2 U | 1.9 U | 2 U | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |
| beta-BHC | 1.8 U | 1.8 U | 2 U | 1.9 U | 2 U | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |
| delta-BHC | 1.8 U | 1.8 U | 2 U | 1.9 U | 2 U | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |
| gamma-Chlordane | 1.8 U | 1.8 U | 2 U | 1.9 U | 2 U | 1.9 UJ | 2.1 UJ | 2 UJ | 1.8 UJ | 2.2 UJ | 1.9 UJ | 2 UJ |

**Notes:**

NA - Not analyzed
J - Reported value is estimated
JN - Analyte present at approximate quantity
R - Unreliable result
U - Analyte not detected
UJ - Analyte not detected; quantitation limit may be imprecise
Shading Indicates Detection

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**Table 5**
East Vieques Dioxin TEQ Values
*Vieques, Puerto Rico*

| SITE ID | SAMPLE ID | ANALYTE | RESULT (PG/G) | Q | 2,3,7,8-TCDD Eq (ppt) |
|---|---|---|---|---|---|
| E-SWMU-1 | CGW1SS08-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS08-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-1 | CGW1SS08-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 5.4 | | |
| E-SWMU-1 | CGW1SS08-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS08-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS08-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-1 | CGW1SS08-R01 | Total heptachlorodibenzo-p-dioxin | 10 | | |
| E-SWMU-1 | CGW1SS08-R01 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS08-R01 | Octachlorodibenzo-p-dioxin | 51 | | |
| E-SWMU-1 | CGW1SS08-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-1 | CGW1SS08-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.069** |
| E-SWMU-1 | CGW1SS17-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS17-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-1 | CGW1SS17-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 18 | | |
| E-SWMU-1 | CGW1SS17-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS17-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS17-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-1 | CGW1SS17-R01 | Total heptachlorodibenzo-p-dioxin | 33 | | |
| E-SWMU-1 | CGW1SS17-R01 | Total hexachlorodibenzo-p-dioxin | 12 | | |
| E-SWMU-1 | CGW1SS17-R01 | Octachlorodibenzo-p-dioxin | 130 | | |
| E-SWMU-1 | CGW1SS17-R01 | Total pentachlorodibenzo-p-dioxin | 4.2 | | |
| E-SWMU-1 | CGW1SS17-R01 | Total tetrachlorodibenzo-p-dioxin | 4.9 | | **0.22** |
| E-SWMU-1 | CGW1SS33-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 3.8 | | |
| E-SWMU-1 | CGW1SS33-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-1 | CGW1SS33-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 141 | | |
| E-SWMU-1 | CGW1SS33-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS33-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 3.2 | | |
| E-SWMU-1 | CGW1SS33-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-1 | CGW1SS33-R01 | Total heptachlorodibenzo-p-dioxin | 256 | | |
| E-SWMU-1 | CGW1SS33-R01 | Total hexachlorodibenzo-p-dioxin | 32 | | |
| E-SWMU-1 | CGW1SS33-R01 | Octachlorodibenzo-p-dioxin | 1120 | | |
| E-SWMU-1 | CGW1SS33-R01 | Total pentachlorodibenzo-p-dioxin | 1.7 | | |
| E-SWMU-1 | CGW1SS33-R01 | Total tetrachlorodibenzo-p-dioxin | 2.3 | | **2.4** |
| E-SWMU-1 | CGW1SS35-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 13 | | |
| E-SWMU-1 | CGW1SS35-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-1 | CGW1SS35-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 236 | | |
| E-SWMU-1 | CGW1SS35-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 3.0 | | |
| E-SWMU-1 | CGW1SS35-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 7.3 | | |
| E-SWMU-1 | CGW1SS35-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.6 | | |
| E-SWMU-1 | CGW1SS35-R01 | Total heptachlorodibenzo-p-dioxin | 456 | | |
| E-SWMU-1 | CGW1SS35-R01 | Total hexachlorodibenzo-p-dioxin | 65 | | |
| E-SWMU-1 | CGW1SS35-R01 | Octachlorodibenzo-p-dioxin | 2950 | | |
| E-SWMU-1 | CGW1SS35-R01 | Total pentachlorodibenzo-p-dioxin | 8.5 | | |
| E-SWMU-1 | CGW1SS35-R01 | Total tetrachlorodibenzo-p-dioxin | 3.5 | | **7.1** |
| E-SWMU-1 | CGW1SS48-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS48-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-1 | CGW1SS48-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 56 | | |
| E-SWMU-1 | CGW1SS48-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS48-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-1 | CGW1SS48-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-1 | CGW1SS48-R01 | Total heptachlorodibenzo-p-dioxin | 99 | | |
| E-SWMU-1 | CGW1SS48-R01 | Total hexachlorodibenzo-p-dioxin | 11 | | |
| E-SWMU-1 | CGW1SS48-R01 | Octachlorodibenzo-p-dioxin | 512 | | |
| E-SWMU-1 | CGW1SS48-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-1 | CGW1SS48-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.71** |
| E-SWMU-2 | CGW2SS03-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS03-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-2 | CGW2SS03-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 13 | | |
| E-SWMU-2 | CGW2SS03-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS03-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS03-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SS03-R01 | Total heptachlorodibenzo-p-dioxin | 28 | | |
| E-SWMU-2 | CGW2SS03-R01 | Total hexachlorodibenzo-p-dioxin | 3.5 | | |
| E-SWMU-2 | CGW2SS03-R01 | Octachlorodibenzo-p-dioxin | 173 | | |
| E-SWMU-2 | CGW2SS03-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SS03-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.18** |
| E-SWMU-2 | CGW2SS07-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS07-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-2 | CGW2SS07-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 5.4 | | |
| E-SWMU-2 | CGW2SS07-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS07-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS07-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SS07-R01 | Total heptachlorodibenzo-p-dioxin | 14 | | |
| E-SWMU-2 | CGW2SS07-R01 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS07-R01 | Octachlorodibenzo-p-dioxin | 71 | | |
| E-SWMU-2 | CGW2SS07-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SS07-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.075** |

Q = Qualifier
1 PG/G = 1 trillionth of a gram
part per trillion (ppt) = 10E-12

**Table 5**
East Vieques Dioxin TEQ Values
*Vieques, Puerto Rico*

| SITE ID | SAMPLE ID | ANALYTE | RESULT (PG/G) | Q | 2,3,7,8-TCDD Eq (ppt) |
|---|---|---|---|---|---|
| E-SWMU-2 | CGW2SS09-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 4.8 | | |
| E-SWMU-2 | CGW2SS09-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-2 | CGW2SS09-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 114 | | |
| E-SWMU-2 | CGW2SS09-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS09-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.9 | | |
| E-SWMU-2 | CGW2SS09-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SS09-R01 | Total heptachlorodibenzo-p-dioxin | 220 | | |
| E-SWMU-2 | CGW2SS09-R01 | Total hexachlorodibenzo-p-dioxin | 53 | | |
| E-SWMU-2 | CGW2SS09-R01 | Octachlorodibenzo-p-dioxin | 781 | | |
| E-SWMU-2 | CGW2SS09-R01 | Total pentachlorodibenzo-p-dioxin | 9.0 | | |
| E-SWMU-2 | CGW2SS09-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **2.1** |
| E-SWMU-2 | CGW2SS12-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS12-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-2 | CGW2SS12-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 3.7 | | |
| E-SWMU-2 | CGW2SS12-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS12-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS12-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SS12-R01 | Total heptachlorodibenzo-p-dioxin | 10 | | |
| E-SWMU-2 | CGW2SS12-R01 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SS12-R01 | Octachlorodibenzo-p-dioxin | 48 | | |
| E-SWMU-2 | CGW2SS12-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SS12-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.05** |
| E-SWMU-2 | CGW2SB01-R01-10 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | Total heptachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | Octachlorodibenzo-p-dioxin | 5.0 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-2 | CGW2SB01-R01-10 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.00** |
| E-SWMU-5 | CGW5SS01-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 3.2 | | |
| E-SWMU-5 | CGW5SS01-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-5 | CGW5SS01-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 107 | | |
| E-SWMU-5 | CGW5SS01-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-5 | CGW5SS01-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.7 | | |
| E-SWMU-5 | CGW5SS01-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-5 | CGW5SS01-R01 | Total heptachlorodibenzo-p-dioxin | 209 | | |
| E-SWMU-5 | CGW5SS01-R01 | Total hexachlorodibenzo-p-dioxin | 33 | | |
| E-SWMU-5 | CGW5SS01-R01 | Octachlorodibenzo-p-dioxin | 856 | | |
| E-SWMU-5 | CGW5SS01-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-5 | CGW5SS01-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **1.9** |
| E-SWMU-8 | CGW8SS02-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 13.3 | | |
| E-SWMU-8 | CGW8SS02-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-8 | CGW8SS02-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 267 | | |
| E-SWMU-8 | CGW8SS02-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 3.5 | | |
| E-SWMU-8 | CGW8SS02-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 8.3 | | |
| E-SWMU-8 | CGW8SS02-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 2.0 | | |
| E-SWMU-8 | CGW8SS02-R01 | Total heptachlorodibenzo-p-dioxin | 582 | | |
| E-SWMU-8 | CGW8SS02-R01 | Total hexachlorodibenzo-p-dioxin | 113 | | |
| E-SWMU-8 | CGW8SS02-R01 | Octachlorodibenzo-p-dioxin | 2840 | | |
| E-SWMU-8 | CGW8SS02-R01 | Total pentachlorodibenzo-p-dioxin | 13.2 | | |
| E-SWMU-8 | CGW8SS02-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **8.0** |
| E-SWMU-10 | CGW10SS06-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS06-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SS06-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 50 | | |
| E-SWMU-10 | CGW10SS06-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS06-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS06-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS06-R01 | Total heptachlorodibenzo-p-dioxin | 97 | | |
| E-SWMU-10 | CGW10SS06-R01 | Total hexachlorodibenzo-p-dioxin | 15 | | |
| E-SWMU-10 | CGW10SS06-R01 | Octachlorodibenzo-p-dioxin | 464 | | |
| E-SWMU-10 | CGW10SS06-R01 | Total pentachlorodibenzo-p-dioxin | 3.0 | | |
| E-SWMU-10 | CGW10SS06-R01 | Total tetrachlorodibenzo-p-dioxin | 7.0 | | **0.63** |
| E-SWMU-10 | CGW10SS07-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS07-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SS07-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 71 | | |
| E-SWMU-10 | CGW10SS07-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS07-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS07-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS07-R01 | Total heptachlorodibenzo-p-dioxin | 160 | | |
| E-SWMU-10 | CGW10SS07-R01 | Total hexachlorodibenzo-p-dioxin | 24 | | |
| E-SWMU-10 | CGW10SS07-R01 | Octachlorodibenzo-p-dioxin | 838 | | |
| E-SWMU-10 | CGW10SS07-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS07-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.96** |

Q = Qualifier

1 PG/G = 1 trillionth of a gram

part per trillion (ppt) = 10E-12

**Table 5**
East Vieques Dioxin TEQ Values
*Vieques, Puerto Rico*

| SITE ID | SAMPLE ID | ANALYTE | RESULT (PG/G) | Q | 2,3,7,8-TCDD Eq (ppt) |
|---|---|---|---|---|---|
| E-SWMU-10 | CGW10SS10-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 4.0 | | |
| E-SWMU-10 | CGW10SS10-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SS10-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 154 | | |
| E-SWMU-10 | CGW10SS10-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS10-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 3.1 | | |
| E-SWMU-10 | CGW10SS10-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS10-R01 | Total heptachlorodibenzo-p-dioxin | 364 | | |
| E-SWMU-10 | CGW10SS10-R01 | Total hexachlorodibenzo-p-dioxin | 51 | | |
| E-SWMU-10 | CGW10SS10-R01 | Octachlorodibenzo-p-dioxin | 1410 | | |
| E-SWMU-10 | CGW10SS10-R01 | Total pentachlorodibenzo-p-dioxin | 2.0 | | |
| E-SWMU-10 | CGW10SS10-R01 | Total tetrachlorodibenzo-p-dioxin | 81 | | **2.7** |
| E-SWMU-10 | CGW10SS11-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.7 | | |
| E-SWMU-10 | CGW10SS11-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SS11-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 67 | | |
| E-SWMU-10 | CGW10SS11-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS11-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS11-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS11-R01 | Total heptachlorodibenzo-p-dioxin | 147 | | |
| E-SWMU-10 | CGW10SS11-R01 | Total hexachlorodibenzo-p-dioxin | 26 | | |
| E-SWMU-10 | CGW10SS11-R01 | Total pentachlorodibenzo-p-dioxin | 5.0 | | |
| E-SWMU-10 | CGW10SS11-R01 | Total tetrachlorodibenzo-p-dioxin | 25 | | |
| E-SWMU-10 | CGW10SS11-R01 | Octachlorodibenzo-p-dioxin | 687 | | **1.1** |
| E-SWMU-10 | CGW10SS13-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS13-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SS13-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 2.6 | | |
| E-SWMU-10 | CGW10SS13-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS13-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS13-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS13-R01 | Total heptachlorodibenzo-p-dioxin | 5.4 | | |
| E-SWMU-10 | CGW10SS13-R01 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS13-R01 | Octachlorodibenzo-p-dioxin | 23 | | |
| E-SWMU-10 | CGW10SS13-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS13-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.033** |
| E-SWMU-10 | CGW10SS15-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS15-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SS15-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 45 | | |
| E-SWMU-10 | CGW10SS15-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS15-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS15-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS15-R01 | Total heptachlorodibenzo-p-dioxin | 91 | | |
| E-SWMU-10 | CGW10SS15-R01 | Total hexachlorodibenzo-p-dioxin | 18 | | |
| E-SWMU-10 | CGW10SS15-R01 | Octachlorodibenzo-p-dioxin | 435 | | |
| E-SWMU-10 | CGW10SS15-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | | |
| E-SWMU-10 | CGW10SS15-R01 | Total tetrachlorodibenzo-p-dioxin | 4.0 | | **0.58** |
| E-SWMU-10 | CGW10SS19-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS19-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SS19-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 33 | | |
| E-SWMU-10 | CGW10SS19-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS19-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SS19-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SS19-R01 | Total heptachlorodibenzo-p-dioxin | 107 | | |
| E-SWMU-10 | CGW10SS19-R01 | Total hexachlorodibenzo-p-dioxin | 14 | | |
| E-SWMU-10 | CGW10SS19-R01 | Octachlorodibenzo-p-dioxin | 381 | | |
| E-SWMU-10 | CGW10SS19-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | | |
| E-SWMU-10 | CGW10SS19-R01 | Total tetrachlorodibenzo-p-dioxin | 3.0 | | **0.45** |
| E-SWMU-10 | CGW10SB06-R01-5 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB06-R01-5 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SB06-R01-5 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB06-R01-5 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB06-R01-5 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB06-R01-5 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SB06-R01-5 | Total heptachlorodibenzo-p-dioxin | 3.2 | | |
| E-SWMU-10 | CGW10SB06-R01-5 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB06-R01-5 | Octachlorodibenzo-p-dioxin | 12 | | |
| E-SWMU-10 | CGW10SB06-R01-5 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SB06-R01-5 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.0037** |
| E-SWMU-10 | CGW10SB11-R01-5 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB11-R01-5 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SB11-R01-5 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 7.4 | | |
| E-SWMU-10 | CGW10SB11-R01-5 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB11-R01-5 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB11-R01-5 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SB11-R01-5 | Total heptachlorodibenzo-p-dioxin | 17 | | |
| E-SWMU-10 | CGW10SB11-R01-5 | Total hexachlorodibenzo-p-dioxin | 2.8 | | |
| E-SWMU-10 | CGW10SB11-R01-5 | Octachlorodibenzo-p-dioxin | 76 | | |
| E-SWMU-10 | CGW10SB11-R01-5 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SB11-R01-5 | Total tetrachlorodibenzo-p-dioxin | 2.0 | | **0.10** |

Q = Qualifier
1 PG/G = 1 trillionth of a gram
part per trillion (ppt) = 10E-12

**Table 5**
East Vieques Dioxin TEQ Values
*Vieques, Puerto Rico*

| SITE ID | SAMPLE ID | ANALYTE | RESULT (PG/G) | Q | 2,3,7,8-TCDD Eq (ppt) |
|---|---|---|---|---|---|
| E-SWMU-10 | CGW10SB13-R01-5 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | Total heptachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | Octachlorodibenzo-p-dioxin | 5.0 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SB13-R01-5 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.00** |
| E-SWMU-10 | CGW10SB19-R01-5 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB19-R01-5 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-10 | CGW10SB19-R01-5 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 2.9 | | |
| E-SWMU-10 | CGW10SB19-R01-5 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB19-R01-5 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB19-R01-5 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SB19-R01-5 | Total heptachlorodibenzo-p-dioxin | 6.0 | | |
| E-SWMU-10 | CGW10SB19-R01-5 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-10 | CGW10SB19-R01-5 | Octachlorodibenzo-p-dioxin | 29 | | |
| E-SWMU-10 | CGW10SB19-R01-5 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-10 | CGW10SB19-R01-5 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.038** |
| E-SWMU-12 | CGW12SS05-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-12 | CGW12SS05-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-SWMU-12 | CGW12SS05-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-12 | CGW12SS05-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-12 | CGW12SS05-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-12 | CGW12SS05-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-12 | CGW12SS05-R01 | Total heptachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-12 | CGW12SS05-R01 | Total hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-SWMU-12 | CGW12SS05-R01 | Octachlorodibenzo-p-dioxin | 8.0 | | |
| E-SWMU-12 | CGW12SS05-R01 | Total pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-SWMU-12 | CGW12SS05-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **0.0024** |
| E-AOC-G | CGAGSS04-R01 | 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 3.6 | | |
| E-AOC-G | CGAGSS04-R01 | 2,3,7,8-TCDD (dioxin) | 1.0 | U | |
| E-AOC-G | CGAGSS04-R01 | 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 123 | | |
| E-AOC-G | CGAGSS04-R01 | 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 2.5 | U | |
| E-AOC-G | CGAGSS04-R01 | 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 3.1 | | |
| E-AOC-G | CGAGSS04-R01 | 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 1.0 | U | |
| E-AOC-G | CGAGSS04-R01 | Total heptachlorodibenzo-p-dioxin | 257 | | |
| E-AOC-G | CGAGSS04-R01 | Total hexachlorodibenzo-p-dioxin | 40 | | |
| E-AOC-G | CGAGSS04-R01 | Octachlorodibenzo-p-dioxin | 1400 | | |
| E-AOC-G | CGAGSS04-R01 | Total pentachlorodibenzo-p-dioxin | 2.0 | | |
| E-AOC-G | CGAGSS04-R01 | Total tetrachlorodibenzo-p-dioxin | 1.0 | U | **2.3** |

Q = Qualifier
1 PG/G = 1 trillionth of a gram
part per trillion (ppt) = 10E-12

**Table 6**

Soil Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs)

*Vieques, Puerto Rico*

| | Concentrations (ug/kg) | | |
|---|---|---|---|
| **Compound** | **Rural Soil** | **Agricultural Soil** | **Urban Soil** |
| Acenaphthene | 1.7 | 6 | |
| Acenaphthylene | | 5 | |
| Anthracene | | 11 – 13 | |
| Benzo(a)anthracene | 5 – 20 | 56 – 110 | 169 – 59,000 |
| Benzo(a)pyrene | 2 – 1,300 | 4.6 – 900 | 165 – 220 |
| Benzo(b)fluoranthene | 20 – 30 | 58 – 220 | 15,000 – 62,000 |
| Benzo(e)pyrene | | 53 – 130 | 60 – 14,000 |
| Benzo(g,h,i)perylene | 10 – 70 | 66 | 900 – 47,000 |
| Benzo(k)fluoranthene | 10 – 110 | 58 – 250 | 300 – 26,000 |
| Chrysene | 38.3 | 78 – 120 | 251 – 640 |
| Fluoranthene | 0.3 – 40 | 120 – 210 | 200 – 166,000 |
| Fluorene | | 9.7 | |
| Ideno(1,2,3-c,d)pyrene | 10 – 15 | 63 – 100 | 8,000 – 61,000 |
| Phenanthrene | 30.0 | 48 – 140 | |
| Pyrene | 1 – 19.7 | 99 – 150 | 145 – 147,000 |

**Reference:**

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons. August.*

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# Final Responses to EPA Comments on the

# Draft Master Standard Operating Procedures, Protocols, and Plans for the Environmental Restoration Program at the Former Vieques Naval Training Range, Vieques, Puerto Rico

# July 2009

## General Human Health Risk Assessment Technical Review Comments

1. The current approach does not address the potential for subsurface volatile organic compound (VOC) sources to adversely impact indoor air via the processes of vapor intrusion. Please indicate whether the vapor intrusion pathway is assumed to be complete (under current or future potential land use conditions) for any location at the site. If so, please provide the proposed methodology (and associated sampling and data collection) to evaluate associated complete exposure pathways.

   ***Navy Response:***

   The vapor intrusion pathway is not expected to be complete for any site to be evaluated in the Environmental Restoration Program. However, the following text has been added to the "Data Collection and Evaluation" section of the protocol:

   > "During the site investigation phase, soil analytical results will be used to determine if/where the collection of groundwater data is warranted. If groundwater sampling is warranted, and compounds that are sufficiently volatile and toxic (as identified in Table A-1 of the DOD Vapor Intrusion Handbook [2009]) are detected in groundwater, and it is known or reasonably anticipated that these chemicals are the result of a CERCLA-related release attributable to the Navy, and the detections are within 100 feet of an existing building (or a preferential pathway to an existing building is present), or a building may be reasonably considered to be constructed onsite in the future, a phased vapor intrusion evaluation will be performed. This approach is consistent with the DOD Vapor Intrusion Handbook (2009).
>
> In the initial phase, a screening level assessment will be performed. This evaluation will involve comparing site groundwater data with generic risk-based screening values. The EPA residential air RSLs (EPA, 2009) will be used with EPA's generic attenuation factors (AFs) obtained from EPA's draft vapor intrusion guidance (EPA, 2002). The default AF is 0.001 for groundwater. The air RSL will be used with the default AF and the temperature-adjusted Henry's Law Constant to calculate the generic screening level for groundwater that is protective of indoor air vapor intrusion exposures. The residential air RSLs based on non-carcinogenic

effects will be adjusted for a hazard quotient (HQ) of 0.1 to account for potential cumulative effects from the presence of multiple non-carcinogens. If maximum detected groundwater concentrations are below the generic calculated screening levels, it will be concluded that the site does not pose a vapor intrusion risk if a vadose zone source is not present. If exceedances are observed, the data will be re-evaluated in a vapor intrusion model (Phase 2). If a significant vadose zone source is present (based on site-specific data evaluation), soil gas samples will be collected above the vadose zone source area.

The next phase, if warranted based on the initial phase, will consist of using a mixture of generic default and site-specific parameters in the Johnson and Ettinger (J&E) model. The parameter values to be considered for verification or development of site-specific values will be determined based on site conditions. In some cases, the modeling results may be sufficient to determine that the site does not pose a vapor intrusion risk; in other cases, the modeling results will be one of the multiple lines of evidence used to evaluate whether there is a unacceptable vapor intrusion risk. If modeled results indicate unacceptable risks (as defined by EPA), a site-specific vapor intrusion study will be conducted.

If needed, the next phase includes multi-media sampling, and may include the collection of near-slab soil gas, sub-slab soil gas, and/or indoor air samples. A site-specific vapor intrusion work plan will be prepared prior to collection of these data. Multiple lines of evidence may be used to evaluate the magnitude and extent of vapor intrusion. Depending on the results of the investigation and a human health risk assessment, it may be determined that either no further action is necessary or that mitigation or remediation may be warranted."

References added to the Human Health Risk Assessment Protocol

Department of Defense. 2009. DOD Vapor Intrusion Handbook. Prepared by the Tri-Service Environmental Risk Assessment Workgroup. January.

United States Environmental Protection Agency (EPA). 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway (Subsurface Vapor Intrusion Guidance). Office of Solid Waste and Emergency Response, Washington, DC. EPA-530-D-02-004. November.

2. It is unclear from the methodologies outlined within the Protocol how exposures to lead in soil will be evaluated. If concentrations in site media indicate lead as a Contaminant of Potential Concern (COPC), ensure that the appropriate U.S. EPA-approved lead exposure model is utilized [e.g., Adult Lead Model (ALM), All-Ages Lead Model (AALM), Integrated Exposure Uptake Biokinetic Model (IEUBK), Lead Spread, etc.]. Please revise the Protocol as appropriate.

***Navy Response:***

The following text has been added to the end of the toxicity assessment section.

"When lead is identified as a COPC in soil, sediment, or fish/crab tissue, the potential risks associated with lead exposure will be evaluated using the EPA's adult lead methodology (ALM) and Integrated Exposure Uptake Biokinetic (IEUBK) model, unless a more recent EPA-recommended lead exposure model is available. Although other draft EPA or state-specific software packages to estimate lead exposures are available (e.g., EPA's All-Ages Lead Model and Cal/EPA's LeadSpread), these additional software packages will not be used in HHRAs unless they become EPA's recommended lead exposure models. At the time a risk assessment is prepared, the most recent EPA-recommended lead exposure model will be used.

The ALM (EPA 2003a; 2009a) will be used to evaluate risks associated with non-residential adult exposures. The model focuses on estimating fetal blood lead levels (BLLs) in pregnant workers exposed to lead in soil (EPA 2003b). When lead is identified as a COPC for indirect exposure through the food consumption (fish/crab) pathway, the most recent ALM spreadsheets provided by EPA will be modified and used to calculate BLLs.

The baseline BLL and geometric standard deviation (GSD) for U.S. women of child-bearing age from the most recent population-based survey study (e.g., NHANES) will be used. The model results are expressed as the predicted geometric mean BLL for adults and the corresponding 95th percentile fetal BLLs and the percent of the population potentially experiencing concentrations above 10 micrograms per deciliter (µg/dL).

For child receptors, the potential risks associated with lead exposures will be addressed using the most recent version of the IEUBK model (EPA, 1994; 2009a). The IEUBK model was designed to provide predictions of the probability of elevated BLLs for children. This model addresses three components of environmental risk assessments: the multi-media nature of exposures to lead, lead pharmacokinetics, and significant variability in exposure and risk, through estimation of probability distributions of BLLs for children exposed to similar environmental concentrations.

When using the IEUBK model for evaluation of risk associated with soil or sediment, the default exposure concentrations embedded in the IEUBK model will be used for other non-site-related exposure media (air and groundwater). For the evaluation of lead exposure through consumption of fish and/or crab, the "alternative dietary" option will be used initially, as a conservative approach, assuming that 100 percent of the total meat eaten by a child is fish or crab obtained from the site. The default exposure concentrations embedded in the IEUBK model will be used for other non-site-related exposure media (air and groundwater) except for soil. The arithmetic mean of the lead concentration in soil will be used to represent potential site-specific exposures to lead in soil."

### References added to the Human Health Risk Assessment Protocol

EPA. 2009a. ALM spreadsheet (MS Excel). Available: http://www.epa.gov/superfund/health/contaminants/lead/products.htm#alm

EPA. 2009b. Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children Windows® Version, (IEUBKwin v1.1 Build 9). June.

EPA. 2003a. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil. Office of Solid Waste and Emergency Response. OSWER 9285.7-54. January.

EPA. 2003b. Adult Lead Methodology (ALM) Spreadsheets. Office of Solid Waste and Emergency Response. On-line, http://www.epa.gov/superfund/programs/lead/products/alm05_03.xls. Last update on 19 May.

EPA. 1994. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. OSWER Directive 9355.4-12

## Specific Human Health Risk Assessment Technical Review Comments

1. **Figure 2, Zoning, Vieques, Puerto Rico, page 4:** The colors in the key do not match the colors in the figure. For example, the figure includes 2 shades of yellow/orange, but only 1 is represented in the key.

***Navy Response:***

The previous Figures 1 and 2 have been replaced with one that consolidates planned land use and zoning classifications (see revised Figure 1 attached).

2. **Data Collection Summary and Evaluation, pages 5 – 7:**

a. The screening concentration for lead is 400 ppm. This value is not adjusted, as it is not derived using the HQ approach. Please include this in the text.

***Navy Response:***

The 2nd and 3rd sentences in the first bullet under Data Collection Summary and Evaluation on page 5 have been revised as follows:

> "The non-carcinogenic RSL values will be reduced by a factor of 10 (adjusted to a Hazard Quotient [HQ]=0.1) to account for the potential presence of multiple constituents affecting the same target organ, with the exception of lead. EPA considers lead to be a special case because of the difficulty in identifying the classic "threshold" needed to develop an RfD. The residential soil RSL for lead (400 mg/kg) is based upon the Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children and, therefore, will not be adjusted downward by a factor of 10."

b. Although it is unlikely that chemicals other than perchlorate would have similar modes of action, it is premature to assume this is the case and therefore screen perchlorate against a concentration set at a hazard index of 1. Since the screening step is a conservative one, please screen perchlorate against a concentration set at an HQ of 0.1.

***Navy Response:***

See Response to Comment 2a.

c. Soil saturation limits should not be used as a screening concentration. These concentrations are influenced by several factors, such as soil type, organic carbon content, pH, and other factors. Please use only risk-based screening concentrations in the screening process.

***Navy Response:***

Not only does the inclusion of soil saturation limits add additional conservatism to the COPC selection process, it provides valuable information indicating the potential presence of free product (e.g., NAPL) in soil. Additionally, the RSL User Guide states that "Chemical-specific $C_{sat}$ concentrations must be compared with each VF-based SL because a basic principle of the SL volatilization model is not applicable when free-phase contaminants are present." Therefore, consideration of the soil saturation limit in the screening process is appropriate.

3. **Potentially Exposed Populations, page 7:** U.S. EPA concurs that it is not necessary to quantify potential exposures associated with trespassers or site visitors, given the spectrum of additional receptor populations assumed to be at issue at the subject sites. However, trespassers and site visitors should still be portrayed within the site Conceptual Site Model (which can indicate that these potential exposures, while relevant to the site, are not quantified based on the spectrum of other, more significant, relevant exposures).

***Navy Response:***

The Conceptual Site Model (RAGS D Table 1) to be prepared for each site undergoing a quantitative human health risk assessment will include trespassers and site visitors as potential receptors, as requested. No change to the protocol is necessary since these receptors are already acknowledged.

4. **Table 1, Exposure Factors for Soil/Sediment Ingestion and Dermal Exposure Intakes – Non-MMOA COPSs:** Please remove the Exposure Time (ET) component from the Recreational User (adult, youth and child) dermal contact with sediment intake equations. The ET parameter has no bearing on an assessment of baseline dermal exposure-derived dose.

   ***Navy Response:***

   The ET component for dermal contact with sediment by Recreational Users (adult, youth, and child) in Table 1 has been removed and the associated equations revised accordingly (see attached revised Table 1).

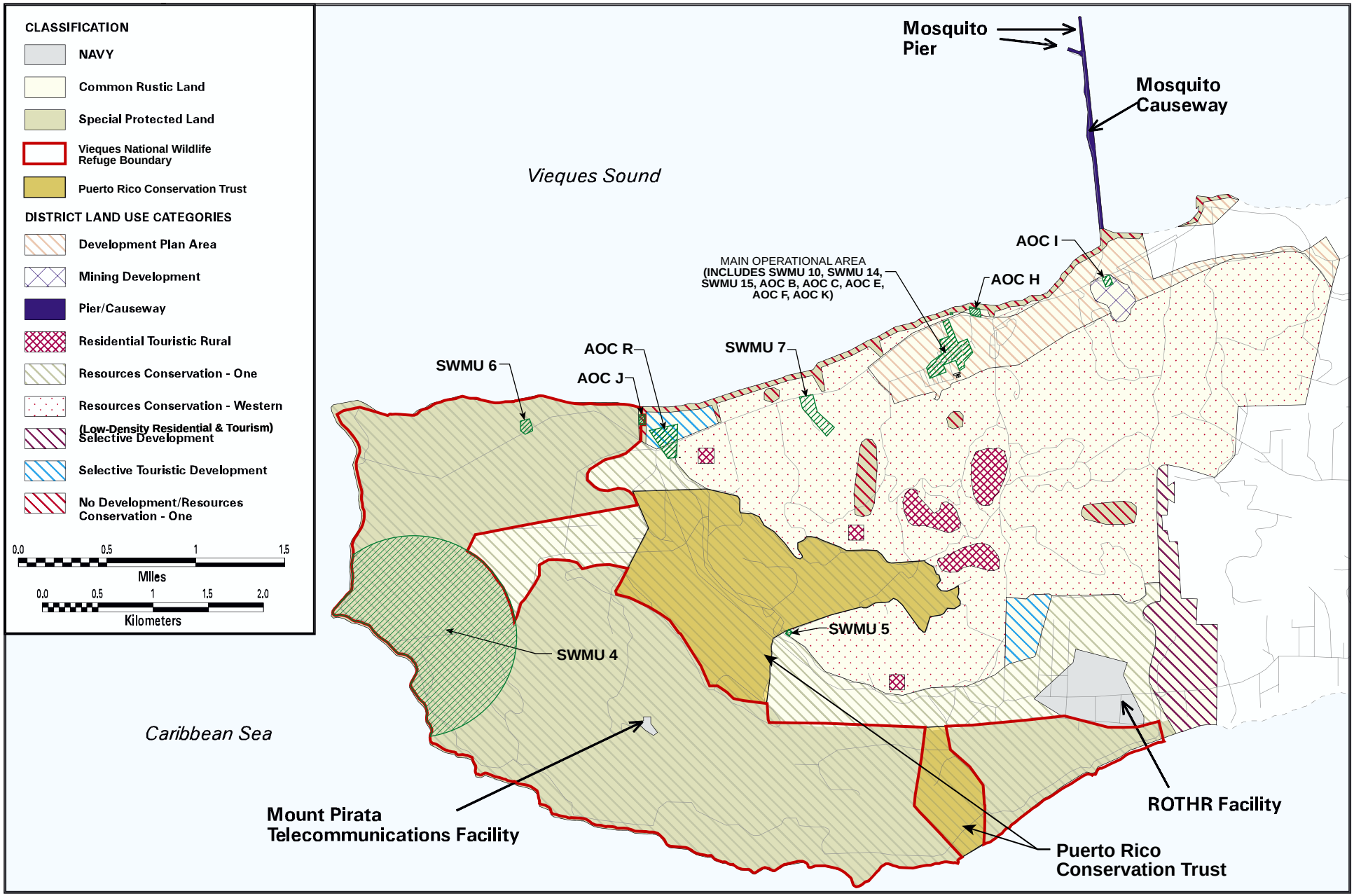
5. **Carcinogenic Risk Estimation, page 22:** Please include a discussion of the Mutagenic Mode of Action and the Age-Dependent Adjustment Factors.

   ***Navy Response:***

   A discussion of Mutagenic Mode of Action and the Age-Dependent Adjustment Factors are included in the second to the last paragraph under the Risk Characterization section. The following text has been included at the end of the Toxicity Assessment section:

   **"Mutagens"**

   For chemicals with a mutagenic mode of action for carcinogenesis, in the absence of chemical-specific data, the risk for exposures that occur at early life stages will be calculated by applying the default age-dependent adjustment factors (ADAFs) to the non-age-specific slope factor to address the potential for differential carcinogenic potency associated with exposure during early life (less than 16 years of age)."




Source: PRPB 2000, US Navy 2000

FIGURE 1
Proposed Land Use and Zoning Classifications by Puerto Rico Planning Board
*Former NASD, Vieques Island, Puerto Rico*

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# Final Responses to EPA Comments on the

# Draft Master Standard Operating Procedures, Protocols, and Plans for the Environmental Restoration Program at the Former Vieques Naval Training Range, Vieques, Puerto Rico

# July 2009

## Ecological Risk Assessment Protocol

The Ecological Risk Assessment (ERA) Protocol review indicated that most of the previous EPA recommendations had been included in the Protocol. However, the review did identify a few areas in the ERA Protocol that need clarification and/or further development. For example, the methodologies and approaches used for the Screening-level Ecological Risk Assessment and Baseline Ecological Risk Assessment are intertwined in the text and need to be more clearly separated to avoid confusion. This issue among others is discussed below.

### General Ecological Risk Assessment Technical Review Comments

1. The current layout either intertwines or does not clearly separate the approaches and methodologies for the Screening-level Ecological Risk Assessment (SERA) and the Baseline Ecological Risk Assessment (BERA). Whenever possible, it is suggested to subdivide each section into "SERA approach" and "BERA approach" to avoid any confusion. Two examples follow:

   - The Exposure Point Concentrations section (starting on p. 6 of the draft protocol) should include the subtitle "SERA approach" in front of the paragraph starting with "For the screening exposure estimates, …" (p. 7), and the subtitle "BERA approach" in front of the paragraph starting with "In the baseline assessment, …" (p. 7).

   - The terrestrial plant section (on p. 8 of the draft protocol) provides a way to estimate tissue contaminant levels in the above-ground vegetative portion of terrestrial plants. However, the text does not specify if the approach pertains to the SERA or BERA, or both. This section should be split into "SERA approach" and "BERA approach". If the current text pertains to both approaches, then it should be placed under "SERA approach" and a note to that effect should be included under "BERA approach".

   Please ensure that the protocol is unambiguous and consistent on this issue. Clearly separating the two approaches will make it easier for readers to identify which steps pertain to the SERA and which pertain to the BERA.

   ***Navy Response:***

   The structure of the document will be revised as indicated in the comment.

2. Numerous decisions were made to derive the screening and baseline Bioconcentration Factors (BCFs) and Bioaccumulation Factors (BAFs) provided in Tables 3 through 8. The "basis" for selecting the screening and baseline BCFs and BAFs is outlined on p. 7 of the protocol, but is both incomplete and unclear. In Table 5, for example, the "basis" for the screening values consists of arithmetic mean, 90th percentile, not specified, assumed, maximum, and single value. In the same table, the "basis" for the baseline values consists of geometric mean, assumed, mean, and median.

   It is not possible to independently verify the accuracy of each "basis" based on the available information. Please develop a detailed flowchart which shows all of the decisions used to select one "basis" over another. If available, it would also help to include as an appendix the calculations for identifying the various data distributions.

   ***Navy Response:***

   Rather than add a series of flowcharts, the text will be expanded to clearly explain the rationale for selecting the basis for the BCFs/BAFs. Briefly, at the screening level, values were based upon the 90th percentile if available in the cited reference or on the maximum if not. Baseline values considered both the distribution of the data (e.g., normal or log normal) and the recommendations in the cited reference. Geometric means were preferred for log normal distributions and arithmetic means for normal distributions. In some cases, neither distribution was applicable or the distribution was biased by an outlying value. In those cases, point estimates like the median were then considered. Where an individual study (as opposed to a compilation of multiple studies) was cited, the best available value was sometimes a single value or the derivation was not specified. The term "assumed" was used when no data were available and the default value specified in the text was used (usually 1.0). Since the data distributions were not typically calculated (the calculations were in the cited reference), adding an appendix of these distributions is not warranted.

Specific Ecological Risk Assessment Technical Review Comments

1. **Selection Criteria for Analytical Data, page 5, 5th bullet:** This bullet states that soil data collected underneath permanent barriers will not be used in the ERA unless the conceptual model specifies that a potentially complete ecological exposure pathway exists. The protocol does not clearly state if the future redevelopment of the permanent barriers will be considered when selecting analytical data. For example, buildings may be demolished in the future or parking lots moved to different locations. The soils underneath permanent barriers should be included in the evaluation if any potential exists for these barriers to be removed and the soils underneath exposed. Please address this issue in the protocol.

   ***Navy Response:***

   All available soil samples will be considered for inclusion in the ERA but data quality considerations and the conceptual site model will be used to select the subset of samples (depth will also be an important consideration) that will be used in the ERA. This will occur as part of each site-specific interim deliverable, on which the regulatory agencies

will have the opportunity to comment. Future site use will be considered as part of the conceptual site model, where appropriate.

2. **Exposure Point Concentrations, 2nd paragraph, page 7:**

   a. The text states that Table 2 provides a list of the bioaccumulative chemicals, except for dioxins, furans, and Polychlorinated Biphenyls (PCB) congeners. Instead, these compounds "will be added to the list as part of the site-specific ERA interim deliverable for specific sites where their analysis is warranted". Please include these compounds in Table 2 and make sure they are carried over into the subsequent BCF and BAF tables (Tables 3 through 8), the media-based Toxicity Reference Value (TRV) tables (Tables 12 through 18), and the ingestion-based TRV tables (Tables 20 and 21) for independent review. Note that the Aroclors are already included in these tables, but not the dioxins or furans. This effort will ensure that a consensus-based, comprehensive ERA protocol for the Vieques environmental restoration program applicable to all sites is developed.

   ***Navy Response:***

   The full list of bioaccumulative chemicals will be included in Table 2 but the chemicals will not be included in subsequent tables unless they are typically sampled for at Vieques (these will be clearly identified in the revised Table 2). Should a compound not typically sampled for be sampled at a specific site, the applicable BAF values, etc. will be derived and included in the site-specific interim deliverable. This process will ensure that effort is not wasted developing values that have a very low probability of ever being used at the facility while providing a mechanism, prior to the conduct of the ERA, to allow regulatory review of the values for any "new" chemicals.

   b. The text states that "any explosive compounds detected in the media at a particular site will be added to the list of chemicals evaluated for food web exposures and will also be specified in the site-specific ERA interim deliverable". Please include these compounds in the BCF and BAF tables (Tables 3 through 8) and the ingestion-based TRV tables (Tables 20 and 21) for independent review. Note that the explosive compounds are already included in the media-based TRV tables, when available (see Tables 12 through 18). It is important to develop upfront a consensus-based, comprehensive ERA protocol for the Vieques environmental restoration program which is applicable to all sites.

   ***Navy Response:***

   The explosive compounds will be added to the BCF and TRV tables as requested since they are typically sampled for at the facility.

3. **Fish, page 10:** The text states, "Tissue concentrations in whole-body fish will be estimated using sediment-to-fish BAFs or BSAFs from the literature for applicable fish species. Alternately, tissue concentrations may be calculated from surface water on a site-specific basis." It should be noted that, on a site-specific basis, the collection of fish or other aquatic receptors (e.g., crab) may be necessary under certain scenarios (e.g., should appropriate BAFs or BSAFs be lacking).

***Navy Response:***

Tissue sampling of appropriate receptors will be considered at specific sites as part of the normal application of the 8-step ERA process, as warranted.

4. **Table 6, Soil Bioaccumulation Factors for Small Mammals:** The soil BAFs for pesticides, PCBs, volatile organic compounds, or semi-volatile organic compounds are listed as "NA" with a reference of "See Text". However, the section on small mammals (pg. 9) states chemicals without a BAF will be assumed to have a BAF of 1.0. Please revise Table 6 to include a value of 1.0 for those chemicals lacking a BAF.

***Navy Response:***

The text refers to a diet to whole body BAF while the table lists soil to whole body BAFs. The two values are not equivalent. The text will be revised to more clearly indicate this.

5. **Table 12, Fresh Surface Water TRVs:** A few errors were identified during a review of the 2006 National Ambient Water Quality Standards (NAWQC). For example, an EcoTox Threshold value of 0.0069 ug/L was listed for heptachlor. However, a NAWQC value of 0.0038 ug/L is available and this value should have been chosen over an EcoTox Threshold value based on the Surface Water TRV hierarchy. Please review all the values in this table to ensure that the selected value is consistent with the surface water TRV hierarchy.

***Navy Response:***

The table will be checked for consistency with the specified hierarchy. However, the protocol also contains a provision (see Section 1.2.2.2; page 12) that allows the hierarchy to be modified under some circumstances. The example cited in the comment is one such instance. The NAWQC value for heptachlor is based upon a final residue value (FRV) while the EcoTox value is based upon a secondary (Tier II) chronic value (SCV). The protocol clearly states (bottom of page 12) that a final chronic value (FCV) or SCV will be used in place of a FRV if available.

# Technical Evaluation of the Preliminary Responses to Comments on

# PREQB Technical Evaluation of the Draft Master Standard Operating Procedures, Protocols, and Plans, Environmental Restoration Program, Vieques, Puerto Rico

PREQB has conducted an evaluation of the Navy's preliminary response to comments. PREQB's evaluation of the responses is provided below each Navy response in italics.

## General Comment:

1. Please submit the SOP entitled *Disposal of Waste Fluids and Soils*. This SOP is referenced in a few of the SOPs, but is not included in the draft document.

   ***Navy Response:***

   The SOP has been superseded by the Master Waste Management Plan; all references to the SOP have been changed to reference the Master Waste Management Plan.

   ***Evaluation of Response to Comment:*** The response is acceptable.

## Standard Operating Procedure Comments:

### Soil Sample Depth Selection Protocol

1. **Page 1.** Please modify Item 1 of the procedures for sampling the top 24 inches to read as follows: "*The site is near water and the land crab or burrowing reptiles (e.g., nesting sea turtles) are potential receptors of concern*."

   ***Navy Response:***

   Comment incorporated, but because the current soil sample depth selection protocol wording is somewhat ambiguous, because another selection criterion was recently used (i.e., for the SI/ESI), and based on observations of how the ERP Technical Subcommittee is actually implementing the protocol on projects, the following is proposed as a replacement of the Surface Soil selection criteria:

   - "Surface soil samples will be collected from the top 24 inches of soil when the sample location is near a surface water body and land crabs or burrowing reptiles (e.g., nesting sea turtles) are potential receptors of concern at the sample location.
   - Surface soil samples will be collected from the top 12 inches of soil when the sample location is not near a surface water body and land crabs or burrowing

reptiles (e.g., nesting sea turtles) are not potential receptors of concern at the sample location.

- Surface soil samples will be collected from the top 6 inches of soil when collected from under debris or contaminated soil that has been removed to determine whether a release to underlying soil has occurred."

***Evaluation of Response to Comment:*** The response is acceptable.

## Master Waste Management Plan

1. **Page 2-1, Section 2.3.** Please expand the second sentence to "…the groundwater will be discharged to the ground surface *at least 25-feet from the well* in an area…"

   ***Navy Response:***

   Master Waste Management Plan, Section 2.3, second sentence has been revised to: "If groundwater is extracted from a background location or from where previous investigations have confirmed that contamination does not exist at that location, the groundwater will be discharged to the ground surface at least 25 feet from the well in an area that will not affect the well being sampled or adjacent sampling locations."

   ***Evaluation of Response to Comment:*** The response is acceptable.

2. **Page 2-2, Section 2.3, Paragraph 1 and Step 1.** Remove the procedure of returning purge water to the monitoring well. Water should not be introduced into a well as it may alter the representativeness of samples later collected from the well. Wells in which purge water is returned will need to be redeveloped such that three-times the volume of water is removed to ensure representativeness. The revised procedure should read "If purged groundwater does not meet these criteria (contaminated or potentially contaminated), it will be containerized for characterization and disposal, as described in Section 3 and 4."

   ***Navy Response:***

   There is a significant cost and burden on the environment to offsite management of investigation-derived waste and every effort should be made to minimize them. Returning purged groundwater to the monitoring well following sampling is a more sustainable approach and will not likely alter the representativeness of samples collected later from the well any more than redeveloping the well would. However, it is important to ensure that only the groundwater removed from the well is returned to the well and that this does not take place until all wells at the site have been sampled. Therefore, the sentence has been revised to read: "If purged groundwater does not meet these criteria (contaminated or potentially contaminated), it may be returned to the monitoring well (after all wells at the site have been sampled) from which it was purged as long as:

   - No NAPL or other evidence of gross contamination is observed in the purged water

- The purged water is collected in a decontaminated vessel and excludes groundwater or fluids from any other source (including other wells)"

***Evaluation of Response to Comment:*** Groundwater that is known to be contaminated or is obtained from a well that might be contaminated needs to be managed as contaminated and disposed of appropriately. Typically, this involves containerizing and transport to an off-site location for treatment. Alternatively, the water within the container may be sampled in order to verify that the purge water is not contaminated and then may be disposed of to the ground at least 25 feet from the well. As clarified in EPA December 27, 1989 OSWER Directive 9234.1-06, reinjection of contaminated water violates RCRA Section 3020(a) ban on hazardous waste by underground injection and is applicable to both RCRA and CERCLA sites.

***Navy 2nd Response:***

The revised procedure will read: "If purged groundwater does not meet these criteria (i.e. it is contaminated or potentially contaminated), it, and all other water generated that doesn't meet the standards for discharging to the ground, will be contained for characterization and disposal, as described in Section 3.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

3. **Page 3-3, First, Second and Third Bullets.** The three (3) labels should be expanded so that the location of waste source (e.g., SWMU 9, etc.) can be indentified on the label. This will assist with container management at the collection and storage area(s).

***Navy Response:***

That information is already in the first label, but will be expanded as follows: "Site" has been revised to: "Site (e.g., East Vieques, SWMU 1)." The same has text has been added to the second and third bullets as well.

***Evaluation of Response to Comment:*** The response is acceptable.

4. **Page 3-4, Section 3.3.** The procedure should be expanded to indicate that the inspection frequency is at least daily while containers are staged. This will ensure that container integrity is being closely monitored to avoid any leaks/spills.

***Navy Response:***

The text is sufficient as is for ensuring inspections are performed at an adequate frequency. This process has been followed in the past and has worked well. Daily inspections would place undue burden on the program.

***Evaluation of Response to Comment:*** The response is acceptable.

5. **Table 4-1, Page 4-1, Section 4.** The word "liquid" should be deleted from 1 sample per 500 tons/bulk container. The words "and heterogeneous" should be removed from site characteristics for drums and other small containers since sampling 1 out of 10 drums is not appropriate for heterogeneous media. Table 4-1 should be expanded to include a fourth option: Heterogeneous media, and the sampling frequency should be 1 sample for each drum. The table should include a foot note that clarifies that "soil or homogenized soil is not considered homogenous."

***Navy Response:***

***Section 4 has been updated for clarity.*** The sampling frequencies apply to each individual waste stream not to each individual media as there may be several waste streams that comprise a single media. The terms homogeneous and heterogeneous apply to characteristics of contamination at the site (e.g., level of contamination), not physical characteristics of individual media (e.g., grain size of soil) as suggested by the comment. In response to the PREQB comments concerning the sampling frequencies:

***In response to the first part of comment 5 that states:*** The word "liquid" should be deleted from 1 sample per 500 tons/bulk container, 1 sample / 500 tons of each waste stream comprising solid media stored in bulk containers is appropriate. 1 sample per bulk liquid container (tank) is also appropriate. It is understood that there may be several waste streams at a site that comprise a single media. For example, consider two bulk containers – one with excavated soil from a source or highly contaminated area (documented by either previous knowledge, high PID readings, or visual or odor signs) and then another with soil from an area with low levels of contamination. These are different waste streams, so 1 sample/500 tons would apply to each waste stream and a sample would be taken from each container. See below for revised Section 4.

***In response to the second part of comment 5 that states:*** The words "and heterogeneous" should be removed from site characteristics for drums and other small containers since sampling 1 out of 10 drums is not appropriate for heterogeneous media.

***Please see above for what was meant by the terms homogeneous and heterogeneous.*** To avoid confusion the terms have been eliminated from Section 4. The sampling frequency of 1/10 drums is appropriate for each waste stream. It is understood that there may be several waste streams at a site that comprise a single media. For example, consider two groups of drums - one with excavated soil from a source or highly contaminated area (documented by either previous knowledge, high PID readings, or visual or odor signs) and then another with soil from an area with low levels of contamination. These are different waste streams, so 1 sample/10 drums would apply to each waste stream and a composite sample would be taken from each set of 10 drums from each of those waste streams. See below for revised Section 4.

***Section 4 of the Waste Management Plan has been revised to read:***

> Wastes will be characterized based on analytical results, and the characterization will be documented on a waste profile. The following analytical protocol generally will be conducted: Full Toxicity Characteristic Leaching Procedure (TCLP), Reactivity (Cyanide and Sulfide), Ignitability, and Corrosivity. Certain analyses may be eliminated or added based on site-specific conditions and site history, if known. Added or eliminated analyses will be documented in site-specific work plans and/or reports as appropriate.

The sampling approach will be determined based on site history, the composition of the waste stream, the process generating the waste stream, and the types of containers in which the waste is collected. Samples will be collected such that the results are representative of each waste stream. In general, for each waste stream, samples will be taken at the following frequency:

- One sample per 500 tons of solid media will be taken for solids collected in bulk containers,
- One sample per bulk container will be taken for liquids collected in bulk containers, and
- One sample per 10 drums is required for liquids or solids collected in drums.

Site conditions may dictate deviations from these guidelines. Such deviations will be documented in site-specific work plans and/or reports as appropriate.

Waste characterization information will be documented on a waste profile form provided by the offsite treatment and/or disposal facility as part of the waste acceptance process. The profile will be reviewed and approved by CH2M HILL prior to submission to the Navy for generator signature. CH2M HILL will provide the Navy with a waste approval package for each waste stream. This package will include a waste profile naming the U.S. Navy as the generator of the waste, analytical summary table(s) applicable to the waste, and any other applicable information necessary for the Navy to complete its review of the disposal package and provide a signature as the generator. Signed profile(s) will then be submitted to the disposal facility for approval.

The profile typically requires information including but not limited to the following:

- Generator information including name, mailing address, contact, and phone number
- Site name including street address
- Process generating waste (e.g., soil removal, well installation, etc.)
- Source of contamination
- Historical use for area
- Waste composition
- Physical state of waste

- Applicable hazardous waste codes

A facility approved copy of the waste profile or approval letter will be received prior to scheduling of offsite transportation of the waste.

***Evaluation of Response to Comment:*** The response is acceptable.

6. **Page 5-1, Section 5.** The use of the word "site" in the text should be reviewed and revised, if appropriate. It appears that the text is referring to the storage area and not the site (i.e., source of contaminated media).

***Navy Response:***

All occurrences of the word "site" on page 5-1 have been replaced with "waste staging area."

***Evaluation of Response to Comment:*** The response is acceptable.

## SOP A-1, Soil Boring and Abandonment

1. Please include a requirement for utility and UXO clearance prior to intrusive activities in this SOP.

***Navy Response:***

SOP A-1, Soil Boring Drilling and Abandonment. III Procedures and Guidelines, Section A Utility and UXO clearance will be inserted above Drilling to say: "A. Utility and UXO clearance

Utility and UXO clearance will be accomplished by checking with the Navy representative as to the potential for utilities in the area and the likelihood of UXO on the site. If there is the potential for municipal utilities to be present, the local utility company(ies) will be contacted as well. If live utilities are anticipated in the area of work, they will be marked by a third party utility location contractor or the local utility company. If the Navy representative indicates there is the potential for UXO to be present at a site, an operational readiness evaluation call will take place among the senior CH2M HILL UXO safety specialist and CH2M HILL field personnel to go over the avoidance procedures, and the safety specialist will designate the appropriate UXO safety procedures and personnel required."

***Evaluation of Response to Comment:*** The response is acceptable.

## SOP A-2, Soil Sampling

1. **Page 1, Section III (A).** This section states that for VOC samples in jars, the jars should be completely filled to avoid headspace. Please do not use this procedure is obsolete as it is obsolete. If EnCore® samplers are not being used, then collect samples directly into pre-preserved vials in the field. Please detail this procedure in the SOP, including the

number of vials used for both low-level and high-level VOC analyses and the anticipated preservatives.

***Navy Response:***

There are instances where neither Encore® nor Terra core® are appropriate (Terra core® is the method that specifies putting the collected sample in the pre-preserved vials in the field). Unconsolidated soft sediments are often too soft to appropriately sample with either of the above methods. If neither method can be appropriately used, then samples will be collected in zero headspace jars. The SOP A-6 "Soil Sampling for VOCs Using the Terra Core® Sampler" specifies the preservative and number of vials, but be aware that the number of vials is often laboratory specific. SOP A-2, Soil Sampling, III Procedures and Guidelines, A. Surface and Shallow Subsurface Sampling with Hand Auger, second to last sentence has been revised to: "If Encore® and/or Terra core® samplers cannot be used to collect a sample, then zero headspace jars will be used." SOP A-6 "Soil Sampling for VOCs Using the Terra Core® sampler" attached.

***Evaluation of Response to Comment:*** Collecting samples in zero-headspace jars for VOCs is an obsolete procedure. If the matrix does not allow the use of the EnCore® or Terracore® sampler for storage and shipping of the sample, then use the EnCore® or Terracore® sampler (or a cut-off disposable syringe) to collect the sample and immediately transfer it to a pre-preserved vial (5 mL deionized water is used for low-level VOCs and 5 mL methanol is used for high-level VOCs; typically two-low-level VOC vials and one high-level VOC vial is collected). The main item of importance here is that the sample be in preservative as soon as possible after it is exposed to the atmosphere.

***Navy 2nd Response:***

Collecting soft sediment samples in zero-headspace jars for VOCs is not an obsolete procedure, it is best available technology. If soft sediment (or very wet very soft soil) is too soft to allow the Encore® or Terra core® samplers to fill when the sampler is pressed into the sediment/soil, then those two sampling systems cannot be filled following manufacturer's procedure. The cut-off syringe works the same way as the two samplers, it is pushed into the sediment/soil to be filled, but has similar restrictions as to softness of sediment/soil. Pulling the syringe plunger while inserting is not allowed, as that would put a vacuum on the sample potentially losing some volatiles. The standard Terracore® sampler process is to push the sampler into the matrix to fill the sampling chamber, and then extrude it into a 40 mL pre-preserved VOA vial. However, if the sampler cannot be filled, it cannot be used to fill the pre-preserved VOA vial. Collecting a 5 gram sample in a small VOA vial using a small scoop will disturb the sample more than a larger jar with a larger volume. In the event that these two small sample systems cannot be collected as per manufacturer's instructions, then collecting a larger volume sample to minimize contaminant loss is the best available technology. A 2-oz or 4-oz jar filled so that there is zero head space (fairly easy to do accurately if the material is soft) provides the larger volume to minimize contaminant loss, and is more likely to provide a

representative sample to the lab than trying to fill one of the small volume samplers in a method not following the manufacturer's instructions.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

2. **Page 2, Section A, Paragraph 1.** Please define the term "EIS" in the text.

***Navy Response:***

The text "Environmental Information Specialist" has been added in front of "(EIS)" in the sentence."

***Evaluation of Response to Comment:*** The response is acceptable.

3. **Page 2, Section B, Paragraph 1.** Please revise the first sentence to "Advance a boring to *just above* the sample depth…" Revise the final sentence to "Record the weight, blow count (number of blows required to advance 6 inches), and *penetrated length* into the boring log."

***Navy Response:***

SOP A-2, Soil Sampling, III Procedures and Guidelines, B. Split-Spoon or Direct Push Sampling, first paragraph, first sentence has been revised to: "Advance a boring to just above the sample depth using a drilling rig, slide hammer, or direct push technology (DPT) rig." First paragraph, last sentence has been revised to: "Record the weight, type, blow count (number of blows required to advance 6 inches), and penetrated length into the boring log. Record only the penetrated length if using DPT."

***Evaluation of Response to Comment:*** The response is acceptable.

## SOP A-4, Soil Sampling for VOCs Using the EnCore® Sampler

1. The May 2007 version of this SOP provided details on how many EnCore samplers to collect for low-level and high-level VOC analyses. Revise the current version of this SOP to also include this information.

***Navy Response:***

The number of EnCores® per sample is laboratory specific. Therefore, a specific number is not included in the SOP. However the SOP has been revised to reflect that the number of EnCores® is laboratory specific. SOP A-4, Soil Sampling for VOCs Using the EnCore® Sampler, III.A. Surface and Shallow Subsurface Sampling, third paragraph, after the last sentence has been added: Collect the number of EnCores® per sample required by the laboratory.

***Evaluation of Response to Comment:*** The response is acceptable. However, the revised SOP A-4 was not on the Vieques web site with the other SOPs recently submitted. Please add this SOP to the website.

***Navy 2nd Response:***

The intent was to only provide the completely new SOPs at this time. If only minor changes were made to a SOP, and if the description of the change in the response to comments document was interpreted to be sufficient to describe the change to the SOP, then the revised SOP was not provided at this time. The entire revised SOP document will be provided at the draft final and final stages.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

2. Revise Section IIIA of the SOP to clarify that sediment samples which cannot be collected with an EnCore® samples will need to be collected in "pre-preserved" vials.

***Navy Response:***

"Pre-preserved" vials systems, such as Terra Core® samplers have the same sample media low stiffness limitations as EnCores®. SOP A-4, Soil Sampling for VOCs Using the EnCore® Sampler, III.A. Surface and Shallow Subsurface Sampling, third paragraph, after the last sentence has been added: "Low stiffness sediments are not appropriately sampled using EnCores® (or Terra Cores®). Low stiffness sediment VOC samples will be collected in zero headspace jars."

***Evaluation of Response to Comment:*** Please see response to SOP A-2, comment #1.

***Navy 2nd Response:***

Please see second response to SOP A-2, comment #1.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

## SOP A-5, Slide Hammer Soil Sampling

1. Please provide the attachments (lift evaluation form and self-assessment checklist for lifting) listed in the SOP.

***Navy Response:***

The CH2M HILL safety documents "Lift evaluation form" and "Self-assessment checklist" have been added to the SOP.

***Evaluation of Response to Comment:*** The response is acceptable.

## SOP B-1, Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling

1. **Page 3, Section V, Pre-Sampling Activities.** The May 2007 version of this SOP included a step to measure VOCs with a PID or FID after removing the well cap. Please revise step #3 to put this step back in the procedure. It should also be noted that this step is required in the EPA Region 2 low flow sampling SOP.

   ***Navy Response:***

   Step 3 has been modified to read: Remove well cap, measure and record VOCs in the breathing zone above well with a PID or FID. Do not take the reading directly above or within the well casing as this air tends to be moisture-laden and may interfere with the instrument reading."

   ***Evaluation of Response to Comment:*** The response is acceptable. However, the revised SOP B-1 was not on the Vieques web site with the other SOPs recently submitted.

   ***Navy 2nd Response:***

   Please see response to SOP A-4 #1.

   Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

2. **Page 4, Section V, Pre-Sampling Activities.** Please revise step #5 to include a reference to the SOP H-2, *Water-Level Measurements.*

   ***Navy Response:***

   The first sentence of Step 5 has been revised to read: "Measure and record the depth to water in accordance with *SOP H-2, Water-Level Measurements* in all wells to be sampled prior to purging."

   ***Evaluation of Response to Comment:*** The response is acceptable. However, the revised SOP B-1 was not on the Vieques web site with the other SOPs recently submitted.

   ***Navy 2nd Response:***

   Please see response to SOP A-4 #1.

   Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

3. **Page 4, Section V, Sampling Procedures.** The May 2007 version of this SOP included a step to record the depth to which the pump is lowered in the well. Please revise step #1 to put this step back in the procedure. It is critical that this information be recorded for data evaluation as well as future sampling events. Note that this step is required in the EPA Region 2 low flow sampling SOP.

***Navy Response:***

The following sentence has been added after the first sentence of Step 1 under Sampling Procedures: "Record the depth to which the pump is lowered in the well."

***Evaluation of Response to Comment:*** The response is acceptable. However, the revised SOP B-1 was not on the Vieques web site with the other SOPs recently submitted.

***Navy 2nd Response:***

Please see response to SOP A-4 #1.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

4. **Page 5, Section V.** Step #4 allows for a possible exception to the 0.3′ drawdown goal if it is going to take an unreasonable duration of time to fill the sample bottles and pumping rates are below 100 mL/min. Please clarify what is meant by "unreasonable duration." PREQB suggests a duration greater than 2 hours as unreasonable.

***Navy Response:***

The second sentence of the second paragraph of Step 4 has been revised to read: "If it will take an unreasonable duration of time (i.e., greater than approximately 2 hours) to fill the required bottleware, consider documenting an exception to the 0.3′ drawdown goal."

***Evaluation of Response to Comment:*** The response is acceptable. However, the revised SOP B-1 was not on the Vieques web site with the other SOPs recently submitted.

***Navy 2nd Response:***

Please see response to SOP A-4 #1.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

5. **Page 5, Section V.** Please explain why the step to measure the water level with the pump in the well prior to purging was eliminated in the current version of the SOP. This step was present in the May 2007 version and is also required in the EPA Region 2 low flow sampling SOP.

***Navy Response:***

A measurement of the water level in the well is always collected immediately prior to installing the pump. This has been clarified in the SOP. The EPA Region 2 low flow sampling SOP measures the water level after installing the pump. In order to avoid measuring the water level affected by the installation of the pump, the SOP specifies collection of the water level prior to installation of the pump. As a first step, directly before installing the pump, the following has been added to the SOP "1.

Prior to installing the purging/sampling pump, measure and record the depth to water (to 0.01 ft) in the well to be sampled. "

***Evaluation of Response to Comment:*** Consistent with USEPA Region 2 low flow sampling guidance (U.S. Environmental Protection Agency Region II Ground Water Sampling Procedure, Low Stress (Low Flow) Purging And Sampling, March 16, 1998), please measure the water level after the pump has been placed in the well and prior to purging.

***Navy 2nd Response:***

A water level will be measured in wells after the pump has been installed and prior to purging. However, since the water level collected after installing the pump is less representative of the actual water table than the water level collected just before installing the pump. Drawdown records will be based on the actual water table/piezometric surface (the pre-pump installation water level) rather than a measurement possibly raised by an installed slug (the pump).

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

6. **Page 5, Section V.** Please explain why the step to measure and record the well depth was eliminated in the current version of the SOP. This step was present in the May 2007 version and is also required in the EPA Region 2 low flow sampling SOP.

***Navy Response:***

The well depth is a known, so measuring its depth does not provide information useful to the goal of sampling the aquifer. In addition, there is a significant potential disadvantage to measuring the well depth prior to sampling. If there is sediment at the bottom of the well (which almost every well has), it can be suspended when the tape measure impacts the bottom of the well, even at slow speeds. It is significantly more advantageous to avoid suspending the sediment at the bottom of the well just before sampling than it is to record a depth that is already known. Also by measuring the full depth of the well, it is necessary to decontaminate the full wetted length of the measuring tape; this practice provides greater risks of cross-contamination of wells.

***Evaluation of Response to Comment:*** The response is acceptable.

7. Please include the field log book requirements provided in the May 2007 version of this SOP in the current version of this SOP (B-1).

***Navy Response:***

The information may be recorded in a logbook, but may also be recorded on groundwater sampling forms. The following information has been added as Step 1 under Sampling Procedures:

"A field log book or groundwater sampling form will be kept each time groundwater monitoring activities are conducted in the field. The field log book or groundwater sampling form should document the following:

- Well identification number and physical condition
- Well depth (from well completion records; do not measure depth prior to sampling)
- Static water level depth (to 0.01 ft), date, time, and measurement technique
- Presence and thickness of immiscible liquid layers and detection method
- Collection method and quantity of immiscible liquid layers (if removed from the well)
- Pumping rate, drawdown, indicator parameters values, and clock time, at approximately 3- to 5-minute intervals
- Well sampling sequence and time of sample collection
- Sample identification numbers
- Field observations of sampling event
- Name of sample collector(s)
- Weather conditions
- QA/QC data for field instruments (often in separate calibration log)"

***Evaluation of Response to Comment:*** The response is acceptable. However, the revised SOP B-1 was not on the Vieques web site with the other SOPs recently submitted. Please add this SOP to the website.

***Navy 2nd Response:***

Please see response to SOP A-4 #1.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

8. Please include a standard Groundwater Sample form as an attachment to the SOP, if such a form will be used.

***Navy Response:***

Attached. Groundwater sample form formats may vary with project-specific requirements; the attached is the current format.

***Evaluation of Response to Comment:*** The response is acceptable.

## SOP C-1, Calibration and Measurement with Field Instruments

1. The May 2007 version of this SOP provided specific details on how to calibrate for pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential. All of these details have been eliminated in the current version of the SOP and replaced with a simple reference to manufacturer's instructions. Many times, the calibration procedures used in the field vary from the manufacturer's instructions and the intent of the SOP is not to provide a single statement to refer to the manufacturer. Please include these details in this SOP.

   ***Navy Response:***

   The May 2007 version stated that "calibrate using the procedure described by the manufacturer of the instrument. The following describes typical calibration checks for specific field parameters." The typical calibration checks of the May 2007 version have been re-inserted, but it is noted in this response that the manufacturers calibration protocol will be followed in general, not necessarily the typical calibration.

   ***Evaluation of Response to Comment:*** Please perform the same calibration checks on the water quality instruments, regardless of the manufacturer. For instance, pH calibration must be performed with a minimum of two different pH standards and the acceptance criteria must be ±0.2 (per the SOP), regardless of the manufacturer. This same logic applies to the remaining water quality parameters. All procedures in the SOP need to be followed at all times. Note that the revised SOP C-1 was not on the Vieques web site with the other SOPs recently submitted.

2. Several sections of the SOP refer to compressed gas calibration standards. It is assumed that these would be used for the calibration of the PID and FID. Please include detailed procedures on the calibration of the PID and FID.

   ***Navy Response:***

   Calibration of the PID and FID will depend on the manufacturer and model of the instrument, which will be followed.

   ***Evaluation of Response to Comment:*** Regardless of the manufacturer and model of the instrument, isobutylene will typically be used for the calibration of the PID and methane will typically be used for the calibration of the FID. In addition, regardless of the manufacturer and model of the instrument, the readings of these standards need to be within ±10% of the true value. Please include specific procedures for the calibration of the PID and FID in the SOP.

   ***Navy 2nd Response:***

   Calibration generalities were intentionally left out of the SOP so as to not confuse the reader. PID and FID calibration readings do need to be within ±10% of the calibration standard, and PIDs do calibrate on isobutylene, but multi-rae PIDs calibrate on isobutylene and mixed gas. Calling out some characteristics of some calibrations, while leaving others in the manufacturers SOP just confuses issues. Calibration of field instruments will follow the manufacturer's instructions.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

## SOP D-1, Monitoring Well Installation

1. **Page 1, Section IV, Procedures.** Please discuss how the user will select the screen depth. For example, partially penetrating screens should be installed for water table wells.

   ***Navy Response:***

   A bullet has been added under "Procedures" that states: "Screen depths will be based on site-specific information and project-specific goals, and discussed in the - project-specific SAP. Screen depths will be designed based on the depth of known or anticipated contamination, the type of contamination, etc. In general, 10-foot screens will be placed at the first encountered groundwater (i.e., across the top 10 feet of the water-bearing unit), unless site-specific information or project-specific goals suggest screening a different interval (check project-specific SAP). For wells where floating product is anticipated or detected during drilling, the well screen should be installed across the water table."

   ***Evaluation of Response to Comment:*** The response is acceptable.

2. **Page 2, Section B, First Bullet.** Please verify that the word "ID" should not be revised to "OD."

   ***Navy Response:***

   ID is correct.

3. Please provide the attachments (monitoring well construction schematic diagram and schematic diagram of double-cased monitoring well construction) listed in the SOP.

   ***Navy Response:***

   The attachments have been added at the end of the SOP.

   ***Evaluation of Response to Comment:*** The response is acceptable.

## SOP D-2, Monitoring Well Development

1. Please provide the attachment (well development form) listed in the SOP.

   ***Navy Response:***

   The attachment has been added at the end of the SOP.

   ***Evaluation of Response to Comment:*** The response is acceptable.

## SOP G-1, Surface Water Sampling

1. Section IIIA states that measurements of percent oxygen saturation are collected. Please include the details on how this parameter is measured in this SOP. Also, please provide the attachment (surface water quality sampling field data form) listed in the SOP.

***Navy Response:***

Percent oxygen saturation is measured by the dissolved oxygen probe. In the first paragraph of Section IIIA, the phrase "and percent oxygen saturation" has been removed. The attachment has been added to the end of the SOP.

***Evaluation of Response to Comment:*** The response is acceptable. However, the revised SOP G-1 was not on the Vieques web site with the other SOPs recently submitted.

***Navy 2nd Response:***

Please see response to SOP A-4 #1.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

## SOP G-2, Sediment Sampling

1. Please revise Section IV, Section D, step #4 of the SOP to clarify that samples for VOCs should be immediately placed in "pre-preserved" jars prior to homogenization. Please provide the details of this procedure in the SOP, including the number of vials used for both low-level and high-level VOC analyses and the anticipated preservatives.

***Navy Response:***

Generally sediments are too soft to sample with either the Terra Core® or the EnCore®; However, Step 4 has been amended to include the following statement: "If sediment is stiff enough to sample with EnCore® or Terra Core® samplers for VOC analysis, follow the instructions contained in the EnCore® or Terra Core® SOPs, as applicable."

***Evaluation of Response to Comment:*** See response to SOP A-2, comment #1.

***Navy 2nd Response:***

Please see second response to SOP A-2, comment #1.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

## SOP H-4, Chain-of-Custody

1. Please explain why details from the May 2007 version of this SOP regarding the notation of Federal Express in the "Received By" line as well as the recording of the air bill number were deleted from this version of the SOP.

   ***Navy Response:***

   See attached blank sample COC. CH2M HILL keeps the FedEx air bill with the chain. The laboratory notes the air bill and shipping information on the chain upon receipt, and CH2M HILL gets a copy of that chain. Therefore, it is not necessary to note Federal Express in the chain in the Received By section. Likewise it is not necessary to put the air bill number on the chain.

   ***Evaluation of Response to Comment:*** The response is acceptable.

## SOP I-1, Vegetation Clearance SOP for Environmental Investigations

1. **Page 1, Purpose and Scope.** A threatened and endangered species protocol is cited that will be followed for "munitions areas." Please add a sentence to clarify if and how those survey methods might be applied to non-munitions areas.

   ***Navy Response:***

   The munitions area threatened and endangered species surveys are designed for large munitions areas that will have large tracts of land cleared. The Vegetation Clearance SOP for Environmental Investigations is designed for the vegetation clearing generally conducted for environmental work (i.e., smaller areas with more surgical clearing). The two protocols are specifically tailored to meet the requirements of their style of proposed work. Please also note that the Vegetation Clearance SOP for Environmental Investigations was developed with FWS and has been approved by FWS for use by the ERP.

   ***Evaluation of Response to Comment:*** Please provide a threatened and endangered species protocol for non-munitions areas.

   ***Navy 2nd Response:***

   Threatened and Endangered Species Surveys have already been completed for all sites we currently are investigating in the Environmental Restoration Program. A Threatened and Endangered Species Survey SOP is therefore not necessary. The following is a list of Threatened and Endangered Species surveys completed on Vieques:

   List of Habitat Characterization Studies on Vieques:

   1) CH2M HILL. 2008. Technical Memorandum, Ecological Survey of Laguna Boca Quebrada at SWMU 4, Former Naval Ammunition Support Detachment, Vieques Island, Puerto Rico. February 20. Included in an Appendix of the Draft

Remedial Investigation Report, Solid Waste Management Unit 4 Report dated August 2009.

2) Department of the Navy, October 23, 2008. Vegetation Clearance Ecological Field Survey Results Comprehensive Liability Environmental Action Navy (CLEAN) Program Site Inspection/Expanded Site Inspection 7 Consent Order and 15 PI/PAOC Sites. Letter from NAVFAC Atlantic to USFWS, included in an Appendix of the Draft SI/ESI 7 Consent Order Sites and 16 PI/PAOC Sites Report submitted October 2009.

3) Geo-Marine, Inc. and CH2M HILL, July 2007. Methods and Approach for Threatened and Endangered Species and Habitat Surveys Within the ECA, SIA, And EMA On Vieques, Puerto Rico.

4) Geo-Marine, Inc. December 16, 2005. Habitat Characterization at Areas of Concern (AOC) AOC-R, PI-4, PI-7, PAOC-J, K, and S For The Former Vieques Naval Training Range (VNTR) and Naval Ammunition Support Detachment (NASD), Vieques Island, Puerto Rico.

5) Geo-Marine, Inc. Plan Years 2003-2012. Integrated Natural Resources Management Plan (INRMP), Navy Lands on Vieques.

6) Geo-Marine, Inc. March 2002. Mangrove Forrest Health and Status Vieques Island, Naval Station Roosevelt Roads, Puerto Rico, Draft Report for NAVFAC Atlantic Division.

7) Geo-Marine, Inc. 2001. Habitat Characterization of Area of Concern (AOC) H, AOC I, AOC J, AOC L, and AOC R, Naval Ammunition Support (NASD) Detachment, Vieques Island, Puerto Rico. April 24.

8) Geo-Marine, Inc. 2001. Naval Station Roosevelt Roads (NSRR). Draft Report Wetland Delineation of the Live Impact Area, Vieques Island. Vieques, Puerto Rico. Atlantic Division, Naval Facilities Engineering Command.

9) Geo-Marine, Inc. 2001. Naval Station Roosevelt Roads (NSRR). Biological Assessment for Continuing Training Activities on the Inner Range, Vieques, Puerto Rico. Atlantic Division, Naval Facilities Engineering Command.

10) Geo-Marine, Inc. 2000. Habitat Characterization of Solid Waste Management Units (SWMU) 4, SWMU 5, SWMU 6, SWMU 7, and the Public Works Area, Naval Ammunition Support (NASD) Detachment, Vieques Island, Puerto Rico. August 29.

11) Geo-Marine, Inc. 2000. Biological Assessment for Continuing Training Activities on the Inner Range, Vieques, Puerto Rico. Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia.

12) Geo-Marine, Inc. and Reforesta, Inc. 2000. Naval Station Roosevelt Roads (NSRR). Survey of Endangered, Threatened, and Candidate Plant Species, Naval Ammunition Support Department (NASD), Vieques, Puerto Rico. Draft Report.

13) Geo-Marine, Inc., March 1997. Rare, Threatened, And Endangered Species Habitat Inventory of Navy Lands on Vieques, Puerto Rico.

14) T. Mitchell Aide and Alejandro Cubina Reforesta. October 2001. Description of Selected Unique Plant Communities within the Navy Lands on Vieques, for Atlantic Division NAVFACENGCOM.

15) U.S. Department of the Interior, Fish and Wildlife Service, Southeast Region. August 2007. Vieques National Wildlife Refuge, Comprehensive Conservation Plan and Environmental Impact Statement. Vieques, Puerto Rico.

16) U.S. Fish and Wildlife Service (USFWS). 1989. A qualititative post-hurricane habitat and population assessment at Ceiba and Vieques Island, Puerto Rico. Boqueron, Puerto Rico.

17) U.S. Fish and Wildlife Service (USFWS). 1985. National Wetlands Inventory Map – Island of Vieques, P.R. U.S. Department of Interior, Washington, D.C.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

2. **Page 3, paragraph 2.** This paragraph states that a "*Reasonable effort will be made to avoid cutting or damaging threatened and endangered plant species*." Please clarify what is meant by "reasonable effort." Please clarify if it is a reasonable effort to include a qualified botanist/biologist with knowledge of the local flora and of potential occurrences of protected plants to walk the corridors to be cleared and clear them for the presence of protected plant species.

***Navy Response:***

The Vegetation Clearance SOP for Environmental Investigations, as written, was developed with and approved by FWS.

***Evaluation of Response to Comment:*** Please clarify whether a qualified botanist or biologist will search areas to be cleared for protected plant species and will identify and protect or rescue protected plants prior to clearing of vegetation.

***Navy 2nd Response:***

As discussed in *Step 3-Initial site visit to delineate access routes* Navy contractor qualified botanist or biologist and if USFWS determines it necessary, qualified USFWS personnel ground truth the areas to be cleared and dual red and white flag vegetation or habitats that should not be damaged or removed. USFWS assisted in development of and approved this SOP.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

3. **Pages 3 and 4, Steps for Developing Site-specific Vegetation Clearance Process, Step 2.** Please provide field guides and illustrations or photographs of protected plant species similar to the sheet done for protected snakes that can be provided to the clearing crews to improve chances that rare plants will be recognized and preserved.

***Navy Response:***

A table and field guide of protected plant species has been attached, and will be referenced in the text.

***Evaluation of Response to Comment:*** Please note that the response accepted conditionally, as the referenced table and field guide were not provided for review. Please provide the table and field guide for agency review.

***Navy 2nd Response:***

The referenced table and field guide were provided with the rest of the draft information, and are located on the Vieques Island IR Web Portal at:

Environmental Restoration Subcommittee Folder

Draft Master SOPs, Protocols, and Plans

SOPs

7a T and E Plants on Vieques (the field guide)

7b TE Plant Table (the table)

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

4. **Page 4, Steps for Developing Site-specific Vegetation Clearance Process, Step 3.** Under Item 2c, it is stated that trees greater than 3 inches in diameter that cannot be avoided will be tagged. Please also document whether the trees are protected plant species and note whether they were preserved or removed.

***Navy Response:***

The Vegetation Clearance SOP for Environmental Investigations, as written, was developed with and approved by FWS.

***Evaluation of Response to Comment:*** As requested in the original comments, please also document whether the tagged trees are protected plant species and note whether they were preserved or removed.

***Navy 2nd Response:***

Documentation of clearing cannot be conducted in step 3 At step 3 of the process, (as developed in concert with the regulating authority for threatened and endangered plants), the report documents what vegetation and habitats are identified (Step 3 #2, h requires documentation of protected plant and animal species on or near the

route). This documentation along with considerable other information is given to the USFWS Refuge Manager (see Step 4) prior to conducting a site visit with USFWS personnel (Step 5). Only after USFWS give concurrence on the clearing (step 6) does the vegetation clearance occur (Step 7). USFWS personnel determine what can and cannot be cut in Step 5, and USFWS personnel and Navy contractor biologists or other qualified Navy contractor personnel are present during implementation of clearing activities to monitor what is cut and not cut.

Discussed during the Environmental Technical Subcommittee meeting of the week of January 25, 2010. Response accepted by PREQB.

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# Chain of Custody

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| Client: **CH2M HILL, PM:** **Contact:** | Contract: **N62470-02-D-3052** | Phone #: **( 757 ) 671-6208** | Fax #: **( 773 ) 695-1378** |
| Address: **5700 Cleveland St, Suite 101** | City: **Virginia Beach** | State: **VA** | Zip Code: **23462** |
| Purchase Order #: **926754** | Proj. Name/No.: **Vieques SWMU-4** | | Katahdin Quote #: |
| Bill (if different than above): CH2M HILL Inc, A/P | Address: **PO Box 241329, Denver, CO 80224** | | |
| Sampler (Print/Sign): | | | Copies To: |

| **LAB USE ONLY** | Work Order #: Katahdin Project Number | | |
|---|---|---|---|
| Remarks: | | | |
| Shipping Info: | FEDEX | UPS | CLIENT |
| Airbill No: | | | |
| Temp C | Temp Blank | Intact | Not Intact |

Analysis and Container Type Preservatives

| * | Sample Description | Date/Time Collected | Matrix | No. of Containers | 0.5 L HNO3 Metals (ILM05.3) | 0.25 L NaOH CN (ILM05.3) | | | | | | | | | | Comments |
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COMMENTS: **28-Day Turn Around Time**

| Relinquished By: | Date/Time | Received By: | Relinquished By: | Date/Time | Received By: |
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# Final Responses to

# PREQB Technical Evaluation of the Draft Master Standard Operating Procedures, Protocols, and Plans, Environmental Restoration Program, Vieques, Puerto Rico

## Baseline Human Health Risk Assessment Protocol for Vieques Environmental Restoration Program

1. **Page 1, paragraph 1.** Please remove the word "conservative" from the first sentence, as the third sentence states that both conservative and realistic potential exposure scenarios will be evaluated.

   ***Navy Response:***

   The first sentence has been revised as follows:

   > "A baseline human health risk assessment (HHRA) provides an evaluation of the potential risks associated with existing site conditions, under both current and potential future land-use conditions."

2. **Page 2, Risk Results Format and Interim Deliverables, paragraph 3.** Please add the depths of the samples to the information that will be provided in the pre-interim deliverable.

   ***Navy Response:***

   The following sentence has been included after the first sentence in paragraph 3:

   > "The depth of each surface soil and subsurface soil sample will be included."

3. **Page 2, Risk Results Format and Interim Deliverables, paragraph 3.** Suggest adding "if needed" or something similar to the end of the last sentence so that the conference call is not mandatory.

   ***Navy Response:***

   The words "if needed" have been added to the last sentence of paragraph 3 to read:

   > "Subsequently, if needed, a conference call will be held with the agencies to discuss the data groupings to be used in the baseline HHRA."

4. **Page 2, Risk Results Format and Interim Deliverables, paragraph 4.** Just a small typo in first sentence – add space after Tables 1-6.

   ***Navy Response:***

   A space has been added after "Table 1-6".

5. **Figure 1.** Please add AOC and SMWU locations to this figure.

   ***Navy Response:***

   The approximate locations of AOCs and SWMUs has been added to the figure (see revised Figure 1 attached, which consolidates proposed land use and zone classifications, and replaces the previous Figures 1 and 2).

6. **Figure 2.** Please remove or define the label boxes on the figure and add AOC and SWMU locations.

   ***Navy Response:***

   The previous Figures 1 and 2 have been replaced with one that consolidates planned land use and zoning classifications (see revised Figure 1 attached).

7. **Page 5, Data Collection and Evaluation.** Please include a discussion on how nondetects will be evaluated. The ERA Protocol states that the reporting limit will be used to represent the concentration. Please ensure that a similar statement is included in this section.

   ***Navy Response:***

   The following text has been added to the end of the second paragraph:

   > "For non-detected results, the sample quantitation limit (SQL) will be used to represent the concentration and will be used in the calculation of exposure point concentrations using the most recent version of ProUCL software (currently version 4.00.04; EPA, 2009c)."

8. **Page 5, Data Collection and Evaluation, paragraph 2**. Please clarify why the procedure for dealing with field duplicates in the HHRA protocol is different than that used in the ERA protocol and potentially less conservative. In the ERA protocol, the higher of the two results is used. In the HHRA protocol, the results from the original sample are always selected for use over the field duplicate results.

   ***Navy Response:***

   For the sake of consistency, the approach proposed in the ERA protocol was adapted and will be used in future HHRAs. The following text replaced the last sentence in the 2nd paragraph:

   > "For samples with field duplicate analyses, the higher of the two concentrations will be used when both values are detects or when both values are non-detects. In cases where one result is a detect and the other a non-detect, the detected value will be used in the risks assessment."

9. **Page 6, Data Collection Summary and Evaluation paragraph 4.** The following bullet discussing how soil samples will be screened using soil screening levels for the protection of the soil-to-groundwater migration pathway has been deleted. Although it is acceptable not to include this text in the HHRA Protocol, the process for conducting this screening was negotiated and agreed upon and should be included in a Master SOP. Please provide the reference to the SOP that now includes this information or please prepare a new SOP that contains this information:

> Surface and subsurface soils will also be screened against soil-to-groundwater protection criteria. This comparison will not be used to select the COPCs for the HHRA calculations, but will be used to help understand chemical transport potential. The leachability potential will be assessed by comparing site-specific concentrations to published EPA Soil Screening Levels (SSLs) based on a dilution/attenuation factor (DAF) of 1, or site-specific SSLs if site-specific data have been collected to permit their calculation. The site-specific SSL values will be calculated using the input factors from the data collected for each site. The site-specific DAF for SSL values will be calculated following the EPA guidance (EPA, 1996 and 2002b).

***Navy Response:***

Evaluation of the soil-to-groundwater migration pathway (by comparison to SSLs) is not part of the HHRA process and will be conducted as part of the site-specific soil data evaluation. However, the following text was re-inserted into the HHRA protocol:

> "Surface and subsurface soils will also be screened against soil-to-groundwater protection criteria. This comparison will not be used to select the COPCs for the HHRA calculations, but will be used to help understand chemical transport potential. The leachability potential will be assessed by comparing site-specific concentrations to published EPA Soil Screening Levels (SSLs) based on a dilution/attenuation factor (DAF) of 1, or site-specific SSLs if site-specific data have been collected to permit their calculation. The site-specific SSL values will be calculated using the input factors from the data collected for each site. The site-specific DAF for SSL values will be calculated following the EPA guidance (EPA, 1996 and 2002b)."

10. **Page 6, Data Collection Summary and Evaluation, paragraph 5.** Please provide more specificity on the methods and values that will be used in determining fish tissue concentrations, consistent with the approach agreed upon for SWMU 4. Please note the following:

    a. For bioaccumulation of contaminants in fish tissue from surface water, the following summarizes the methods agreed upon for SWMU 4 that should be presented in this section:

        i. Other COPCs may be evaluated on a site-specific basis, in addition to the general criteria presented (i.e., Kow > 3).

***Navy Response:***

The "Surface Water" section under the 3rd bullet of the Data Collection Summary and Evaluation section has been replaced with the following text:

> "Surface water COPCs for the fish ingestion pathway will be identified based on comparison of site surface water concentrations to National Recommended Water Quality Criteria (NRWQC; EPA, 2006) for consumption of organisms, the constituent's log $K_{ow}$, and the constituent's bioaccumulation potential. If a NRWQC value is not available for consumption of organisms, the value for the consumption of water + organisms will be used. If a NRWQC value is not available for an organic constituent, it will be identified as a COPC (excluding polycyclic aromatic hydrocarbons [PAHs]) if its log $K_{ow}$ exceeds 3. If a NRWQC value is not available for an inorganic constituent, the constituent will be identified as a COPC if it is considered bioaccumulative according to EPA guidance (EPA, 2000). Figure 2 provides a flow chart describing the surface water COPC selection process for the fish ingestion pathway.

ii. Should the development of site-specific BAFs be required, EPA (2000a) guidance for deriving human health NRWQC will be followed.

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol.

> "If development of site-specific BAFs or BCFs is required, EPA (2000b) guidance for deriving human health NRWQC and its supporting documents (EPA, 2003b; EPA, 2009e) will be used."

References added to the Human Health Risk Assessment protocol:

EPA. 2000b. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000). Technical Support Document Volume 1: Risk Assessment. EPA-822-B-00-005. October.

EPA. 2003b. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000). Technical Support Document Volume 2: Development of National Bioaccumulation Factors. EPA-822-R-03-0303. December.

EPA. 2009e. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000). Technical Support Document Volume 3: Development of Site-Specific Bioaccumulation Factors. EPA-822-R-09-008. September.

iii. The Draft National BAFs for methyl mercury will be used.

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol.

> *"If mercury is detected in surface water that supports edible-size fish, the draft National BAF for methylmercury of 2,670,000 L/kg (geometric mean value for trophic level 4; EPA, 2006) will be used."*

Reference added to the Human Health Risk Assessment protocol:

EPA. 2006b. Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. EPA-823-B-04-001. August 2006.

iv. If national BAF cannot be derived, then may apply appropriate Trophic Level 4 BAFs/BCFs from Superfund Chemicals Data Matrix (SCDM)

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol.

> "Should the development of site-specific BAFs or identification of appropriate BCFs be infeasible, BAFs from SCDM may be applied."

v. Separate BAFs/BCFs for inorganic and methyl mercury will be provided. Note that the same is recommended for inorganic and organic lead, to address lead impacts from petroleum releases, if needed.

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol.

> "When mercury or lead is detected in surface water supporting edible-size fish, the concentration in fish tissue will be estimated using BAFs/BCFs for both inorganic and organic forms of the constituents."

vi. A compilation of proposed BAFs/BCFs, including appropriate values from COC-specific NRWQC documents, related guidance, SCDM, etc. will be provided.

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol.

> "If needed, BCFs will be obtained from EPA guidance (EPA, 2002) and other relevant sources and used to develop site-specific BAFs in

accordance with EPA (2000) guidance for deriving human health NRWQC and its supporting documents (EPA, 2003b; EPA, 2009e)."

Reference added to the Human Health Risk Assessment protocol:

EPA. 2002d. National Recommended Water Quality Criteria: 2002 Human Health Criteria Calculation Matrix. EPA-822-R-02-012. November.

b. For bioaccumulation of contaminants in fish tissue from sediment, the following summarizes the methods agreed upon for SWMU 4 that should be presented in this section:

i. Other COPCs may be evaluated on a site-specific basis, in addition to the general criteria presented (i.e., Kow > 3 and list presented in EPA's 2000 sediment quality guidance.

***Navy Response:***

The "Sediment" section under the 3rd bullet of the Data Collection Summary and Evaluation section has been replaced with the following text:

"Sediment COPCs for the fish ingestion pathway will be identified based on the constituent's log $K_{ow}$ and the constituent's bioaccumulation potential according to EPA guidance (EPA, 2000). Organic constituents detected in sediment will be identified as COPCs (excluding PAHs) if their log $K_{ow}$ value exceeds 3. Figure 2 provides a flow chart describing the sediment COPC selection process for the fish ingestion pathway."

ii. Biota-sediment accumulation factors (BSAFs) or list of BSAF sources will be presented.

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol.

"The BSAF sources that will be used in the HHRA include (but are not limited to):

- Biota-Sediment Accumulation Factor Data Set, Version 1.0 (EPA, 2008b).
- United States Army Corps of Engineers (USACE) BSAF Database (USACE, 2008).
- Washington Department of Ecology (WDE) Bioaccumulation Factor Approach Analysis for Metals and Polar Organic Compounds (WDE, 1995).

Reference added to the Human Health Risk Assessment protocol:

EPA. 2008b. Biota-Sediment Accumulation Factor Data Set, Version 1.0. Prepared for the U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Mid-Continent Ecology Division (MED), Duluth, Minnesota. Prepared Computer Sciences Corporation Duluth, Minnesota Contract 68-W-02-032, Task 5003 and 5004. January 2008. http://www.epa.gov/med/Prods_Pubs/bsaf.htm

United States Army Corps of Engineers (USACE). 2008. BSAF Database. Available online: http://el.erdc.usace.army.mil/bsaf.

Washington Department of Ecology (WDE). 1995. Bioaccumulation Factor Approach Analysis for Metals and Polar Organic Compounds. October.

iii. The use of BSAFs, normalized for sediment TOC and fish lipid content where possible, is the preferred approach.

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol:

> "If multiple BSAFs are available, preference will be given to BSAFs normalized for sediment TOC and fish lipid content."

iv. BSAFs will be developed following EPA guidance for human health NRWQC and national BAFs for Trophic Level 4 fish.

***Navy Response:***

Please see Response to Comment 10.a.ii.

v. SCDM surface water BAFs/BCFs for Trophic Level 4 fish will be used to derive BSAFs only when infeasible to apply HH NRWQC or national BAF methods

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol:

> "BSAFs may be developed based on SCDM surface water BAFs/BCFs only when infeasible to apply HH NRWQC or national BAF methods."

vi. Default assumptions and methods to be used to derive BSAFs when site-specific data on sediment TOC and fish lipid content are not available will be presented.

***Navy Response:***

The following text has been added after the 3rd paragraph on page 18 of the protocol:

"The following assumptions will be applied when concentrations in fish tissue are estimated based on lipid-normalized BSAFs:

- 3% organic carbon in sediment
- 8% lipid and 75% moisture in fish tissue"

11. **Page 7, Data Collection Summary and Evaluation, paragraph 7.** Please indicate that the qualitative evaluation of those chemicals without screening criteria will be included in the pre-interim deliverable.

***Navy Response:***

A qualitative evaluation of chemicals without screening criteria will be presented in the text of the interim deliverable, rather than pre-interim deliverable. The following text has been added after the second sentence in paragraph 7:

"A qualitative evaluation of those chemicals without screening criteria will be included in the interim deliverable."

12. **Table 5, Exposure Factors for Fish Consumption Exposures Intakes.** Please provide a similar set of tables for crab tissue ingestion.

***Navy Response:***

An additional exposure factor table was created for crab consumption scenarios and is provided as new Table 6 (attached).

13. **Page 17, Calculation of Groundwater EPCs.** The text has been changed from what was agreed upon in the Master QAPP HHRA Protocol. Please replace the first sentence with the following, taken from the Master QAPP HHRA protocol: "The groundwater EPCs will be calculated from the wells located in the apparent center of the plume per EPA guidance on EPCs in Groundwater (EPA, 1991a)."

***Navy Response:***

The first sentence has been modified as requested to read:

"Initially, the groundwater EPCs will be calculated from the wells located in the apparent center of the plume (if distinguishable) per EPA guidance on calculating EPCs in groundwater (EPA, 1991a); however, at some sites, if risk estimates based on wells located within the apparent center of the plume or with the highest contaminant concentrations indicate unacceptable risks, additional evaluations may be conducted that represent a more realistic exposure scenario

(e.g., consideration of wells throughout the area of contamination, evaluation of groundwater flow directions and capture areas, etc.). If a more realistic evaluation is warranted, the approach and associated justification will be proposed to the regulatory agencies and a conference call held, if necessary, to reach resolution on the more realistic evaluation prior to the evaluation being conducted." This approach reflects the reality that groundwater extraction from a well or wells within the plume center will draw in water from a capture area around the wells that may include areas outside the plume center.

14. **Page 17, last paragraph.** Please include a statement that use of the MDL when an SQL are not available is only applicable to historical data used in the HHRA, not current data.

***Navy Response:***

The 3rd sentence of the last paragraph has been changed as follows:

"When SQLs are not available for non-detected inorganic results in a historical dataset, MDLs will be used as the quantitation limit.

15. **Table 6.** Please provide the full reference for the mean annual windspeed and clarify whether this new value represents the mean annual windspeed or a daily average and for what city/state or whether it represents a value for Puerto Rico.

***Navy Response:***

Previous Table 6 is now Table 8. The following footnote has been added to Table 8 (attached):

"The daily average windspeed from measurements at Observation Post 5 on Vieques (10.1 knots = 5.19 m/s) were used."

Reference added to new Table 8 and to the Human Health Risk Assessment protocol:

Department of the Navy. 1979. Draft Environmental Impact Statement: Volume I – Continued Use of the Atlantic Fleet Weapons Training Facility Inner Range (Vieques). December.

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# Final Responses to

# PREQB Technical Evaluation of the Draft Master Standard Operating Procedures, Protocols, and Plans, Environmental Restoration Program, Vieques, Puerto Rico

# Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program

This final response document provides a summary of the discussions to resolve PREQB comments on the ERA protocol based upon three calls (on 10, 15, and 17 December 2009) among the Technical Subcommittee members, their consultants, and the Navy.

The EPA has indicated that the Navy's response to EPA's comments on the ERA protocol were acceptable and require no additional discussion or comment.

## General Comments

1. Terminology. As previously agreed and incorporated into the protocol blueprint, please apply the term toxicity reference value (TRV) only to ingestion-based toxicity effects thresholds for wildlife receptors, such as birds and mammals. The term ecological screening value (ESV) should be applied exclusively to media-specific ecotoxicity benchmark criteria for surface soil, sediments, and surface water that are used to select chemicals of potential concern (COPCs) and calculate media-specific hazard quotients (HQs) for ambient COPC concentrations in abiotic media. Please make these changes in all text and tables.

   ***Navy Response:***

   The requested change in terminology will be made throughout the document.

   ***Group 3 comment:*** Response accepted without additional discussion or comment.

2. Content Sequence. The presentation of content does not appear to follow the same sequence followed in the *Proposed Summary of ERA Protocol Modifications* ("protocol blueprint") developed jointly by Navy, USEPA and EQB, last revised by Navy on May 7, 2009. Although the Introduction summarizes the 8 step ERA process, the Approach and Methodology section begins with an Exposure Assessment subsection without first discussing the COPC screening process of Step 2 or the agreed hierarchy of media-specific ESVs to be used in COPC selection. Although ESVs are first applied in ERA Step 2, the default sources and priorities for applying ESVs now first appear in the Effects Assessment on page 12. While the wildlife TRVs should remain in the Effects Assessment subsection, the ESVs should be moved up to precede the Exposure Assessment discussion. Please reorganize the document to match the original content sequence of protocol blueprint so that the protocol more closely mirrors the 8 step Navy ERA process.

***Navy Response:***

The structure of the protocol follows the structure of the ERA reports as conducted at Vieques. The Step 2 and 3A screens are conducted consecutively as part of risk characterization (see the recently delivered draft ERA for SWMU 4 as an example). As such, the structure of the protocol is appropriate as currently configured.

***Group 3 comment:*** Response accepted without additional discussion or comment.

## Page-Specific Comments

1. Table 2, Bioaccumulative Chemicals List. Please review and revise this table to add all of the chemicals that appear in Table 4-2 of the USEPA (2000) source document, such as dioxins, furans, nine pesticides noted by EPA as having BCFs > 1,000 and log Kow > 4.2, and tributyl tin. Please also add a footnote acknowledging that all PCB congeners are considered bioaccumulative.

   ***Navy Response:***

   The full list of bioaccumulative chemicals, as outlined in Table 4-2 of USEPA (2000), will be included in Table 2. Only the 23 specific PCB congeners listed in USEPA (2000) will be included in Table 2 (as a footnote).

   ***Group 3 comment:*** Response accepted without additional discussion or comment.

2. Page 7, Exposure Point Concentrations. The last sentence of the 3rd paragraph states that "*If measured tissue concentrations are available, they will be used in place of modeled values.*" However, if data are available from a limited number of tissue samples and/or COPC concentrations the tissue-associated physical media are not representative of the full range of COPC concentrations throughout a site, use of measured tissue burdens alone may introduce additional uncertainty. To address this scenario, please add a final sentence to this paragraph saying that "*Alternatively, where appropriate, tissue data may be used with paired data for physical media to derive BAFs/BCFs or algorithms that would then allow estimates of tissue burdens using all available media analytical data for a site.*"

   ***Navy Response:***

   If tissue sampling is warranted at a site, it will be scoped, with input from the regulatory agencies, as part of the development of the Step 4 ERA work plan/Sampling and Analysis Plan (SAP) and will be based upon the results from the previous steps (Steps 1 through 3) of the ERA process at the site. Thus, the resulting tissue data (in terms of sample sizes, spatial coverage, etc.) should be adequate and representative of site conditions. In the unlikely case where the resulting tissue data are not considered representative and/or adequate, developing BAF values based upon these data is counterintuitive since the resulting BAF values could also be considered unrepresentative. However, the process outlined in the comment will be considered,

where appropriate, for extrapolating the tissue data from one site to another if habitat conditions, etc. support such an extrapolation.

***Group 3 comment:*** Response accepted without additional discussion or comment.

3. Page 7, Exposure Point Concentrations. In the last paragraph, it is stated that "*Average prey concentrations are most appropriately estimated using central tendency estimates of media concentrations and accumulation factors.*" However, as stated on page 7 of the protocol blueprint, it was also agreed that during Step 3A the maximum detected concentrations would be replaced "with central tendency exposures (e.g., arithmetic means) and/or reasonable maximum exposures (i.e., 95th percentile upper confidence limit of the mean)." Please add a sentence confirming that the baseline ERA will evaluate exposures and calculate HQs for both the mean and RME (95% UCL) concentrations of COPCs.

***Navy Response:***

The paragraph will be modified as requested in the comment.

***Group 3 comment:*** Response accepted without additional discussion or comment.

4. Page 8, Terrestrial Plants and Tables 3 & 4. As agreed during development of the protocol blueprint, the default source of preferred BAFs or regression-based algorithms for plants will be those constant BAFs or equations presented/used in USEPA's development of Eco-SSLs, such as Attachment 4-1 of the Eco-SSL guidance or chemical-specific Eco-SSL derivation documents. However, as discussed in the text and presented in Tables 3 and 4, it is not sufficiently clear that the alternative values and approaches presented in Tables 3 and 4 may be used only in the absence of a plant BAF or uptake algorithm used by USEPA (2007) to develop wildlife Eco-SSLs. Please revise the text to indicate that the soil-concentration-based BAFs and algorithms published by USEPA (April 2007) in Tables 4a, 4b and 4c of the EcoSSL Guidance Attachment 4-1 supersede those derived from other sources or methods. Please also edit the 3rd paragraph on page 8 to read as follows: "*For inorganic chemicals lacking chemical-specific BAFs or algorithms prescribed in the EcoSSL Guidance Attachment 4-1 (default value) or other literature based BAFs, a soil-to-plant BAF of 1.0 was used. For non-ionic organic chemicals without literature-based BAFs, soil-to-plant BAFs were estimated using the rinsed foliage algorithm provided in Figure 5 of USEPA (2007j):*"

***Navy Response:***

The protocol blueprint indicated that the Eco-SSL document would be "preferentially considered" as a source of these values (and TRVs), not that it would be the default source. As such, the requested clarifications are not appropriate. However, the 3rd paragraph of this subsection on page 8 will be revised as follows: "For inorganic chemicals lacking literature-based, chemical-specific BAFs or applicable algorithms, a soil-to-plant BAF of 1.0 was used. For non-ionic organic chemicals without literature-based BAFs, soil-to-plant BAFs were estimated using the rinsed foliage algorithm provided in Figure 5 of USEPA (2007j):"

***Group 1/2 comment:*** There was a general discussion during the 10 December 2009 call concerning how the Eco-SSL guidance document should be used. There was general consensus that this document should be a primary source (which is how it was used) but that there are technically justifiable reasons for deviating from it in some cases (see Comments 5 through 10). As such, the Navy will edit the 3rd paragraph per its original response. In addition, where the values used match the Eco-SSL document but the original reference was cited, the Eco-SSL document will also be cited (dual citation).

5. Tables 3 & 4, Terrestrial Plants. Plant BAFs and algorithms in Tables 3 and 4 are confusing because they appear to contradict each other. They should be revised to: (a) footnote the octanol-water partitioning-based BAFs in Table 3 to indicate that these alternative BAFs are to be used *only in the absence of Eco-SSL BAFs and algorithms* based on soil concentrations; (b) eliminate values calculated in Table 3 using the octanol-water partitioning equation from the Eco-SSL guidance for all chemicals for with a BAF or uptake algorithm for plants in the EcoSSL guidance Tables 4a, 4b and 4c that uses site-specific soil COPC concentrations; (c) include in Table 4 only the BAFs and equations from Tables 4a, 4b and 4c of the EcoSSL Guidance Attachment 4-1 (USEPA, April 2007); (d) include in Table 4 the missing plant BAFs for chromium (0.041), cobalt (0.0075) and manganese (0.079) that are provided in Table 4a of the EcoSSL Guidance Attachment 4-1; and (e) replace the Bechtel Jacobs (1998a) plant equation for arsenic with the EcoSSL plant BAF of 0.03752 [Table 4a of Attachment 4-1].

***Navy Response:***

The protocol blueprint indicated that the Eco-SSL document would be "preferentially considered" as a source of these values (and TRVs), not that it would be the default source. Since the derived Eco-SSL values for birds/mammals are applied in a pre-screening step as part of the protocol, the Eco-SSL methodology, in its entirety, is incorporated indirectly in the Screening ERA (Step 2). Table 3 provides plant BAF values based upon point estimates or models (using log $K_{ow}$) while Table 4 provides regression equations to calculate plant BAFs from soil concentrations. The use of point estimates or regression equations will be made on a site-specific basis as part of the site-specific interim deliverable.

In response to 5(d), these values are included in Table 3 (since they are point estimates) but were derived from the original source document and so differ slightly from those reported in the Eco-SSL document. In response to 5(e), the value for arsenic is included in Table 3 (since it is a point estimate); the existing equation in Table 4 will remain. Available regression equations from the Eco-SSL document will be added to Table 4 for the bioaccumulative PAHs since they were inadvertently omitted.

***Group 1 comment:*** Discussed during the 10 and 17 December 2009 calls. There was agreement on the following items: (1) minor differences between the values in Table 3 and the Eco-SSL document for chemicals that the Eco-SSL document recommends point-estimate BAFs were the result of differential selection of point estimates from the same original reference (arithmetic or geometric means in Table 3 versus medians in the Eco-SSL document). There was consensus that the use of the mean values was acceptable (applies to Tables 5 and 6 also); (2) the point estimate BAFs in Table 3 (screening set) will

be used in Step 2; the regression equations in Table 4 will be the first choice for developing BAFs for Step 3A (provided that there are no site-specific factors that preclude their use, such as surface soil concentrations outside the range of concentrations used to develop the regression equation, which would be documented in the site-specific interim deliverable), followed by point-estimate BAFs in Table 3 (baseline set) (this general process will also be applied to the other BAF sets [earthworms, small mammals, benthic invertebrates, and fish]); (3) the $K_{ow}$-based equations in Table 3 (baseline set used for Step 3A) will be removed for chemicals that have soil-based regression equations in Table 4; and (4) the specific table from which values were extracted (ORNL documents) will be added to the citations in Tables 3 though 7).

Text will be added to each subsection (i.e., Terrestrial Plants, Soil Invertebrates, Small Mammals, Benthic Invertebrates, and Fish) to clarify the process for BAF selection, as warranted.

6. Page 9, Soil Invertebrates (Earthworms) and Tables 4 & 5. As agreed during development of the protocol blueprint, the default source of preferred BAFs or regression-based algorithms for soil invertebrates should be those constant BAFs or equations presented and used in USEPA's development of Eco-SSLs, such as Attachment 4-1 of the Eco-SSL guidance or chemical-specific Eco-SSL derivation documents. However, as discussed in the text and presented in Tables 4 and 5, it is not sufficiently clear which of the alternative BAFs and equations in Tables 4 and 5 are the preferred default values/method and which are alternatives. Please revise the text for greater clarity about the hierarchy of BAFs/methods and add a sentence clearly stating that the soil-concentration-based earthworm BAFs and algorithms published by USEPA (April 2007) in Tables 4a, 4b and 4c of the *EcoSSL Guidance Attachment 4-1* are the default choices and supersede those derived from other sources or methods. Also, please revise Table 4 to: (a) replace the soil invertebrate equation for copper from Sample et al (1998a) with the BAF of 0.515 from the EcoSSL guidance [also used in Sample 1999]; and (b) add the missing earthworm BAFs for antimony (1.0), beryllium (0.045), chromium (0.306), and cobalt (0.122) that are provided in the EcoSSL documents.

***Navy Response:***

The protocol blueprint indicated that the Eco-SSL document would be "preferentially considered" as a source of these values (and TRVs), not that it would be the default source. Since the derived Eco-SSL values for birds/mammals are applied in a pre-screening step as part of the protocol, the Eco-SSL methodology, in its entirety, is incorporated indirectly in the Screening ERA (Step 2). Table 5 provides soil invertebrate BAF values based upon point estimates or models (using log $K_{ow}$) while Table 4 provides regression equations to calculate soil invertebrate BAFs from soil concentrations. The use of point estimates or regression equations will be made on a site-specific basis as part of the site-specific interim deliverable.

In response to 6(a) and 6(b), these values are included in Table 5 (since they are point estimates) but were derived from the original source document (Sample et al. 1998) and so differ slightly from those reported in the Eco-SSL document. Also, differences in

reported values between Sample et al. (1998) and Sample et al. (1999), both of which were considered in the Eco-SSL document, will be investigated and the most appropriate values will be used in Tables 4 and 5.

***Group 1 comment:*** Discussed during the 10 December 2009 call. See Comments 4 and 5. In addition, the Navy agreed to: (1) re-check the derivation of the antimony BAF in Table 5 and either justify the use of the value or withdraw the value and use the "default" value of 1.0; (2) investigate the BAF values in Table 5 for chromium and copper to identify differences between values derived in Sample et al. (1998) versus Sample et al. (1999) and change the values if appropriate; and (3) explain the rationale for the selection of the BAF values for PAHs in Table 5 (Eco-SSL modeled values versus literature-based measured median values; see the response to Comment 8).

7. Table 4, Plants, Soil Invertebrates and Mammals. Please review and revise Table 4 to add all of the missing inorganic and organic chemical BAFs for plants, soil invertebrates, and/or small mammals that were presented in Tables 4a, 4b, and 4c of the *EcoSSL Guidance Attachment 4-1*, such as barium, chromium, cobalt, manganese, silver, vanadium, RDX, TNT, PAHs (individual, LWM, HMW and Total), pentachlorophenol, dieldrin, DDT, and DDT metabolites. Please also cross check the small mammal BAF algorithms from Sample et al. (1998) against those from the Eco-SSL guidance and revise the table as needed to include and indicate that the Eco-SSL BAFs/equations supersede the Sample equations. Please revise text references to small mammal BAFs/equations in Table 4 to clearly indicate that the preferred, default BAFs/algorithms are those presented in the Eco-SSL guidance.

***Navy Response:***

The protocol blueprint indicated that the Eco-SSL document would be "preferentially considered" as a source of these values (and TRVs), not that it would be the default source. Since the derived Eco-SSL values for birds/mammals are applied in a pre-screening step as part of the protocol, the Eco-SSL methodology, in its entirety, is incorporated indirectly in the Screening ERA (Step 2). Table 4 will be reviewed and any missing equations will be added as appropriate (also, please see the responses to Specific Comments 5, 6, 8, 9, and 10).

***Group 1 comment:*** Discussed during the 10 December 2009 call. See Comments 4 and 5. In addition, the Navy agreed to consider the Eco-SSL-derived values for RDX and TNT during its compilation of BAFs for explosive compounds (explosive compounds, plus perchlorate, will be added to the BAF and TRV tables per the response to EPA Specific Comment 2b). Also, EQB agreed to send the Navy a link to an explosives data base developed for Los Alamos (received 12/10/2009), and the Navy agreed to evaluate this data base and incorporate any useful and relevant information it may contain.

8. Table 5, Soil Bioaccumulation Factors for Soil Invertebrates. BAFs and equations are available in Tables 4a, 4b and 4c of *EcoSSL Guidance Attachment 4-1*, but were not presented in Table 5, for 13 inorganics and several organics. Please revise and footnote Table 5 to replace or complement the invertebrate BAFs with all available BAFs or algorithms

presented in these Eco-SSL guidance tables and state that these Eco-SSL derived BAFs supersede those derived from other sources or methods and represent the default choices for the Baseline ERA. For example, the median values for individual PAHs from Beyer & Stafford (1993) proposed for use in the Baseline ERA need to be replaced by the values used to derive Eco-SSLs. Please also: (a) replace the incorrect value of 11.2 applied to DDD, DDE and DDT with the chemical-specific algorithms for DDT, DDD, and DDE from Table 4b of the *EcoSSL Guidance Attachment 4-1*; (b) add an entry of 11.2 for "*DDT, DDD and DDE Combined*" from the same EcoSSL table; and (c) add missing BAFs/equations from the Eco-SSL tables for individual PAHs, including coronene and naphthalene (now missing from Table 5), as well as Totals MLW and HMW PAHs.

***Navy Response:***

The protocol blueprint indicated that the Eco-SSL document would be "preferentially considered" as a source of these values (and TRVs), not that it would be the default source. Since the derived Eco-SSL values for birds/mammals are applied in a pre-screening step as part of the protocol, the Eco-SSL methodology, in its entirety, is incorporated indirectly in the Screening ERA (Step 2). The Eco-SSL values for PAHs, which are modeled values, are proposed for use in the SERA. Since the Beyer and Stafford values are measured and represent a central tendency estimate (median), their use is proposed for the BERA.

In response to: 8(a) and 8(b), these algorithms are included in Table 4; the total DDT value (11.2) is applied to 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in Table 5 since total DDT is not directly measured (i.e., is not a facility analyte); and 8(c), see above; there are no regression equations for individual PAHs in the Eco-SSL document related to soil invertebrate BAFs. Coronene, naphthalene, and TPAH are not food web analytes.

***Group 1 comment:*** Discussed during the 10 December 2009 call. See Comments 4 and 5. Following the three calls, EQB voiced concern, in its review of the post-call version of this document, with the omission of available BAFs for selected PAHs because, if total PAHs (HMW and/or LMW) exceeds its mammalian Eco-SSL in Step 2, PAHs will become food web COPCs for which BAF values will be required. In this instance, it is the Navy's position that the individual PAHs subsequently evaluated will default back to the bioaccumulative chemicals list (Table 2), which includes all but a few of the PAH compounds used to derive the mammalian Eco-SSL.

9. Page 9, Small Mammals. Please revise the text on small mammal BAFs/equations to clearly state that the preferred, default small mammal BAFs and uptake algorithms are those presented in the Eco-SSL guidance. Please insert new sentences after the 2nd sentence of the first paragraph stating: "*The soil-to-small mammal BAFs and equations provided in Tables 4a, 4b and 4c of Attachment 4-1 of the Eco-SSL Guidance (USEPA, 2007) will be the default choice for calculating small mammal COPC body burdens. For COPCs lacking small mammal BAFs and algorithms from the Eco-SSL guidance, the proposed BAF or uptake equation will be proposed in an Interim Technical Memorandum.*"

***Navy Response:***

The protocol blueprint indicated that the Eco-SSL document would be "preferentially considered" as a source of these values (and TRVs), not that it would be the default source. No changes to the text are warranted.

***Group 1 comment:*** Discussed during the 10 and 17 December 2009 calls. See Comments 4 and 5. In addition, it was agreed that: (1) the herbivore and insectivore values and equations will be retained in Tables 4 and 6 even though they are not expected to be used based upon how the small mammal receptors are typically modeled (as omnivores in Step 3A); (2) the equations for omnivorous mammals in Table 4 will be used even if the Eco-SSL equation is based upon a herbivore or insectivore equation and thus differ; and (3) the Eco-SSL BAFs for antimony, barium, and beryllium, which incorporate a cattle biotransfer factor, will not be used in place of the existing values.

In addition, there was discussion about adding bat species as potential receptors. It was agreed that individual species of bats will be considered on a site-specific basis during the development of the site-specific conceptual model as part of the interim deliverable. A statement to this effect will be added to the ERA protocol in Section 1.2.1.2 (Upper Trophic Level Receptors). Receptor-specific parameter values (e.g., body weight) will be provided as part of the site-specific interim deliverable for any bat species that are used.

10. Table 6, Soil Bioaccumulation Factors for Small Mammals. As noted previously for Table 4, the preferred small mammal BAFs and uptake equations are those from Tables 4a, 4b and 4c of *EcoSSL Guidance Attachment 4-1*. Please footnote this table to indicate that these BAFs represent alternatives to be used only when the default, Eco-SSL derived BAFs/equations are not available. Please also discuss the intended use of the values in Table 6 at various steps in the ERA process and explain how and why these values differ from those in Table 4 for the same three small mammal feeding guilds. Also, please add a footnote to the Reference column entries of "See text" citing specific text sections and generically explaining the default method to be used for each chemical, such as a reported BAF, algorithm, etc.

***Navy Response:***

The protocol blueprint indicated that the Eco-SSL document would be "preferentially considered" as a source of these values (and TRVs), not that it would be the default source. Since the derived Eco-SSL values for birds/mammals are applied in a pre-screening step as part of the protocol, the Eco-SSL methodology, in its entirety, is incorporated indirectly in the Screening ERA (Step 2).

A footnote will be added to Table 6 indicating the specific text section that is being referenced. Table 6 provides BAF values based upon point estimates while Table 4 provides regression equations to calculate BAFs from soil concentrations. The use of point estimates or regression equations will be made on a site-specific basis as part of the site-specific interim deliverable.

***Group 1 comment:*** Discussed during the 10 December 2009 call. See Comments 4, 5, and 9.

11. Page 9, Benthic Invertebrates. Please add the following sentence to the end of the last paragraph on page 9: "*For COPCs lacking benthic invertebrate BAFs in Table 7, the proposed BAF or uptake equation will be proposed in an Interim Technical Memorandum*."

***Navy Response:***

The purpose of adding this sentence is unclear. The values in Tables 4 and/or 7 will be used at a site unless there are site-specific reasons for modifying the values (which will be documented in the site-specific interim deliverable) or if new information becomes available. Both of these possibilities were outlined in the introduction to the protocol (page 1).

***Group 2 comment:*** Discussed during the 17 December 2009 call. It was agreed that additional efforts will be made (e.g., additional literature searches), on a site-specific basis, to develop BAF values for chemicals lacking such values that will likely be "risk drivers" at the site. Where warranted, the collection of site-specific data (e.g., tissue residue samples) may be proposed to directly address these data gaps for key COPCs. If the chemical is not a key COPC, the limitations of the available data will be addressed as an uncertainty in the ERA. This process will be added to the text of the ERA protocol.

12. Table 7, Sediment Bioaccumulation Factors for Benthic Invertebrates (Dry Weight). Based on a review of several source documents, it appears that the values presented in Table 7 are a combination of bulk sediment to invertebrate BAFs and sediment-TOC and invertebrate-lipid normalized biota-sediment accumulation factors (BSAFs). To clearly distinguish and segregate sediment BAFs from BSAFs for benthic invertebrates within the protocol, please include a separate table of TOC and lipid normalized BSAFs that will be used preferentially over the sediment-invertebrate BAFs presented in Table 7. Please note that the preferred BSAFs are TOC and lipid normalized values derived from the USEPA and/or Army Corps of Engineers online BSAF databases, such as those for DDD, DDE, DDT, dieldrin, endosulfan compounds and heptachlor compounds. As requested previously for Table 2, please also revise Table 7 to add BAFs for all of the bioaccumulative chemicals that appear in Table 4-2 of the USEPA (2000) sediment guidance, such as dioxins, furans, nine pesticides noted by EPA (2000) as having BCFs > 1,000 and log Kow > 4.2, pentachlorophenol, bis(2-ethylhexyl)phthalate, other phthalates and tributyl tin.

***Navy Response:***

Values are BAFs unless footnoted; any BSAF values are converted to BAFs. The BSAF databases cited in the comment were considered to fill in data gaps but most of the data were for bivalves (not macroinvertebrates such as polychaetes). Because the applicable upper trophic level receptor of interest for this exposure pathway (spotted sandpiper) consumes macroinvertebrates, BAFs based upon macroinvertebrate species were preferentially used while data for bivalves were not.

The full list of bioaccumulative chemicals will be included in Table 2, but the chemicals will not be included in subsequent tables (such as Table 7) unless they are typically sampled for at Vieques (these will be clearly identified in the revised Table 2). Should a compound not typically sampled for be sampled at a specific site, the applicable BAF

values, etc. will be derived and included in the site-specific interim deliverable. This process will ensure that effort is not wasted developing values that have a very low probability of ever having been used at the facility or ever being sampled for during investigation while providing a mechanism, prior to the conduct of the ERA, to allow regulatory review of the values for any "new" chemicals.

***Group 2 comment:*** Discussed during the 17 December 2009 call. It was agreed that Table 7 (and Table 8) will be modified to clearly indicate the basis for the value (BAF versus BSAF). See also Comment 13.

13. Table 7, Sediment Bioaccumulation Factors for Benthic Invertebrates (Dry Weight). Many of the BAFs or BSAFs provided in Table 7 are much lower than values for benthic macroinvertebrates available from the cited source or other sources of measured bioaccumulation factors for sediments. For example, all of the polychaete BSAFs from Maruya (1997) are listed in Table 7 as being maximum reported invertebrate BAFs; however, higher values are available in this source document. Please replace those polychaete values with the highest of the BSAFs reported by Maruya for two species of clams from his Tables 2 and 3 (e.g. acenaphthylene BSAF of 5.42 for the Asian clam rather than 2.04 for a polychaete worm). Some of the 90th percentile sediment BAFs chosen from Bechtel Jacobs (1998b) were for depurated invertebrates while others were based on all pooled data for depurated and non-depurated organisms, so that the highest BAFs were not consistently chosen (e.g. lowest depurated BAF of 0.21 was chosen for nickel rather than the non-depurated BAF of 3.15). Since BAFs are used to assess worst-case ingestion exposures of wildlife from eating invertebrates (including their gut content), please consistently use the highest of the BAFs available within this source document, unless more conservative/protective values are available from other sources. For example, several of the inorganic BAFs from Bechtel Jacobs (1998b) are much lower than empirical BAFs reported in other literature for marine bivalves, such as those reported for oysters and mussels under the NOAA Mussel Watch Program by Thomann et al. (1995). Please replace the lower values for these metals in Table 7 with the more conservative/protective mean values from Thomann et al. for arsenic (2.4), cadmium (35.6), copper (19.2) and selenium (8). Please clarify whether the most up-to-date values and available references have been used from leading peer reviewed journals focused on ecological risk assessment, such as Environmental Toxicology and Chemistry (searchable online), including empirical values from the many studies published by Lawrence Burkhard of the USEPA. Also, since the basis/derivation of the proposed BAF of 0.18 for silver from Hirsch (1998) is unknown, please use a better documented value from another source or an assumed BAF of 1.0. Since BAFs are higher for methyl mercury than inorganic mercury, also please add a BAF and/or BSAF for methyl mercury.

***Navy Response:***

Please see the response to Specific Comment 12 regarding the preferential use of macroinvertebrate data relative to bivalve data. Thus, the selected values from Maruya (1997) are appropriate as is, but an explanation will be added to the text. Similarly, consideration of the Thomann et al. (1995) reference is not warranted.

As indicated in the text at the top of page 10, depurated analyses were preferred over undepurated analyses because direct ingestion of sediment was included as a separate component in the food web model. However, in some cases, the depurated data set was limited or highly variable, and the pooled or undepurated data were then considered. For these cases, footnotes will be added to Table 7 explaining the rationale for the values selected.

A comprehensive search of the primary literature was not conducted for all analytes but key references from the primary literature were considered. The value for silver will be revisited and revised as appropriate, or the default value (1.0) will be applied. Mercury BAFs are for total mercury, which is what is measured in sediment samples collected at Vieques sites. A specific BAF for methyl mercury will be developed as part of a site-specific interim deliverable should this form of mercury ever be measured in sediment.

***Group 1 comment:*** Discussed during the 10 and 17 December 2009 calls. See Comments 4 and 5. The Navy agreed to: (1) revisit the values in Table 7 (e.g., conduct additional searches of BSAF data bases, including Army Corps of Engineers and USEPA, and review the values used in the SWMU 4 HHRA); (2) develop separate sets of BAFs for bivalves and macroinvertebrates (e.g., insects) in the protocol, where available data allow, with the appropriate set to be selected in the site-specific interim deliverable based upon habitat conditions; and (3) consider developing separate sets of values for freshwater and marine where data permit.

14. Table 7, Sediment Bioaccumulation Factors for Benthic Invertebrates (Dry Weight). Please clarify whether the potential use of the BSAF regressions developed by Bechtel Jacobs (1998b) or other published sources was considered for some chemicals, and if so, why their potential use in the baseline ERA was not proposed.

***Navy Response:***

Available regression equations are provided in Table 4. The use of point estimates or regression equations will be made on a site-specific basis as part of the site-specific interim deliverable.

***Group 3 comment:*** Response accepted without additional discussion or comment (but see Comment 5).

15. Page 10, Fish. Please expand the discussion to more clearly and explicitly explain how and when the following three methods will be chosen and used to estimate whole body COPC concentrations in Trophic Level 3 (TL 3) fish: (a) biota:sediment bioaccumulation factors (BSAFs) that are normalized for TOC content in sediments and lipid content in fish [default 1st choice]; (b) bulk fish:sediment fish:sediment BAFs, such as those in Table 8 [2nd option]; and fish:surface water bioconcentration factors (BCFs)[last resort]. The use of TOC/lipid normalized BSAFs is the preferred approach and sources of fish BSAFs include USEPA and Army Corps of Engineers BSAF databases. Please compile a new table of available BSAFs, derived from the Army Corps and USEPA databases and other sources, that will serve as

default BSAFs for TL 3 fish in future ERAs. Since there may be situations requiring the use of fish:surface water BCFs, please also discuss the approach to be used in that scenario, including how USEPA guidance will be applied to estimate whole fish COPC burdens (e.g., use of site-specific, national BAFs to derive fish-ingestion based human health and ecological ambient water quality criteria). Please compile available surface water:fish BCFs, such as those provided in Table 3 of Sample et al. (1996) and explain how they will be used in piscivorous food chain models. Please add the following sentence to the end of this section on page 10: "*For COPCs lacking fish:sediment BAFs in Table 8, the proposed fish:sediment BAF, fish:sediment BSAF, fish:water BCF, or other sediment/water based uptake equation will be proposed in an ERA Interim Technical Memorandum*."

***Navy Response:***

BSAFs, where utilized, were converted to BAFs as noted in the table. The USEPA BSAF database was a potential source of data but does not warrant a separate table. It is unlikely that water-based BAFs will be used for any Vieques site. If their use is warranted at a specific site, the approach and necessary BAF values will be developed as part of the site-specific interim deliverable. The low probability of this occurring does not warrant the inclusion in this protocol since it would require a considerable effort to accomplish this task.

The purpose of adding this sentence is unclear. The values in Table 8 will be used at a site unless there are site-specific reasons for modifying the values (which will be documented in the site-specific interim deliverable) or if new information becomes available. Both of these possibilities were outlined in the introduction to the protocol (page 1).

***Group 1/2 comment:*** Discussed during the 17 December 2009 call. The Navy indicated that BSAFs will be preferred values for organic chemicals and agreed to: (1) revisit the values in Table 8 (e.g., conduct additional searches of BSAF data bases, including Army Corps of Engineers and USEPA, and review the values used in the SWMU 4 HHRA), particularly for organic chemicals whose current values are based upon BAFs (e.g., Oliver and Nimmi 1988); (2) add text to complement footnote clarification as to how BSAFs were converted to BAFs in Table 8; and (3) consider developing separate sets of values for freshwater and marine where data permit.

16. Table 8, Sediment Bioaccumulation Factors for Fish. Please clarify if the values presented in Table 8 are bulk sediment to fish BAFs or if they are sediment-TOC and fish-lipid normalized biota-sediment accumulation factors (BSAFs). The preferred values are TOC and lipid normalized BSAFs, but it appears from the footnote that only 3 of the values are normalized BSAFs. Therefore, if the majority of the values are BAFs, please include a separate table of TOC and lipid normalized BSAFs that will be used preferentially over the sediment-fish BAFs presented in this table. Also, since BAFs are higher for methyl mercury than inorganic mercury, a BAF and/or BSAF needs to be added for methyl mercury.

***Navy Response:***

Please see the response to Specific Comment 15. Mercury BAFs are for total mercury, which is what is measured in sediment at Vieques sites. If methyl mercury analysis is ever warranted, it is highly likely that site-specific fish tissue sampling would be required, which would render a literature-based fish BAF superfluous.

***Group 1/2 comment:*** Discussed during the 17 December 2009 call. See Comment 15. The Navy agreed to propose a site-specific approach for methyl mercury in a site-specific interim deliverable, as needed, to either develop literature-based BSAFs/BAFs or conduct tissue analyses.

17. Page 11 and Table 9. Please add footnotes to provide the allometric equations used to derive each food and water ingestion rate and provide a literature source citation for the equations. Please add notes to the table indicating the assumed age and sex of each species for which the body weights were chosen (e.g., red-tailed hawk weight of 0.957 kg is for an adult male). Please expand the text discussion on page 11 to explain the rationale for age and sex-based parameter choices. Please clarify why: (a) the spotted sandpiper body weight from Dunning (1993) was used instead of that from the Wildlife Exposure Factors Handbook (WEFH; USEPA 1993a); (b) the red-tailed hawk food ingestion rate from Sample and Suter (1994) was chosen rather than using the food ingestion rate from the WEFH or an allometric equation; and (c) why allometric equations are sometimes used rather than factors published in the WEFH (e.g., water ingestion rates for red-tailed hawk and spotted sandpiper).

***Navy Response:***

The allometric equations and references will be added to the document. The table will be annotated to indicate the basis for the body weights and the text will include the rationale for the choices. In addition: 17(a) the WEFH value was from Minnesota; the Dunning value was somewhat more geographically appropriate (Pennsylvania, which is at a lower latitude); 17(b) the WEFH value was for captive animals; and 17(c) the WEFH rates were also based upon allometric factors but used other values for body weights.

***Group 3 comment:*** Response accepted without additional discussion or comment.

18. Page 11 and Table 10. Please add footnotes to provide the allometric equations used to derive each food and water ingestion rate and provide a literature source citation for the equations. Please add notes to the table indicating the assumed age and sex of each species for which the body weights were chosen. Please expand the text discussion on page 11 to explain the rationale for age and sex-based parameter choices. Please also clarify why: (a) the spotted sandpiper body weight from Dunning (1993) was used instead of that from the WEFH (USEPA 1993a); and (b) the red-tailed hawk body weight, food ingestion rate, and home range from Sample and Suter (1994) were chosen rather than values from the WEFH.

***Navy Response:***

The allometric equations and references will be added to the document. The table will be annotated to indicate the basis for the body weights and the text will include the rationale for the choices. In addition: 18(a) the WEFH value was from Minnesota; the Dunning value was somewhat more geographically appropriate (Pennsylvania, which is at a lower latitude); 18(b) the hawk body weight will be changed to 1.134 kg (average of the 6 adult values reported in the WEFH); the WEFH food ingestion rate value was for captive animals; the hawk home range will be changed to 859 ha (the average of the 3 values reported in the WEFH).

***Group 3 comment:*** Response accepted without additional discussion or comment.

19. Page 12, Effects Assessment, Uncertainty Factors and Table 11. An uncertainty factor (UF) of 10 needs to be used to derive a NOAEL/NOEC from a LOAEL/LOEC, rather than the UF of 5, as was listed in Table 11 and used to modify many of the TRVs from those originally derived and published by USEPA in the Eco-SSL documents and/or by Sample et al. (1996). Since the preferred choice of TRVs is those used to derive Eco-SSLs and the second option is usually the TRVs from Sample (1996), the UFs applied in those original TRV derivations need to be retained. The TRVs derived with a UF or 10 in the more recent Eco-SSL guidance documents not only passed a rigorous, scientific quality assurance review but also supersede the older UF of 5 published by Wentsel (1996) from a regulatory perspective under CERCLA.

***Navy Response:***

As noted in Attachment 4-5 of the Eco-SSL guidance, approximately 85 percent of the LOAEL values for mammals and 90 percent for birds are within a factor of 5 of the respective paired NOAEL value. However, a factor of 10 was selected for conservatism as the Eco-SSLs are designed to be conservative screening criteria and about 97 percent of the LOAELs are within a factor of 10 of the paired NOAELs. Since the derived Eco-SSL values for birds/mammals are applied in a pre-screening step as part of the protocol, this conservatism is incorporated indirectly in the ERA. The use of a factor of 5 within the overall UF scheme in the subsequent food web modeling is appropriate since it is fully consistent with the derivation of other parameters (e.g., BAFs based upon the 90$^{th}$ percentile values in the SERA and central tendency estimates in the BERA).

Where an individual study reports both a NOAEL and LOAEL and this study is selected for use in the Eco-SSL or ORNL documents, the reported values for both are used in the protocol without any modification. However, where only a NOAEL is reported, the UFs from Table 11 are applied and not the factor of 10. Tables 20 and 21 will be modified to place the reference cited only next to actual reported values and not to the extrapolated ones derived using the UFs in Table 11.

***Group 1 comment:*** Discussed during the 10 and 15 December 2009 calls. EQB voiced concern that not all of the uncertainty factors (UF) in Table 11 are adequately protective of wildlife receptors, such as the LOAEL-to-NOAEL UF value of 5. However, EQB deferred to USEPA's acceptance of this UF of 5. See also Comments 34 and 35.

20. Page 12, Medium-Specific TRVs. As noted in the general comments, only the ingestion based wildlife TRVs need to be included in this subsection of the Effects Assessment, whereas the medium-specific ESVs need to appear much earlier in the discussion of COPC screening during Step 2 of the ERA.

    ***Navy Response:***

    Please see the response to General Comment 2.

    ***Group 3 comment:*** Response accepted without additional discussion or comment.

21. Page 16, Effects Assessment, Ingestion TRVs. Please insert an introductory paragraph in this subsection to explain that: (a) TRVs derived and applied by USEPA in developing wildlife EcoSSLs will be used preferentially as the default choice of TRVs for birds and mammals; and (b) the Eco-SSL TRVs and those from Sample et al. (1996) will be used without modifying or readjusting the LOAEL-to-NOAEL UF of 10 applied by the original authors of the TRVs.

    ***Navy Response:***

    The protocol blueprint indicated that the Eco-SSL document would be "preferentially considered" as a source of TRVs, not that it would be the default source. Please see the response to Specific Comment 19. No changes to the text are warranted.

    ***Group 1 comment:*** Discussed during the 15 December 2009 call. After the Navy consultants explained that only two proposed TRVs differed from those available in the Eco-SSL guidance (DDT for birds and selenium for mammals), EQB accepted these two TRVs. See Comments 19, 34, and 35 .

22. Risk Characterization, page 17. Since a HQ equal to or greater than one indicates the potential for risk, please delete the phrase "*or equal to*" from the final sentence of the first paragraph so it states that: "*Following the same reasoning, HQs less than one indicate that unacceptable risks are unlikely, enabling a conclusion of negligible (acceptable) risk to be reached with high confidence*."

    ***Navy Response:***

    The paragraph will be modified as requested in the comment.

    ***Group 3 comment:*** Response accepted without additional discussion or comment.

23. Page 17, Risk Characterization. To distinguish ESVs from TRVs, please revise the sentence introducing the first set of bullets to state that: "*In addition to media concentrations or ingested doses of chemicals that respectively exceed ESVs or TRVs, based upon maximum detected*

*concentrations, the following will also apply to COPC selection at Step 2:*" Also, since it is not appropriate to compare MDLs to ingestion-based TRVs, unless COPC concentrations are being measured in food items, please revise the first bullet here to replace the term "*TRV*" with the phrase "*ESV for that medium*".

***Navy Response:***

The text will be modified as requested in the comment. However, note that reporting limits are used for media concentrations to calculate ingestion doses for bioaccumulative chemicals that are not detected in any site sample of the appropriate medium.

***Group 3 comment:*** Response accepted without additional discussion or comment.

24. Page 17, Risk Characterization, Step 3A. Please insert a subheading labeled Step 3A – Refinement of COPCs before the sentence introducing the 2nd set of bullets at the bottom of the page.

***Navy Response:***

The document will be restructured with subheadings to clearly differentiate the SERA from the BERA discussion.

***Group 3 comment:*** Response accepted without additional discussion or comment.

25. Page 18, Risk Characterization, Vieques-Wide Background Concentrations. Please add a statement to emphasize that refinement of COPCs using background comparisons is acceptable only for inorganic COPCs.

***Navy Response:***

While background UTLs have only been formally calculated for metals, background considerations have also been applied to pesticides, PAHs, and dioxin/furans at numerous Vieques sites. This will continue, as appropriate.

***Group 2 comment:*** Discussed during the 17 December 2009 call. It was agreed that background soil values for pesticides derived previously will be added to the ERA protocol. Background considerations for dioxin/furans and PAHs will be addressed on a site-specific basis, as appropriate.

26. Page 18, Risk Characterization, Use of Background Data in CERCLA. Please insert a closing sentence before the Uncertainties section, to state that the use of background in ERA and other CERCLA documentation for Vieques sites will also conform to USEPA guidance on refining COPCs during ERA Step 3A (ECO-Update of June 2001: EPA 540/F-01/014) and on the Use of Background at CERCLA Sites (USEPA, September 2002: EPA 540-R-01-003).

***Navy Response:***

Please see the response to Specific Comment 25. Since a process already exists at Vieques for background evaluations, citing additional guidance is not necessary.

***Group 2 comment:*** Discussed during the 17 December 2009 call. It was agreed that the original response was acceptable if edited as shown above.

27. Table 12, Fresh Surface Water TRVs. Please revise table title to say ESVs instead of TRVs and modify the entries for chromium and mercury to indicate they are for hexavalent chromium and inorganic mercury. Several available ESVs [e.g., PR WQS, NAWQC, etc.] are missing from the table, such as boron, trivalent chromium, molybdenum, tributyl tin and methyl mercury [Buchman 2008 Tier 2 SAV value of 0.0028 µg/L]. Please revise the ESVs to conform to the agreed hierarchy of ESVs, such as cobalt and vanadium. USEPA (1996a) Ecotox Thresholds (ETs) are preferred over the values from Suter and Tsao (1996). Please use available PR WQS, NAWQC or ETs preferentially in Table 12. Examples where PR WQS, NAWQC or ETs are available but were not listed in the table or other values were used rather than values from these preferred sources include benzene, chlorpyrifos, coumaphos, demeton, malathion, mirex, DDT, DDD, DDE, heptachlor, heptachlor epoxide, toxaphene, and Total PCBs [NAWQC of 0.014 µg/L for Total PCBs supersede Suter & Tsao (1996) ESVs for individual Aroclors].

***Navy Response:***

The table title will be revised per the response to General Comment 1. Where a value is based upon a specific form or species, it will be specified. Note that these tables are not intended as a complete compilation of values for all chemicals; only the chemicals that are routinely analyzed for at Vieques are included. Thus, chemicals such as boron and molybdenum are not included. If a specific site does include these analytes in the future, the appropriate ESVs will be derived and included in the site-specific interim deliverable.

The table will be checked for consistency with the specified hierarchy. However, the protocol contains a provision (see Section 1.2.2.2; page 12) that allows the hierarchy to be modified under some circumstances. For example, the protocol states (bottom of page 12) that a final chronic value (FCV) or secondary chronic value (SCV) will be used in place of a final residue value (FRV) if available (e.g., PCBs). Note that PR WQS values based upon human health (e.g., benzene) were not used; only aquatic life criteria were considered. Similarly, and consistent with the protocol process, EcoTox thresholds based upon an older (1994) version of the ORNL values were not used if a later (1996) ORNL value existed (e.g., benzene, cobalt, vanadium).

***Group 3 comment:*** Response accepted without additional discussion or comment.

28. Table 13, Marine Surface Water TRVs. Please revise table title to say ESVs instead of TRVs, modify the entries for chromium and mercury to indicate they are for hexavalent chromium and inorganic mercury and add ESVs for many missing chemicals such as boron, cobalt, trivalent chromium, chlorpyrifos, coumaphos, demeton, fenthion, malathion, molybdenum, methyl mercury, and tributyl tin. Please recheck and replace other ESV choices for which PR WQS, NAWQC or ETs are available, including endrin [use endrin NAWQC and PRWQS for all 3 endrin compounds] and toxaphene. Please also add footnotes to define the acronym entries in the "Type" column of the table.

    ***Navy Response:***

    Please see the response to Specific Comment 27. Footnotes will be added as requested (applies to all ESV tables).

    ***Group 3 comment:*** Response accepted without additional discussion or comment.

29. Table 14, Freshwater Sediment TRVs. Please revise table title to say ESVs instead of TRVs and add ESVs for missing chemicals such as values for heptachlor, methoxychlor, and toxaphene presented in from MacDonald et al. (2000), EPA (1996a), and Buchman (2008).

    ***Navy Response:***

    The table title will be revised per the response to General Comment 1. Note that ESVs for chemicals such as methoxyclor and toxaphene are included in Table 16 since they are based upon equilibrium partitioning.

    ***Group 3 comment:*** Response accepted without additional discussion or comment.

30. Table 15, Marine Sediment TRVs. Please revise table title to say ESVs instead of TRVs and add ESVs for missing chemicals such as TEC values for 3 of 4 BHC isomers (Buchman, 2008), 2 chlordane isomers, DDT, DDD and DDE combined (ERL of 1.58 µg/kg), 2 endrin compounds, and Total PCBs (ERL of 22.7 supersedes TECs listed in table for individual Aroclors). Please clarify whether all the values in the table conform to the agreed default ESV reference hierarchy. It appears that some deviate from the default hierarchy and some values that are available in the preferred references are not included in the table. For example, the preferred ESV for all Arochlors is an ERL of 22.7 µg/kg, which differs from what is presented in this table, the dieldrin ERL of 0.02 µg/kg is the preferred ESV, and the default value for three BHC isomers of 0.32 µg/kg (Buchman, 2008) is not included in the table. Please identify those that deviate from the agreed hierarchy and clarify why each of the alternative ESVs is proposed. Note that it is EQB's understanding that modifications to the agreed default ESVs would be presented in site-specific interim deliverables. Please apply surrogate ESVs for similar chemicals (e.g., ER-L for endrin to other endrin compounds, same for heptachlor). As agreed upon in the protocol blueprint, please also list in the comment field the test species for which the ESV was developed, such as the AETs listed in Buchman (2008) AETs (e.g., amphipod, Neanthes, echinoderms). This information is necessary to identify those receptors for which the ESV is protective.

***Navy Response:***

The table title will be revised per the response to General Comment 1. The table will be checked for consistency with the specified hierarchy. There are no values reported in Buchman (2008) for alpha, beta, or delta BHC in marine sediment; values for the two chlordane isomers are included in the table; total DDT is not directly measured (i.e., is not a facility analyte); there are no values for endrin ketone or endrin aldehyde; the PCB value used is a consensus-based TEC (that incorporates the ER-L) and so was considered a better value than the ER-L. The protocol contains a provision (see Section 1.2.2.2; page 12) that allows the hierarchy to be modified under some circumstances.

The Navy will consider applying surrogate ESVs to similar chemicals, where appropriate. The taxa on which the AET values were based will be added to the table where available information permits.

***Group 1 comment:*** Discussed during the 15 December 2009 call. It was agreed that: (1) the comment column in Table 15 (and other ESV tables) will be revised to explain key deviations from the hierarchy of source documents; (2) the PCB value based upon the TEC was acceptable; (3) the value for gamma-BHC will be used as a surrogate for the other BHC isomers (in general, there should be consistency in the application of surrogate values); (4) 1990 ER-L values are not part of the formal hierarchy and were considered if no better value was available; this will be explained in the protocol text; (5) use of the TEL values for chlordane and dieldrin in place of the 1990 ER-L values was acceptable (see (4)); (6) the values for DDD and DDT will be changed to the TEL (1.22 and 1.19, respectively); (7) values based upon the Washington State document will be checked to see if any changed in the later 1995 version, which will be cited; and (8) the specific table from which values were obtained from the cited source will be specified, as appropriate (global comment for the ESV tables).

31. Table 16, Freshwater Sediment Values Based on Equilibrium Partitioning. Please clarify whether all values presented in this table follow the preferred hierarchy and if not, provide the rationale for deviating from the agreed upon hierarchy. For example, numerous Washington State 1991 values were used even though values from USEPA 1996 are available. It is EQB's understanding that modifications to the agreed default ESVs would be presented in site-specific interim deliverables. Please provide additional information in the Comment field to note which water quality standard (e.g., PRWQS, AWQC or secondary chronic values) were used to derive the sediment ESVs. This information is needed to ensure that the most up-to-date values were used in the calculation of these values. Similarly, please note which of the USEPA (2008b) values were derived via conventional methods *versus* use of the narcosis model for EqP-based ESVs and clarify why the selected method was used.

***Navy Response:***

The table will be checked for consistency with the specified hierarchy. No Washington State values were used for freshwater. In Table 17 (marine), no Washington State value was used in place of an EcoTox threshold based upon equilibrium partitioning. Where

available information permits, the water value on which the sediment value was derived will be specified. All USEPA (2008b) values were based upon the conventional model since narcosis is such a nebulous endpoint.

***Group 3 comment:*** Response accepted without additional discussion or comment.

32. Table 17, Marine Sediment Values Based on Equilibrium Partitioning. Please clarify whether all values presented in this table follow the preferred hierarchy and if not, provide the rationale for deviating from the agreed upon hierarchy. It is EQB's understanding that modifications to the agreed default ESVs would be presented in site-specific interim deliverables. For example, bulk sediment ETs of EPA (1996a) take precedence over bulk sediment ESVs in Jones et al. (1997) and the USEPA Region III BTAG values (which were not identified in the protocol blueprint), but these documents are sources of Eq-P based ESVs. Please explain why the Eq-P based sediment SQBs/SQC from USEPA (1996a) were not used preferentially instead of values such as those from Washington State (1991) or USEPA Region III BTAG (2000b). To assure adequate conservatism in the ERA, please revise the table to include the lower of these alternative EqP-based ESVs, from USEPA (1996a) and other sources. Please review the table against available ESV sources and add values now missing for some chemicals, such as bromophenyl ether and diazinon. Please add comments to the table to note which of the USEPA (2008b) values were derived via conventional methods versus use of the narcosis model for EqP-based ESVs and clarify why the selected method was used.

***Navy Response:***

The table will be checked for consistency with the specified hierarchy. Values from Jones et al. (1997) are not applicable to marine systems. In freshwater (Table 16), there were no instances in which an ORNL (or Region 3) value was used where an EcoTox value based upon equilibrium partitioning existed. See also the response to Specific Comment 31.

Note that these tables are not intended as a complete compilation of values for all chemicals; only the chemicals that are routinely analyzed for at Vieques are included. Thus, chemicals such as diazinon are not included. If a specific site does include this or other such analytes in the future, the appropriate ESVs will be derived and included in the site-specific interim deliverable.

Where available information permits, the water value on which the sediment value was derived will be specified. All USEPA (2008b) values were based upon the conventional model since narcosis is such a nebulous endpoint.

***Group 1 comment:*** Discussed during the 15 and 17 December 2009 calls. It was agreed that: (1) the value for alpha-BHC will be used as a surrogate for the other BHC isomers; (2) the value for endrin will be used as a surrogate for the other endrin isomers; (3) the use of USEPA (2008b) is acceptable in place of other values, even though it is not part of the source hierarchy, because it is a more recent compilation; (4) the Navy will recheck the values in NAVFAC (2007) Table 3-5 and revise the protocol tables as appropriate; and (5) freshwater EqP values will not be extrapolated to marine (and vise versa) in the

protocol but such extrapolations may be considered on a site-specific basis as part of the site-specific interim deliverables where conditions warrant.

33. Table 17, Soil TRVs. Please rename the table as "Soil ESVs for Plants and Soil Invertebrates" and add missing entries of the Type/Receptor protected by ESVs where applicable, such as for the Beyer (1990) values. Please also clarify the meaning of "B value" [background as reported by Beyer, 1990?].

***Navy Response:***

The table will be renamed as specified in the comment. Type/Receptor information was provided if available from the source. The "B value" is defined as soil concentrations that require additional evaluation; "A values" are background and "C values" are basically clean-up thresholds.

***Group 3 comment:*** Response accepted without additional discussion or comment.

34. Table 20, Ingestion-Based TRVs for Mammals. Please clarify why the default Eco-SSL and/or Sample et al (1996) TRVs were modified using an uncertainty factor of 5 rather than the default value of 10, which is the LOAEL-to-NOAEL uncertainty factor used by the original authors of the agreed default values. Please include the TRV for Total PCBs of 0.01 mg/kgBW/day for reproductive effects in mink (Platonow & Karstad, 1973). Please update the table to include available TRVs, such as hexavalent chromium (value now presented needs to be renamed as trivalent chromium), inorganic mercury (mink TRVs now presented are for methyl mercury and need to be so noted), tetrachloroethylene, thallium, tin, vinyl chloride, and xylene. Please include the full suite of effect endpoints that are protected by these TRVs, as presented in the USEPA Eco-SSL and/or Sample et al (1996) documents for each chemical (e.g., lowest TRV that is protective of reproduction, growth, and survival). This information is necessary to provide clarity on how broadly protective the TRVs are with respect to the range of potential affects on mammals.

***Navy Response:***

Please see the response to Specific Comment 19. Total PCBs are not an ingestion-based analyte (nor are tetrachloroethylene, thallium, tin, vinyl chloride, and xylene). Where a value is based upon a specific form or species, it will be specified. The effect/endpoint is already specified in the table (6$^{th}$ column).

***Group 2 comment:*** Discussed during the 17 December 2009 call (also includes discussions during the 15 December 2009 call related to Comment 21). The following was agreed to: (1) chemical form will be added to Table 20 where applicable; (2) exclusion of the Eco-SSL mammal TRV for selenium is acceptable; the Navy will check to see if the study on which the TRV in Table 20 is based is included in the Eco-SSL compilation; (3) EQB agreed to provide the full citation for the Platonow and Karstad (1973) reference (received 12/17/2009); the Navy agreed to consider this study; (4) the effect/endpoint for PAHs from the Eco-SSL document will be reviewed and Table 20 revised as

appropriate; and (5) TRVs from Sample et al. (1996) will be rechecked (particularly the endosulfan value) and Table 20 will be revised as appropriate.

35. Table 21, Ingestion-Based TRVs for Birds. Please clarify why the default Eco-SSL and/or Sample et al (1996) TRVs were modified using an uncertainty factor of 5 rather than the default LOAEL-to-NOAEL extrapolation factor of 10, which is the uncertainty factor used by the original authors of the agreed default values. Please include missing TRVs available from Sample et al. (1996) or other sources, such as dioxins, Total DDT metabolites (Eco-SSL TRV of 0.227 mg/kgBW/day), endrin, heptachlor (woodcock survival NOAEL of 0.13 mg/kg BW/day from Stickel, 1965), methyl mercury [TRV now in table should be noted as inorganic], phthalates, and tin.

***Navy Response:***

Please see the response to Specific Comment 19. Total DDT is not an ingestion-based analyte (nor are phthalates and tin). Where a value is based upon a specific form or species, it will be specified. Values exist for endrin and heptachlor. The Navy will consider other studies (such as Stickel 1965) if the full citation is provided and the study is readily available. Dioxins are not standard analytes evaluated at Vieques sites. They were evaluated in the past only because portions of Vieques were under a RCRA Consent Order and Appendix IX was the typical analytical protocol, not because dioxins were believed to be site-related. If dioxins are analyzed for at a future site, the appropriate information to evaluate this constituent will be presented in the site-specific interim deliverable.

***Group 1 comment:*** Discussed during the 17 December 2009 call (also includes discussions during the 15 December 2009 call related to Comment 21). The following was agreed to: (1) chemical form will be added to Table 21 where applicable; (2) exclusion of the Eco-SSL bird TRV for DDT is acceptable; the Navy will check to see if the studies on which the TRVs in Table 21 are based are included in the Eco-SSL compilation; (3) EQB agreed to provide the full citation for the Stickel (1965) reference (received 12/17/2009); the Navy agreed to consider this study; (4) the screech owl value for Aroclor-1242 will be reviewed to try and determine why this value changed from the 1994 version of the ORNL document; (5) the Navy agreed to consider avian TRVs from additional sources provided by EQB, such as TRVs for endrin and other pesticides published by Hill and Camardese (1986) (received on 12/17/2009); and (6) TRVs from Sample et al. (1996) will be rechecked and Table 21 will be revised as appropriate.

# Responses to

# EPA and EQB Comments on the

# Draft Final Master Ecological Risk Assessment Protocol in the Standard Operating Procedures, Protocols, and Plans for the Environmental Restoration Program at the Former Vieques Naval Training Range, Vieques, Puerto Rico

# February 2010

EQB and EPA have completed our review of the Final Draft Master Operating Procedures, Protocol and Plans, Environmental Restoration Program, Vieques, Puerto Rico, dated February 2010. Our review was directed to the ERA Protocol potion of the document.

## I. EPA Comments

Overall, the Final Draft Master Operating Procedures, Protocol and Plans, addressed most of the requested changes. Only those comments requiring further clarification are discussed below:

1. "The Navy will add text to the revised protocol explaining the process for developing the BAFs (Bioaccumulation Factors) for Polycyclic Aromatic Hydrocarbons (PAHs) presented in Table 5 (Soil Bioaccumulation Factors for Soil Invertebrates)." (Page-specific comment 6, 3rd bullet, Conference Call Summary - December 10, 2009)

   A discussion on how BAFs for PAHs were developed for soil invertebrates was not found in Section 1.2 (Approach and Methodology) of the revised protocol. Please update this section accordingly.

   ***Navy Response:***

   A footnote was added to Table 5 (Soil Bioaccumulation Factors For Soil Invertebrates) of the draft final protocol. The footnote indicated that for PAHs, Eco-SSL values are used only for the SERA because they are modeled values, whereas in the BERA, measured median values available from the literature are applied. This information was also added to Section 1.2.1.3 (Soil Invertebrate subsection) and expanded upon per EPA Comment 3 in the final protocol.

2. "PREQB reported that the Los Alamos National Laboratory (LANL) has developed a database with ecological screening values for numerous explosives which would provide useful information to include in the revised protocol. The Navy requested the PREQB provide a link to the LANL website to retrieve these data." (Page-specific Comment 7, 2nd bullet, Conference Call Summary – December 10, 2009)

The potential sources of ecological screening values (ESVs) for surface water (marine and fresh), sediment (marine and fresh), and soil listed in Section 1.2.2.2 (Medium-Specific ESVs) did not include the LANL database. A review of the explosive ESVs listed in Tables 12-18 (ecological screening value tables for the media types listed above) found that none of explosive ESVs from the LANL database were incorporated into to the revised protocol. Please justify why this potential source of explosive ESVs was not used.

***Navy Response:***

The LANL database was reviewed for explosives information. Other than a bird TRV for 1,3-dinitrobenzene (which was incorporated into Table 21 of the draft final protocol), no new and relevant information was obtained. Note that, in many cases, the LANL database contained the values already cited in the draft final protocol. Where this occurred, the original citation was retained and the LANL database was not cited. However, the LANL database has been added to the text of Section 1.2.2.2 as a potential source of explosives information (where Talmage et al. is also cited) in the final protocol.

3. "A question arose about how the screening and baseline BAFs for PAHs presented in Table 5 (Soil Bioaccumulation Factors for Soil Invertebrates) were developed. The PREQB questioned the difference of up to one order of magnitude between the screening and baseline BAFs. The Navy responded that the screening BAFs were derived using generic models based on PAH-specific Kow values. Worm models tend to greatly overestimate bioaccumulation because they do not consider metabolism and depuration. The Navy used modeled BAFs to derive the screening BAFs, but real media-specific values derived by Beyer and Strafford (1993) for baseline BAFs. The Navy will add text to the revised protocol to explain this difference." (Page-specific comment 8, 2nd bullet, Conference Call Summary – December 10, 2009)

   A discussion on the difference between the modeled PAH BAFs using PAH-specific Kow values and the media specific values derived by Beyer and Stafford (1993) was not found in Section 1.2 (Approach and Methodology – Soil Invertebrates) of the revised protocol. Please update this section accordingly.

   ***Navy Response:***

   Please see the response to EPA Comment 1.

4. "The Navy stated that it did not retain the small mammal BAFs for antimony, barium, and beryllium developed by the Eco-SSL guidance document because they included a cattle biotransfer factor. A default BAF of 1.0 for these three metals will be used instead in Table 6 (Soil Bioaccumulation Factors for Small Mammals). (Page-specific comment 9 and 10, 4th bullet, Conference Call Summary – December 10, 2009)

   A review of Table 6a (Soil Bioaccumulation Factors for Small Mammals) in the revised protocol showed that the BAF values for antimony, barium or beryllium had not been

changed to the default value of 1.0. Please change the BAF values for these compounds to 1.0 in Table 6a.

***Navy Response:***

As discussed in the response to EPA Specific Comment 4 on the draft protocol, the text refers to a diet to whole body BAF while the table lists soil to whole body BAFs. The two values are not equivalent. The final protocol text has been revised again to more clearly indicate this. In addition, a footnote has been added to Table 6 of the final protocol for these three chemicals explaining what was done.

5. "A discussion was started on using Vieques-specific background data for organic compounds to refine the list of Contaminants of Potential Concern (COPCs). The Navy's preference would be to defer the pesticide, Polycyclic Aromatic Hydrocarbons (PAHs) and dioxins/furans refinement step to the site-specific interim deliverables. The EPA observed that pesticides had background detections throughout Vieques Island and should therefore be included in the revised protocol. It was decided that the Navy would only include the soil, surface water, and sediment background data for pesticides in the revised protocol, and provide the PAHs, and dioxins/furans background data in the interim deliverables, as needed. The EPA and PREQB also requested for review and evaluation a copy of the report developed by the Navy on the background datasets for VNTR." (Page-specific comment 25, Conference Call Summary – December 17, 2009)

   A review of Table 22c (Surface Water and Sediment Background Data) showed that no background pesticide data were provided for surface water or sediment. Please update this table to include the surface water and sediment pesticide results, if available. In addition, indicate in a footnote if the results are below detection limits and therefore not presented.

   ***Navy Response:***

   Due to the uncertainty in applying generic background data for surface water and sediment to sites on the west side of Vieques, and as discussed at the ERP/MRP Subcommittee Meeting (March 11, 2010), Table 22c and associated text has been removed from the final protocol. The background issue for surface water and sediment will be addressed, where needed, on a site-specific basis. The proposed procedures will be included in site-specific ERA interim deliverables and/or any site-specific SAPs.

## II. EQB Comments

In additions to the above comments, EQB provided the following comments:

1. It appears that updates expected in the final version of the ERA Protocol were not included. Examples are provided below, which are not inclusive. Please refer to the Navy's Responses to PREQB Technical Evaluation of the Master ERA Protocol for more detailed comments on BSAFs.

   ***Navy Response:***

   Given that screening values and other parameter values will continue to change over time, it is recognized that periodic changes, as concurred upon by all stakeholder agencies, will need to be factored into future ERAs. In addition, there is a system in place that provides a mechanism for the Navy to recommend deviations (including new screening values and other parameter values) and the regulatory agencies to provide input before each site-specific ERA is conducted. This system is the interim deliverable, which provides an efficient mechanism to modify the process, as warranted, for each site-specific ERA. Thus, it is proposed that the Navy address the numbered comments below (as inclusive and not continue to look for additional revisions outside of the numbered comments), finalize the ERA protocol document in accordance with the SMP schedule, and leave further modifications to site-specific interim deliverables and periodic updates to the Master Plans.

2. Please clarify why BSAFs for worm or mollusc BSAFs were used rather than available BSAFs for the burrowing crab (Chasmagnathus granulata), or values based on sediments from salt marshes, mud flats, and even within the crab burrow, which are higher for several pesticides [BSAFs up to 5.0] than the worm or mollusc BSAFs (e.g., BHC isomers, endosulfan isomers, heptachlor, et al.)

   ***Navy Response:***

   Data for burrowing crab were considered during the compilation. However, all data extracted from the two BSAF databases had to be for whole body and the basis (wet or dry weight) had to be specified. In the specific case cited, the maximum burrowing crab BSAF for endosulfan sulfate of 5.0, although whole body, was derived using a mixture of wet and dry weight values. Since the raw data used to develop this BSAF were not reported in the database, the value could not be normalized and so was excluded.

3. Please clarify why the marine mollusc BSAFs for metals that were previously requested were not included from Thomann et al. (1995), but the much lower values for freshwater infauna were included.

***Navy Response:***

Metal BAFs for molluscs/bivalves, although included for organics, were inadvertently left out of Table 7 of the draft final protocol. These BAFs have now been added to Table 7 of the final protocol. The values from Thomann et al. were considered during this compilation, along with other readily available data.

4. Please clarify why the requested BSAFs for molluscs from Maruya et al. (1997 – also a source of BSAFs in USACE database), which are higher than the polychaete BSAFs they included from this same source for several chemicals (e.g., acenaphthylene 5.42 for Asian clam vs. 2.04 for polychaete) were not included.

***Navy Response:***

Some of the Maruya et al. (1997) shellfish data were directly used (e.g., benzo[k]fluoranthene) when adequate useable data from the two BSAF databases were not available. This was rarely the case, however, and 90th percentile (SERA) and median (BERA) values calculated from applicable data points in the two BSAF databases were considered to be more representative values for PAHs. The Maruya et al. (1997) polychaete data were retained to represent invertebrate infauna in the draft final protocol. These values were revisited relative to comparable data contained in the BSAF databases and the values adjusted accordingly in the final protocol.

5. Please clarify why the freshwater clam heptachlor BSAFs ranging as high as 10.7 were excluded, considering a value is listed for heptachlor for marine molluscs (BSAF of 0.3).

***Navy Response:***

The heptachlor value listed in Table 7 of the draft final protocol was extrapolated from heptachlor epoxide. The heptachlor data referred to in the comment were not extracted as part of the initial data query since the data were listed for "total heptachlor" without a CAS number and were thus not flagged by the search parameters used. These data have now been found and downloaded. However, the data point referenced in the comment (actually 10.07) is an extreme value; the next highest value (of the other 5 data points) for the same organism is 0.29. The 90th percentile value (including data from a second species) is 0.0609 (converted to wet weight); the median is 0.0462. These revised values have been added to Table 7 of the final protocol for heptachlor in place of the extrapolated number for heptachlor epoxide.

6. Please clarify why soil BAFs from EcoSSL guidance for the three following PAHs were not included. Although they are not listed in EPA's sediment bioaccumulation guidance, which includes most [but not all] PAHs with log Kow > 3.5, Neff (2005) and others report the following log Kow data:

benzo(e)pyrene = 6.04
coronene = 6.75
naphthalene = 3.4

Some of these also have BAFs higher than those that were included [e.g. naphthalene plant BAF = 12.2, worm BAF=4.4]. Please clarify why these higher values were not selected.

***Navy Response:***

This issue was addressed as part of the response to EQB Page-specific Comment 8 on the draft protocol. In short, the three PAHs referenced are not on the list of bioaccumulative chemicals. In addition, only naphthalene is a "standard" facility analyte (i.e., included on the standard list of chemicals analyzed for).

7. It appears that the higher sediment metal BAFs for marine bivalves previously requested were not incorporated into the Final ERA Protocol. Please clarify.

***Navy Response:***

Please see the response to EQB Comment 2.