

Final

Corrective Measures Study Final Report SWMU 31/32

Naval Station Roosevelt Roads
RCRA/HSWA Permit No. PR2170027203
Ceiba, Puerto Rico



Prepared For
Department of the Navy
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia

Contract No. N62470-95-D-6007
CTO-0033

April 17, 2000

Prepared by



Baker
Environmental, Inc.

CDM
Federal Programs Corp.

TABLE OF CONTENTS

	<u>Page</u>
LIST OF ACRONYMS AND ABBREVIATIONS	iv
EXECUTIVE SUMMARY	ES-1
1.0 INTRODUCTION	1-1
1.1 Regulatory Framework	1-1
1.2 Purpose of the CMS.....	1-2
1.3 Goals of the Corrective Measure Process	1-2
1.4 Organization of the Report	1-3
2.0 SWMU BACKGROUND INFORMATION	2-1
2.1 General Description	2-1
2.2 Investigation History.....	2-2
2.2.1 RCRA Facilities Investigation	2-2
2.2.2 Additional Dioxin Investigation	2-5
3.0 CORRECTIVE ACTION OBJECTIVES	3-1
3.1 Screening For Contaminants of Concern	3-2
3.2 Evaluating Potential Exposure Pathways.....	3-2
3.3 Defining Public Health Implications/Actions	3-3
4.0 RECOMMENDATION AND JUSTIFICATION	
OF THE CORRECTIVE ACTION	4-1
4.1 Description of the Recommended Corrective Action	4-1
4.2 Justification of the Recommended Corrective Action.....	4-1
4.2.1 Technical Considerations.....	4-1
4.2.2 Human Health Considerations	4-2
4.2.3 Environmental Considerations.....	4-2
5.0 REFERENCES	5-1

LIST OF TABLES

2-1	Summary of Phase I RFI Dioxin Analytical Results
2-2	Summary of Phase II RFI Dioxin Analytical Results
2-3	List of Dioxin Congeners and Associated TCDD Toxicity Equivalency Factors
2-4	Summary of Additional Dioxin Analytical Results
3-1	Summary of 2,3,7,8-TCDD Equivalents for the Additional Dioxin Analytical Results

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES

- 1-1 SWMU/AOC Location Map
- 2-1 SWMUs 31/32 Site Plan
- 2-2 SWMUs 31/32 RFI Sample Locations
- 2-3 Additional SWMUs 31/32 Dioxin Sample Locations

- 3-1 Detected Dioxin Concentrations in Terms of Dioxin TEQs

- 4-1 Recommended Corrective Action

APPENDICIES

- Appendix A Photographs of SWMUs 31/32

LIST OF ACRONYMS AND ABBREVIATIONS

AOC	area of concern
ATSDR	Agency for Toxic Substances and Disease Registry
Baker	Baker Environmental, Inc.
bgs	below ground surface
CDDs	chlorinated dibenzo-p-dioxins
CDFs	chlorinated dibenzofurans
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	Corrective Measure Study
COCs	contaminants of concern
DoN	Department of the Navy
HpCDD	heptachlorodibenzo-p-dioxin
HpCDF	heptachlorodibenzofuran
HSWA	Hazardous and Solid Waste Amendments
HxCDD	hexachlorodibenzo-p-dioxin
HxCDF	hexachlorodibenzofuran
ILCR	incremental lifetime cancer risk
IR	Installation Restoration
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
NSRR	Naval Station Roosevelt Roads
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran
ppb	parts per billion
ppt	parts per trillion
PWD	Public Works Department
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SWMU	Solid Waste Management Unit
TCDD	tetrachlorodibenzo-p-dioxin
TDCF	tetrachlorodibenzofuran
TEF	toxicity equivalency factor
TEQs	toxicity equivalents
µg/Kg	micrograms per kilogram
USEPA	United States Environmental Protection Agency
USTs	underground storage tanks

EXECUTIVE SUMMARY

This document presents the Resource Conservation and Recovery Act (RCRA) Corrective Measure Study (CMS) Report for Solid Waste Management Units (SWMUs) 31/32 located at the Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. This report has been prepared by Baker Environmental, Inc. (Baker) under contract to the Atlantic Division, Naval Facilities Engineering Command (LANTDIV).

SWMU Description

SWMUs 31/32 are located in the Public Works Department (PWD) operation yard, which is in the eastern portion of the Station, northeast of Forrestal Drive. The operation yard is used by the transportation shop to service Station vehicles. In general, SWMUs 31/32 include small open parking/storage area surrounding a canopy area attached to the northern corner of PWD Building 31. In addition to PWD Building 31, Buildings 1926 and 2022 (Paint Shop) and a storage building are located within and/or adjacent to the SWMUs 31/32 area. SWMUs 31/32 is used for the management of waste vehicle oils in limited quantities. SWMU 32 was identified in previous investigations as a former battery storage area. The area is currently used for storage of heavy equipment. The majority of the area at SWMUs 31/32 is asphalt-paved. The area immediately northwest of the SWMU is soil covered.

For purposes of this CMS report, the SWMUs 31/32 area will include the general area surrounding the northern corner of the PWD Building 31. This area includes the areas previously investigated as SWMU 31 and SWMU 32 and addition to the area in between these two SWMUs.

Investigation History

SWMUs 31/32 has historically been and is still used for the storage of limited quantities of limited quantities of waste oil. SWMU 32 was a former battery storage area. A number of environmental investigations have been conducted at SWMUs 31/32.

RCRA Facilities Investigation

A two-phase RFI was conducted at SWMUs 31/32 in 1995 and 1997. The objective of the initial RFI (Phase I) was to assess whether a release had occurred at any of the SWMUs or AOCs at NSRR. Under the Phase I RFI, four surface soil samples were collected at SWMUs 31/32. These samples were collected at locations immediately surrounding the Building 31 canopy area. These four samples were collected at a depth of 0 to 1 feet below ground surface (bgs) and were analyzed for several compounds including dioxins and furans.

Dioxins were detected in two of the four Phase I surface soil samples. One of the samples contained total hexachlorodibenzofuran (HxCDF) at a concentration of 0.06J micrograms per kilogram ($\mu\text{g}/\text{Kg}$). The other sample contained total hexachlorodibenzo-p-dioxin (HxCDD) at 12 $\mu\text{g}/\text{Kg}$, total hexachlorodibenzofuran (HxCDF) at 43 $\mu\text{g}/\text{Kg}$, total pentachlorodibenzo-p-dioxin (PeCDD) at 0.74 J $\mu\text{g}/\text{Kg}$, total pentachlorodibenzofuran (PeCDF) at 3.1 $\mu\text{g}/\text{Kg}$, and total tetrachlorodibenzofuran (TCDF) at 0.17J $\mu\text{g}/\text{Kg}$.

Based on the results of the Phase I RFI, additional RFI investigations (Phase II) were conducted at SWMUs 31/32 (in conjunction with five other SWMUs and three AOCs) at the request of the USEPA. This additional work was undertaken in the fall of 1997. At SWMUs 31/32, eight surface soil samples were collected during the Phase II RFI. These surface soil samples were collected at a depth of 3 to 9 inches bgs, and they were analyzed for dioxins/furans only. Dioxins/furans were detected in six of the eight Phase II surface soil samples. The detected dioxins/furans included total HxCDD, HxCDF, PeCDF, and TCDF:

- Total HxCDD 0.16J – 1.5J $\mu\text{g}/\text{Kg}$
- Total HxCDF 0.10J – 3.3 $\mu\text{g}/\text{Kg}$
- Total PeCDF 0.07J – 1.10 $\mu\text{g}/\text{Kg}$
- Total TCDF 0.04J – 0.15J $\mu\text{g}/\text{Kg}$

A human health risk assessment was conducted on the Phase I and Phase II surface soil samples analyzed for dioxins/furans. Potentially unacceptable carcinogenic risks were estimated for current on-site workers and future adult and young child residents. The potential risk was predominantly driven by dermal and ingestion exposures to total HxCDF, PeCDF, and HxCDD in soil.

Additional Dioxin Investigation

In June 1999, 18 additional surface soil samples and two duplicates samples were collected at SWMUs 31/32 to confirm some of the older data and to further delineate the extent of the dioxin contamination. The samples were collected at depths of 3.0 to 9.0 inches bgs. The soil samples collected during this 1999 sampling event were analyzed for the dioxin and furan congeners as per USEPA SW-846 Method 8290. Dioxins/furans were detected in every sample. Total tetrachlorodibenzo-p-dioxin (TCDD) concentrations ranged from not detected to 0.11 µg/Kg. Total TCDF concentrations ranged from not detected to 100 µg/Kg. Total PeCDD concentrations ranged from not detected to 0.61 µg/Kg. Total PeCDF concentrations ranged from 0.00052 to 1.8 µg/Kg. Total HxCDD concentrations ranged from 0.00062 to 1.1 µg/Kg. Total HxCDF concentrations ranged from 0.00056 to 2.8 µg/Kg. Total heptachlorodibenzo-p-dioxin (HpCDD) concentrations ranged from 0.0039 to 1,300 µg/Kg. Total heptachlorodibenzofuran (HpCDF) concentrations ranged from 0.0019 to 52 µg/Kg. Total octachlorodibenzo-p-dioxin (OCDD) concentrations ranged from 0.018 to 900 µg/Kg. Total octachlorodibenzofuran (OCDF) concentrations ranged from 0.001 to 46 µg/Kg.

Corrective Action Objectives

The Agency for Toxic Substances and Disease Registry (ATSDR) adopted an interim policy guideline to assess the public health implications of dioxin and dioxin-like compounds in residential soils near or on hazardous waste sites. The ATSDR interim policy guideline provides an understanding of ATSDR's current approaches and judgements regarding hazards posed by the presence of TCDD and its less toxic dioxin-like congeners in residential soils.

This CMS report for SWMUs 31/32 will use the ATSDR interim policy guideline as the basis to determine if additional investigations and/or a corrective action are warranted at SWMUs 31/32. In general, the interim policy concludes that an action level of 1 part per billion (ppb) toxicity equivalents (TEQs) for dioxin and dioxin-like compounds is protective of public health and continues to represent a level at which consideration of health action to interdict exposure, including cleanup, should occur. This action level of 1 ppb has been documented in several decision documents for CERCLA sites contaminated with dioxins.

The ATSDR guideline has a three step evaluation to determine if further action is warranted at a site. The first step compares the data (in terms of dioxin toxicity equivalency factors) to an evaluation level of 50 parts per trillion (ppt). Four out of 18 samples collected during the 1999 sampling event contained dioxin TEQs greater than 50 ppt. The second step of the guideline evaluates if there are potential exposure pathways at the site. The asphalt pavement at SWMUs 31/32 mitigates the direct contact exposure pathway. If a completed or potentially completed exposure pathway is identified (in Step 2), then the extent of exposure and public health implications are further evaluated (Step 3 of the guideline). If concentrations in residential soils exceed 1 ppb TEQs are significant, site-specific public health recommendations/actions to prevent or interdict exposures should be considered.

With respect to SWMUs 31/32, no dioxin TEQs are greater than 1 ppb, therefore, public health actions should not be necessary.

Recommendation and Justification of the Corrective Action

No further corrective action is recommended for SWMUs 31/32. The majority of the area within SWMUs 31/32 is currently covered with asphalt. This asphalt barrier mitigates the exposure pathway for dermal contact with the surface soil at the SWMU. The remaining small area within SWMUs 31/32 is not paved with asphalt. As a proactive approach, the Navy will construct an asphalt pavement over this earthen area (approximately 5,400 square feet). This area includes one of the localized areas where the dioxin TEQs are greater than 50 ppt. The asphalt will provide a barrier to mitigate a potential exposure pathway. In addition to the construction of the asphalt pavement, the existing pavement and new pavement will be maintained to protect the integrity of the cap. Land use controls will also be implemented to prevent the use of this SWMU for residential housing.

The recommended corrective action for SWMUs 31/32 is technically very easy to implement. Soil excavation and treatment/disposal actions are not necessary. A small area within the SWMU will be asphalt paved. This pavement will connect with the existing pavement within the operation yard. Paving techniques are widely used and readily available.

The action level of 1 ppb TEQ dioxin was established by ATSDR for residential soil to be protective of human health. It has also been used as the cleanup level for CERCLA sites. Based on the most recent dioxin data collected from the SWMU, all of the samples contained TEQs of TCDD less than 1 ppb. Therefore, the selected corrective measure is protective of human health.

The recommended corrective action for SWMUs 31/32 will provide an ecological benefit. Earth-disturbing activities will not be necessary since the dioxin detections are below the action level of 1 ppb TEQ of TCDD. The asphalt pavement will provide additional protection to potential terrestrial receptors by mitigating the exposure pathway for dermal contact and ingestion.

1.0 INTRODUCTION

This document presents the Resource Conservation and Recovery Act (RCRA) Corrective Measure Study (CMS) Report for Solid Waste Management Units (SWMUs) 31/32 located at the Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. This report is prepared under the Corrective Action provisions of the NSRR's RCRA Permit No. PR2170027203. This report has been prepared by Baker Environmental, Inc. (Baker) under contract to the Atlantic Division, Naval Facilities Engineering Command (LANTDIV), Contract Number N62470-95-D-6007.

1.1 Regulatory Framework

In 1943, NSRR was commissioned as a Naval Operations Base. NSRR continued in this status until 1957 when it was designated a naval station with the mission of providing full support for Atlantic Fleet weapons training and development activities.

On October 20, 1994, the United States Environmental Protection Agency (USEPA) Region II issued a RCRA Part B Permit to NSRR, Ceiba, Puerto Rico. This permit includes requirements for 24 SWMUs and three areas of concern (AOCs) at the Station. The location of these SWMUs and AOCs are shown on [Figure 1-1](#). Prior to 1993, environmental activities at NSRR, exclusive of underground storage tanks (USTs), were conducted in compliance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations under the Department of the Navy's (DoN's) Installation Restoration (IR) Program. The RCRA Part B Permit for NSRR includes provisions for corrective action under the RCRA Hazardous and Solid Waste Amendments (HSWA).

RCRA regulations provide a procedure to investigate and remediate areas that may have been affected by a release of hazardous wastes. The first steps for investigating a site/SWMU are the RCRA Facility Assessment (RFA) and the RCRA Facility Investigation (RFI). These assessments and investigations are studies on a property to determine if there has been a release of hazardous waste and to quantify any releases that have occurred. If these studies determine that a release has occurred, then a CMS is conducted.

A RFA was performed in 1988 by A.T. Kearney, Inc. for the USEPA to identify SWMUs and AOCs

at NSRR and to assess the potential for the release of hazardous constituents from any of these areas or units identified. The RFA identified 47 SWMUs and 4 AOCs, and recommended additional investigation at 25 of the SWMUs and all four AOCs. In 1996, a Draft RFI report was prepared for seven SWMUs (6, 10, 13, 26, 31, 32, and 46) and three AOCs (B, C, and D). Additional investigations (to be described in Section 2.0) were also conducted. Because the RFA and RFI indicated that releases had occurred at several areas of the Station, a CMS was deemed necessary. This CMS report specifically focuses on SWMUs 31/32.

1.2 Purpose of the CMS

The purpose of a CMS is typically:

- C to identify and evaluate remedial alternatives that may be used to address a release at a facility;
- C to justify the recommended corrective action based upon technical, human health, and environmental considerations;
- C to determine clean up levels;
- C to provide a system for reporting compliance requirements and use this system to document remediation activities; and
- C to provide information to implement the remedial design.

1.3 Goals of the Corrective Measure Process

The goals of this CMS are to remediate contaminated media at SWMUs 31/32. The contaminants of concern (COCs) at the SWMU (as determined by a site-specific risk assessment) will be remediated to meet the clean up goals established in this CMS report. This CMS will establish the framework for the remediation of the SWMU by providing the site-specific clean up goals, a selected remedial alternative, and other information that is pertinent for the preparation of the remedial design and ultimately SWMU clean up.

1.4 Organization of the Report

The CMS report is organized into five sections. Section 1.0 contains the introduction. Section 2.0 describes the SWMU and summarizes the investigative history. Section 3.0 establishes the corrective action objectives based upon regulatory guidelines and action levels. The recommended corrective action identified for SWMUs 31/32 is discussed in Section 4.0. References are contained in Section 5.0.

2.0 SWMU BACKGROUND INFORMATION

This section contains a general description of SWMUs 31/32. Investigative history and current site conditions are also discussed.

2.1 General Description

SWMUs 31/32 is located in the Public Works Department (PWD) operation yard, which is in the eastern portion of the Station, northeast of Forrestal Drive. The operation yard is used by the transportation shop to service Station vehicles. [Figure 1-1](#) shows the location of SWMUs 31/32 within NSRR.

In general, SWMUs 31/32 include a small open parking/storage area surrounding a canopy area attached to the northern corner of PWD Building 31. [Figure 2-1](#) shows the general site plan of the SWMUs 31/32 area. SWMUs 31/32 are situated in a relatively flat area with elevations ranging around 10 feet above mean sea level. A steep hillside is located to the west and north of the SWMU area. As shown on [Figure 2-1](#), in addition to PWD Building 31, Buildings 1926 and 2022 (Paint Shop) and a storage building are located within and/or adjacent to the SWMUs 31/32 area. Photographs of the SWMUs 31/32 area are presented in [Appendix A](#).

SWMUs 31/32 is used for the management of waste vehicle oils in limited quantities. The majority of the area at SWMUs 31/32 is asphalt-paved. The area immediately northwest of the SWMU is soil covered.

SWMU 32 was identified in previous investigations as a former battery storage area. Batteries had been stored on a pallet at this SWMU and in the bed of a truck also located in the PWD operation yard. In 1988, several dozen batteries were noted to be in various stages of decay, but none appeared to be leaking. The area is currently used for the storage of heavy equipment. Batteries are no longer stored in the area.

For purposes of this CMS report, the SWMUs 31/32 area will include the general area surrounding the northern corner of the PWD Building 31. This area includes the areas previously investigated as SWMU 31 and SWMU 32 and addition to the area in between these two SWMUs. The CMS SWMUs 31/32 boundary is identified on [Figure 2-1](#).

A concrete pad at Building 2022 is occasionally used for temporary storage of 55-gallon waste oil drums that store waste oils prior to recycling. A six-inch concrete curb surrounds the pad. A steel drainage pipe with a valve is set into the curbing.

2.2 Investigation History

SWMUs 31 has historically been and is still used for the storage of limited quantities of waste oil. SWMU 32 was a former battery storage area. A number of environmental investigations have been conducted at SWMUs 31/32. These investigations are summarized in the following subsections.

2.2.1 RCRA Facilities Investigation

A two-phase RFI was conducted at SWMUs 31/32 in 1995 and 1997 as discussed below.

2.2.1.1 Phase I RFI

The initial RFI for NSRR was conducted in 1995. This RFI will be considered for purposes of this report, the Phase I RFI. Several SWMUs and AOCs were investigated under this RFI including SWMUs 31/32. The objective of this investigation was to assess whether a release had occurred at any of the SWMUs or AOCs. The Draft RFI Report, which presented the results of the RFI, was submitted in July 1996 (Baker, 1996). Several of the SWMUs/AOCs investigated were found to require some additional confirmatory sampling or further extensive site characterization. Therefore, additional RFI activities were conducted at these SWMUs/AOCs (Phase II).

Under the Phase I RFI, four surface soil samples were collected at SWMUs 31/32 (31SS01 through 31SS04). These samples were collected at locations immediately surrounding the Building 31 canopy area. These four samples were collected at a depth of 0 to 1 feet below ground surface (bgs) and were analyzed for the full Appendix IX list (including dioxins and furans) and total petroleum

hydrocarbons. [Figure 2-2](#) identifies the location of the Phase I samples.

Dioxins were detected in two of the four Phase I surface soil samples. The detected dioxins/furans included total hexachlorodibenzo-p-dioxin (HxCDD), total hexachlorodibenzofuran (HxCDF), total pentachlorodibenzo-p-dioxin (PeCDD), total pentachlorodibenzofuran (PeCDF), and total tetrachlorodibenzofuran (TCDF). The analytical sample results from Phase I are presented on [Table 2-1](#). As shown on the table, two of the samples contained detected concentrations of dioxins/furans. Sample 31SS02 contained HxCDF at a concentration of 0.06J micrograms per kilogram ($\mu\text{g}/\text{Kg}$). The J value indicates that the reported value is estimated, and it may not be accurate or precise. Sample 31SS04 contained HxCDD (12 $\mu\text{g}/\text{Kg}$), HxCDF (43 $\mu\text{g}/\text{Kg}$), PeCDD (0.74 J $\mu\text{g}/\text{Kg}$), PeCDF (3.1 $\mu\text{g}/\text{Kg}$), and TCDF (0.17J $\mu\text{g}/\text{Kg}$).

For SWMUs 31/32, the Draft RFI (Phase I) Report indicated that there were no unacceptable risks posed by the SWMUs for continued industrial use. However, during the review of the Draft Report, dioxin values to be used for the risk assessment changed. This change caused the risk assessment to be recalculated using the new values. The revised risk assessment results indicated a slight potential risk to on-site workers posed by the dioxin levels identified at the SWMUs (specifically from sample location 31SS04). It should be noted that dioxin wastes were never reportedly managed at the SWMUs or did waste burning activities ever take place at or near the SWMUs. The results of the recalculated human health risk assessment indicated the need to perform additional dioxin-related sampling at SWMUs 31/32.

2.2.1.2 Phase II RFI

Based on the results of the Phase I RFI, additional RFI investigations were conducted at SWMUs 31/32 (in conjunction with five other SWMUs and three AOCs) at the request of the USEPA. This additional work was undertaken in the fall of 1997, based on an USEPA approved RFI work plan addendum (Baker, 1997a). For purposes of this report, this additional RFI investigation will be considered the Phase II RFI.

At SWMUs 31/32, eight surface soil samples were collected during the Phase II RFI: 31-SS05 through 31-SS12. These surface soil samples were collected at a depth of 3 to 9 inches bgs, and they were analyzed for dioxins/furans only. [Figure 2-2](#) identifies the location of these Phase II samples. It appeared based on the Phase I RFI, that only dioxins may be a potential concern at SWMUs 31/32.

Dioxins/furans were detected in six of the eight Phase II surface soil samples. The detected dioxins/furans included total HxCDD, HxCDF, PeCDF, and TCDF. The detected analytical sample results from Phase II are presented on [Table 2-2](#). As shown on the table, the ranges of detections for each of the compounds are as follows:

- Total HxCDD 0.16J – 1.5J µg/Kg
- Total HxCDF 0.10J – 3.3 µg/Kg
- Total PeCDF 0.07J – 1.10 µg/Kg
- Total TCDF 0.04J – 0.15J µg/Kg

A human health risk assessment was conducted on the Phase I and Phase II surface soil samples analyzed for dioxins/furans. Potentially unacceptable carcinogenic risks were estimated for current on-site workers and future adult and young child residents. The potential risk was predominantly driven by dermal and ingestion exposures to total HxCDF, PeCDF, and HxCDD in soil. The calculated incremental lifetime cancer risks (ILCRs) were 2.3×10^{-04} for the on-site worker, 3.8×10^{-04} for the future adult resident, and 4.3×10^{-04} for the future child resident.

The recommendations presented in the Draft Additional Facility Investigation Report for Operable Units 1, 6, and 7 (i.e., the Phase II RFI) for SWMUs 31/32 included no further action. Under this scenario, the DoN proposed to place the SWMUs under a land-use restriction that would negate the potential risks posed to future residents. The potential risk to the current on-site worker would be mitigated by the fact that significant portions of the SWMU area are paved, and where unpaved, the material is hard packed and does not generally produce dust when windblown or transited. Therefore, a complete exposure pathway to the dioxins would be difficult to establish.

On September 15, 1998, the USEPA requested that SWMUs 31/32 to be evaluated further through the performance of a CMS. During the development of the CMS, it was determined that site specific cleanup levels could not be established utilizing the non-congener specific analytical Method 8280. Site-specific risk-based levels may not be measurable and/or achievable with available technologies. The Navy proposed to perform additional sampling in the area of the dioxin detections to accomplish a two fold purpose. First, samples were to be obtained from previous sampling locations and subjected to analysis for the specific dioxin congeners (Method 8290). This provided more specific information for the development of potential cleanup levels. Second, samples were to be obtained from points further away from the building in an effort to quantify the affected area. A work plan for this additional work (Baker, 1999) was submitted to the USEPA and subsequently approved by the USEPA in June 1999.

2.2.2 Additional Dioxin Investigation

In June 1999, 18 additional surface soil samples and two duplicates samples were collected at SWMUs 31/32 to confirm some of the older data and to further delineate the extent of the dioxin contamination. The samples included 31-SS04A through 31-SS08A, 31-SSA through 31-SSG, and 31-SSAA through 31-SSFF as shown on [Figure 2-3](#). The samples were collected at depths of 3.0 to 9.0 inches bgs. Five of these samples (31-SS04A through 31-SS08A) were collected at locations similar to sample locations 31-SSW04 through 31-SS08 from the previous RFI investigations.

The soil samples collected during this 1999 sampling event were analyzed for the dioxin and furan congeners as per USEPA SW-846 Method 8290 ([Table 2-3](#) lists these congeners). This analytical method includes several congeners that are not included in the standard dioxin/furan method (Method 8280). [Table 2-4](#) presents a summary of the analytical data from the 1999 sampling. Both individual congener concentrations and total concentrations are presented on the table where applicable.

As shown on the table, dioxins/furans were detected in every sample. Total tetrachlorodibenzo-p-dioxin (TCDD) concentrations ranged from not detected to 0.11 µg/Kg. Total TCDF concentrations ranged from not detected to 100 µg/Kg. Total PeCDD concentrations ranged from not detected to 0.61 µg/Kg. Total PeCDF concentrations ranged from 0.00052 to 1.8 µg/Kg. Total HxCDD concentrations ranged from 0.00062 to 1.1 µg/Kg. Total HxCDF concentrations

ranged from 0.00056 to 2.8 µg/Kg. Total heptachlorodibenzo-p-dioxin (HpCDD) concentrations ranged from 0.0039 to 1,300 µg/Kg. Total heptachlorodibenzofuran (HpCDF) concentrations ranged from 0.0019 to 52 µg/Kg. Total octachlorodibenzo-p-dioxin (OCDD) concentrations ranged from 0.018 to 900 µg/Kg. Total octachlorodibenzofuran (OCDF) concentrations ranged from 0.001 to 46 µg/Kg.

3.0 CORRECTIVE ACTION OBJECTIVES

The Agency for Toxic Substances and Disease Registry (ATSDR) adopted the following interim policy guideline to assess the public health implications of dioxin and dioxin-like compounds in residential soils near or on hazardous waste sites: “Dioxin and Dioxin-Like Compounds in Soil, Part I: ATSDR Interim Policy Guideline” (ATSDR, 1997a). Dioxin and dioxin-like compounds include TCDD, related chlorinated dibenzo-p-dioxins (CDDs), chlorinated dibenzofurans (CDFs) and other structurally related groups of chemicals from the family of halogenated aromatic hydrocarbons (ATSDR, 1997a). The ATSDR interim policy guideline provides an understanding of ATSDR’s current approaches and judgements regarding hazards posed by the presence of TCDD and its less toxic dioxin-like congeners in residential soils. The guideline is based on a current understanding of the toxicology and epidemiology associated with TCDD and its congeners, and on exposure potential when soil is the primary medium of interest. This policy guideline is consistent with the Technical Support Document for ATSDR Interim Policy Guideline: Dioxin and Dioxin-Like Compounds in Soil (ATSDR, 1997b) and with the ATSDR Public Health Assessment Guidance Manual (ATSDR, 1992).

This CMS report for SWMUs 31/32 will use the ATSDR interim policy guideline as the basis to determine if additional investigations and/or a corrective action are warranted at SWMUs 31/32. In general, the interim policy concludes that an action level of 1 part per billion (ppb) toxicity equivalents (TEQs) for dioxin and dioxin-like compounds is protective of public health and continues to represent a level at which consideration of health action to interdict exposure, including cleanup, should occur.

The interim policy guideline presents three steps to evaluate dioxin detections in soil: (1) Screening for Contaminants of Concern, (2) Evaluating Potential Exposure Pathways, and (3) Defining Public Health Implications/Actions. These three steps will be detailed below with respect to the dioxin analytical results from the 1999 sampling event at SWMUs 31/32.

3.1 Screening For Contaminants of Concern

The first step of the guideline is to review the soil sampling data and compare the levels against dioxin comparison values that are not site specific. If one or more soil sampling values exceed the screening value of 50 parts per trillion (ppt) of TEQs, further site-specific evaluations are needed. The TEQ of TCDD is calculated by multiplying the exposure level of a particular dioxin-like compound by its toxicity equivalency factor (TEF). The toxicity of a dioxin-like compound is commonly referred to in terms of its dioxin TEF. TEFs are based on congener-specific data. The TEF scheme compares the relative toxicity of individual dioxin-like compounds to that of TCDD, which is the most toxic halogenated aromatic hydrocarbon. The TEFs are listed on [Table 2-3](#).

[Table 3-1](#) summarizes the 1999 sampling data from SWMUs 31/32 in terms of TEQs of TCDD. [Figure 3-1](#) displays the TEQs of TCDD for each of the 1999 samples. Only the data from the 1999 investigation is presented since these samples were analyzed for the dioxin/furon specific congeners, where the Phase I and II samples were not. This does not provide an accurate comparison from the 1999 data to the Phase I and II data. Note that the concentrations listed on the table are presented in units of $\mu\text{g}/\text{Kg}$ (or ppb). These concentrations need to be multiplied by 1000 to convert to ppt units. The concentrations shown on [Figure 3-1](#) have been converted and are presented in units of ppt. As shown on the table and figure, four soil samples had TEQs greater than the screening level of 50 ppt. These samples included 31-SS07A (68.3 ppt), 31-SS08A (50.4 ppt), 31-SSDD (184 ppt), and 31-SS05A (349 ppt). The ASTDR generally assumes that further evaluation is required if TEQ sample concentrations exceed the 50-ppt screening level.

3.2 Evaluating Potential Exposure Pathways

If further evaluation is needed (i.e., the 50 ppt screening level is exceeded), Step 2 of the ATSDR guideline is necessary. This step determines the likelihood, extent, and duration of exposure populations. The existence of a potential or completed exposure pathway is determined through site visits, detailed review of analytical data, and evaluation of receptor populations and potential points of contact.

With respect to SWMUs 31/32, the dioxin contamination at the site is not extensive. Only four of 18 samples contained TEQ levels of TCDD greater than 50 ppt. All TEQs of TCDD were below 1 ppb.

The dioxin contamination (TEQs of TCDD greater than 50 ppt) is localized in two areas of the SWMU area (Figure 3-1). One of these areas is covered by asphalt. The other area is located within the earthen covered parking area. The SWMUs 31/32 area is not located within a residential area. Based on all of this information, it appears that the likelihood of human exposure to the dioxin contaminants is minimal at SWMUs 31/32.

3.3 Defining Public Health Implications/Actions

In accordance with ATSDR Guidance, if a completed or potentially completed exposure pathway is identified (in Step 2), then the extent of exposure and public health implications are further evaluated (Step 3 of the guideline). If concentrations in residential soils exceed 1 ppb TEQs are significant, site-specific public health recommendations/actions to prevent or interdict exposures should be considered.

With respect to SWMUs 31/32, no dioxin TEQs are greater than 1 ppb, therefore, public health actions should not be necessary.

4.0 RECOMMENDATION AND JUSTIFICATION OF THE CORRECTIVE ACTION

The recommended corrective action for the surface soil at SWMUs 31/32 is discussed in the following subsections. Human health and environmental considerations associated with the recommended corrective action are also discussed.

4.1 Description of the Recommended Corrective Action

No further corrective action is recommended for SWMUs 31/32. The majority of the area within SWMUs 31/32 is currently covered with asphalt. This asphalt barrier mitigates the exposure pathway for dermal contact with the surface soil at the SWMU. The remaining small area within SWMUs 31/32 is not paved with asphalt. As a proactive approach, the Navy will construct an asphalt pavement over this earthen area (approximately 5,400 square feet). This area includes one of the localized areas where the dioxin TEQs are greater than 50 ppt. The asphalt will provide a barrier to mitigate a potential exposure pathway. In addition to the construction of the asphalt pavement, the existing pavement and new pavement will be maintained to protect the integrity of the cap. Land use controls will also be implemented to prevent the use of this SWMU for residential housing.

4.2 Justification of the Recommended Corrective Measure

The justification for the selection of no further action as the corrective measure is presented in the following subsections. The corrective measure will be evaluated based upon technical, human health, and environmental considerations.

4.2.1 Technical Considerations

The recommended corrective action for SWMUs 31/32 is technically very easy to implement. Soil excavation and treatment/disposal actions are not necessary. A small area within the SWMUs will be asphalt paved. This pavement will connect with the existing pavement within the operation yard. Paving techniques are widely used and readily available.

4.2.2 Human Health Considerations

The action level of 1 ppb TEQ dioxin was established by ATSDR for residential soil to be protective of human health. Based on the most recent dioxin data collected from the SWMU, all of the samples contained TEQs of TCDD less than 1 ppb. Therefore, the selected corrective measure is protective of human health.

In addition to the ATSDR action levels, a cursory review of CERCLA Records of Decision (RODs) for dioxin contaminated sites was conducted. This review was conducted on the USEPA Internet Site (USEPA, 1999). The results of this cursory review indicated that the dioxin cleanup levels were typically set at 1 ppb. Occasionally clean-up levels as high as 20 ppb were documented. Therefore the use of 1 ppb as the cleanup level for SWMUs 31/32 appears to be appropriate.

4.2.3 Environmental Considerations

The recommended corrective action for SWMUs 31/32 will provide an ecological benefit. Earth-disturbing activities will not be necessary since the dioxin detections are below the action level of 1 ppb TEQ of TCDD. The asphalt pavement will provide additional protection to potential terrestrial receptors by mitigating the exposure pathway for dermal contact and ingestion.

5.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 1997a. Dioxin and Dioxin-Like Compounds in Soil, Part I: ATSDR Interim Policy Guideline. Journal of Clean Technology, Environmental Toxicology, and Occupational Medicine, Vol. 6, No. 2. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.

ATSDR. 1997b. Technical Support Document for ATSDR Interim Policy Guideline: Dioxin and Dioxin-Like Compounds in Soil. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.

ATSDR. 1992. Public Health Assessment Guidance Manual. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. NTIS PB 92-147164. Atlanta, Georgia.

Baker Environmental, Inc. (Baker). 1999. Workplan for Additional Dioxin Sampling at SWMUs 31/32/32, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. Prepared for the Department of the Navy Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia. Contract N62470-89-D-4814. CTO-0223. May 28, 1999.

Baker. 1998. Draft Additional Investigations Report, Operable Units 1, 6, and 7, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. Prepared for the Department of the Navy, Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia. Contract N62470-89-D-4814. CTO-0277. May 1998.

Baker. 1997a. Final RCRA Facility Investigation Work Plan – Naval Station Roosevelt Roads, Ceiba, Puerto Rico. Addendum 2 (Revised), Additional Investigation at Certain OU 1,6 and 7 SWMUs. Prepared for the Department of the Navy, Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia. Contract N62470-89-D-4814. CTO 0173. June 13, 1997.

Baker. 1997b. RCRA Facility Investigation Report for Phase I Investigations at Operable Unit 1, 6, and 7 - Addendum. Prepared for the Department of the Navy, Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia. Contract N62470-89-D-4814. 1997.

Baker. 1996. Draft RCRA Facility Investigation Report for Operable Units 1, 6, and 7. Prepared for the Department of the Navy, Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia. Contract N62470-89-D-4814. July, 1996.

USEPA. 1990. National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule. Federal Register, 40 Code of Federal Regulations Part 300, March 8, 1990.

USEPA. 1999. Record of Decision (ROD) Abstracts. <http://www.epa.gov/oerrpage/Superfund/sites/rodsites/.htm> accessed December 16, 1999.

TABLES

TABLE 2-1

**SUMMARY OF PHASE I RFI DIOXIN ANALYTICAL RESULTS
SWMUs 31/32
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO**

Sample ID	31SS01	31SS02	31SS03	31SS04
Sample Date	10/31/95	10/31/95	10/31/95	10/31/95
Depth Range (ft bgs)	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00
Dioxins (ug/kg)				
Total HxCDD	0.10 U	0.06 U	0.06 U	12.0
Total HxCDF	0.10 U	0.06 J	0.06 U	43.0
Total PeCDD	0.13 U	0.09 U	0.07 U	0.74 J
Total PeCDF	0.07 U	0.06 U	0.06 U	3.10
Total TCDF	0.06 U	0.05 U	0.04 U	0.17 J

Data Qualifiers:

J = Analyte present. Reported value may not be accurate or precise.

U = Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ = Not Detected. Quantitation limit may be inaccurate or imprecise.

Notes:

HxCDD = Hexachlorodibenzo-p-dioxin

HxCDF = Hexachlorodibenzofuran

PeCDD = Pentachlorodibenzo-p-dioxin

PeCDF = Pentachlorodibenzofuran

TCDF = Tetrachlorodibenzofuran

ug/kg = micrograms per kilogram

ft bgs = feet below ground surface

TABLE 2-2

**SUMMARY OF PHASE II RFI DIOXIN ANALYTICAL RESULTS
SWMUs 31/32
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO**

Sample ID	31SS05	31SS06	31SS07	31SS08	31SS09	31SS10	31SS11	31SS12
Sample Date	9/24/97	9/24/97	9/24/97	9/24/97	9/24/97	9/24/97	9/24/97	9/24/97
Depth Range (ft bgs)	0.25-0.75	0.25-0.75	0.25-0.75	0.25-0.75	0.25-0.75	0.25-0.75	0.25-0.75	0.25-0.75

Dioxins (ug/kg)

Total HxCDD	1.50 J	0.58 J	1.40 J	0.16 J	0.03 U	0.18 U	0.17 U	0.10 U
Total HxCDF	3.30	1.70	1.80	0.40 J	0.03 U	0.19 U	0.15 U	0.10 J
Total PeCDD	0.12 U	0.01 U	0.17 U	0.02 U	0.05 U	0.03 U	0.05 UJ	0.18 U
Total PeCDF	0.52 J	0.69 J	1.10	0.29 J	0.03 U	0.03 U	0.07 J	0.14 U
Total TCDF	0.08 U	0.15 J	0.12 U	0.04 J	0.01 U	0.04 U	0.08 UJ	0.06 U

Data Qualifiers:

J = Analyte present. Reported value may not be accurate or precise.

U = Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ = Not Detected. Quantitation limit may be inaccurate or imprecise.

Notes:

HxCDD = Hexachlorodibenzo-p-dioxin

HxCDF = Hexachlorodibenzofuran

PeCDD = Pentachlorodibenzo-p-dioxin

PeCDF = Pentachlorodibenzofuran

TCDF = Tetrachlorodibenzofuran

ug/kg = micrograms per kilogram

ft bgs = feet below ground surface

TABLE 2-3
LIST OF DIOXIN CONGENERS AND
ASSOCIATED TCDD TOXICITY EQUIVALENCY FACTORS
SWMUs 31/32
NAVAL STATION ROOSEVELT ROADS

Congener	2,3,7,8-TCDD Toxicity Equivalency Factor⁽¹⁾
Dioxins:	
Tetrachlorodibenzo-p-dioxin (TCDD)	1
Pentachlorodibenzo-p-dioxin (PeCDD)	0.5
Hexachlorodibenzo-p-dioxin (HxCDD)	0.1
Heptachlorodibenzo-p-dioxin (HpCDD)	0.01
Octachlorodibenzo-p-dioxin (OCDD)	0.001
Furans:	
Tetrachlorodibenzofuran (TCDF)	0.1
Pentachlorodibenzofuran (PeCDF)	0.5
Hexachlorodibenzofuran (HxCDF)	0.1
Heptachlorodibenzofuran (HpCDF)	0.01
Octachlorodibenzofuran (OCDF)	0.001

Note:

⁽¹⁾ Agency for Toxic Substances and Disease Registry (ATSDR). 1997a. Dioxin and Dioxin-Like Compounds in Soil, Part I: ATSDR Interim Policy Guideline. Journal of Clean Technology, Environmental Toxicology, and Occupational Medicine, Vol. 6, No. 2. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.

TABLE 2-4

SUMMARY OF ADDITIONAL DIOXIN ANALYTICAL RESULTS
 SWMUs 31/32
 NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

LOCATION	31-SS04A	31-SS05A	31-SS06A	31-SS07A	31-SS08A	31-SSA	31-SSB	31-SSC	31-SSD
SAMPLE ID	31-SS04a	31-SS05a	31-SS06a	31-SS07a	31-SS08a	31-SSA	31-SSB	31-SSC	31-SSD
SAMPLE DATE	06/28/99	06/28/99	06/26/99	06/26/99	06/26/99	06/28/99	06/28/99	06/28/99	06/28/99
DEPTH RANGE (inches bgs)	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0

DIOXINS/FURANS (ug/Kg)

2,3,7,8-TCDD	ND	0.00043	ND	0.0003	0.00036	0.00029	ND	ND	0.00047
TOTAL TCDD	ND	0.0054	ND	0.0003	0.00078	0.00086	ND	ND	0.0012
2,3,7,8-TCDF	ND	0.0012	0.00013	0.0023	0.0016	0.0008	ND	ND	0.00039
TOTAL TCDF	0.0015	0.1	0.085	0.44	0.21	0.12	0.0047	0.00041	0.037
1,2,3,7,8-PeCDD	ND	0.0063	0.00046	0.0039	0.0032	0.0038	0.00036	ND	0.0033
TOTAL PeCDD	ND	0.061	0.00046	0.016	0.013	0.018	0.001	ND	0.014
2,3,4,7,8-PeCDF	0.00024	0.02	0.004	0.081	0.045	0.013	0.00086	ND	0.0049
1,2,3,7,8-PeCDF	ND	0.0064	ND	0.0027	0.0019	0.0014	0.00016	ND	0.00074
TOTAL PeCDF	0.0066	0.7	0.14	1.8	1.1	0.35	0.022	0.00079	0.16
1,2,3,7,8,9-HxCDD	0.00044	0.054	0.002	0.012	0.014	0.018	0.0014	0.00022	0.015
1,2,3,4,7,8-HxCDD	0.0002	0.039	0.00077	0.0062	0.0069	0.0087	0.0007	ND	0.0067
1,2,3,6,7,8-HxCDD	0.0012	0.24	0.0045	0.027	0.023	0.026	0.002	0.00027	0.022
TOTAL HxCDD	0.006	1.1	0.024	0.19	0.15	0.2	0.014	0.0011	0.15
1,2,3,7,8,9-HxCDF	ND	0.0054	ND	0.0023	0.0014	0.00066	ND	ND	0.00072
1,2,3,6,7,8-HxCDF	0.00048	0.12	0.0012	0.02	0.017	0.011	0.00087	ND	0.0068
2,3,4,6,7,8-HxCDF	0.00058	0.068	0.0017	0.046	0.029	0.013	0.0012	ND	0.0089
1,2,3,4,7,8-HxCDF	0.00093	0.063	0.0015	0.01	0.011	0.0066	0.00057	ND	0.0049
TOTAL HxCDF	0.018	2.8	0.089	0.73	0.56	0.38	0.025	0.0016	0.26
1,2,3,4,6,7,8-HPCDD	0.033	9.2	0.11	0.5	0.58	0.69	0.054	0.0028	0.55
TOTAL HPCDD	0.06	17	0.2	0.9	1	1.3	0.1	0.0057	1
1,2,3,4,7,8,9-HPCDF	0.00068	0.1	0.0025	0.0077	0.0091	0.0076	0.00088	ND	0.0082
1,2,3,4,6,7,8-HPCDF	0.022	3.5	0.07	0.23	0.25	0.29	0.022	0.0072	0.2
TOTAL HPCDF	0.048	12	0.18	0.57	0.57	0.62	0.051	0.013	0.51
OCDD	0.36	130	1.2	3.8	5.8	6.2	0.49	0.028	5.9
OCDF	0.039	16	0.18	0.48	0.45	0.42	0.036	0.0047	0.42

Notes:

TCDD = Tetrachlorodibenzo-p-dioxin
 TCDF = Tetrachlorodibenzofuran
 PeCDD = Pentachlorodibenzo-p-dioxin
 PeCDF = Pentachlorodibenzofuran
 HxCDD = Hexachlorodibenzo-p-dioxin
 HxCDF = Hexachlorodibenzofuran
 HPCDD = Heptachlorodibenzo-p-dioxin

HPCDF = Heptachlorodibenzofuran
 OCDD = Octachlorodibenzo-p-dioxin
 OCDF = Octachlorodibenzofuran

ND = Not Detected.
 ug/kg = micrograms per kilogram
 bgs = below ground surface

TABLE 2-4

SUMMARY OF ADDITIONAL DIOXIN ANALYTICAL RESULTS
 SWMUs 31/32
 NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

LOCATION	31-SSE	31-SSF	31-SSG	31-SSAA	31-SSBB	31-SSCC	31-SSDD	31-SSEE	31-SSFF
SAMPLE ID	31-SSE	31-SSF	31-SSG	31-SSAA	31-SSBB	31-SSCC	31-SSDD	31-SSEE	31-SSFF
SAMPLE DATE	06/28/99	06/28/99	06/28/99	06/26/99	06/28/99	06/28/99	06/28/99	06/28/99	06/28/99
DEPTH RANGE (inches bgs)	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0

DIOXINS/FURANS (ug/Kg)

2,3,7,8-TCDD	ND	0.0031	ND	ND	ND	ND	0.11	ND	ND
TOTAL TCDD	ND	0.0034	ND	ND	ND	ND	0.11	ND	ND
2,3,7,8-TCDF	ND	0.0006	0.00021	ND	ND	ND	0.0011	ND	ND
TOTAL TCDF	0.00033	0.044	0.02	0.0015	0.00044	0.00035	0.04	ND	0.014
1,2,3,7,8-PeCDD	ND	0.003	0.00032	ND	ND	ND	0.0035	ND	0.00071
TOTAL PeCDD	ND	0.014	0.0017	ND	ND	ND	0.049	ND	0.0024
2,3,4,7,8-PeCDF	ND	0.0074	0.0021	ND	ND	ND	0.0079	ND	ND
1,2,3,7,8-PeCDF	ND	0.00094	ND	ND	ND	ND	0.0014	ND	ND
TOTAL PeCDF	0.0015	0.23	0.06	0.0094	0.0033	0.001	0.26	0.00052	0.016
1,2,3,7,8,9-HxCDD	ND	0.012	0.0013	0.0012	0.00068	ND	0.022	ND	0.0036
1,2,3,4,7,8-HxCDD	ND	0.0062	0.00053	0.00047	ND	ND	0.01	ND	0.0016
1,2,3,6,7,8-HxCDD	ND	0.018	0.002	0.0018	0.0011	ND	0.061	ND	0.0046
TOTAL HxCDD	ND	0.19	0.014	0.011	0.0054	0.00062	0.43	ND	0.025
1,2,3,7,8,9-HxCDF	ND	0.00049	ND	ND	ND	ND	0.00082	ND	ND
1,2,3,6,7,8-HxCDF	ND	0.0084	0.0012	ND	ND	ND	0.012	ND	0.00094
2,3,4,6,7,8-HxCDF	ND	0.01	0.0017	0.00049	0.00035	ND	0.018	ND	0.00084
1,2,3,4,7,8-HxCDF	ND	0.0045	0.0006	ND	ND	ND	0.0092	ND	0.00079
TOTAL HxCDF	0.00056	0.26	0.04	0.017	0.0077	0.0011	0.57	0.00056	0.024
1,2,3,4,6,7,8-HPCDD	0.00066	0.48	0.058	0.05	0.027	0.0021	2	0.0039	0.1
TOTAL HPCDD	0.00066	1	0.11	0.091	0.049	0.0039	3.6	0.0067	0.18
1,2,3,4,7,8,9-HPCDF	ND	0.0045	ND	0.00095	ND	ND	0.02	ND	0.0012
1,2,3,4,6,7,8-HPCDF	0.00046	0.18	0.021	0.018	0.0092	0.0013	0.46	0.0009	0.023
TOTAL HPCDF	0.00074	0.35	0.052	0.046	0.026	0.0027	1.7	0.0019	0.046
OCDD	0.0024	4.6	0.76	0.59	0.32	0.018	27	0.034	0.9
OCDF	ND	0.24	0.046	0.04	0.026	0.0021	1.9	0.0014	0.032

Notes:

TCDD = Tetrachlorodibenzo-p-dioxin
 TCDF = Tetrachlorodibenzofuran
 PeCDD = Pentachlorodibenzo-p-dioxin
 PeCDF = Pentachlorodibenzofuran
 HxCDD = Hexachlorodibenzo-p-dioxin
 HxCDF = Hexachlorodibenzofuran
 HPCDD = Heptachlorodibenzo-p-dioxin

HPCDF = Heptachlorodibenzofuran
 OCDD = Octachlorodibenzo-p-dioxin
 OCDF = Octachlorodibenzofuran

ND = Not Detected.
 ug/kg = micrograms per kilogram
 bgs = below ground surface

TABLE 3-1

**SUMMARY OF 2,3,7,8-TCDD
EQUIVALENTS FOR THE ADDITIONAL DIOXIN ANALYTICAL RESULTS
SWMUs 31/32
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO**

LOCATION	31-SS04A	31-SS05A	31-SS06A	31-SS07A	31-SS08A	31-SSA	31-SSB	31-SSC	31-SSD
SAMPLE ID	31-SS04a	31-SS05a	31-SS06a	31-SS07a	31-SS08a	31-SSA	31-SSB	31-SSC	31-SSD
SAMPLE DATE	06/28/99	06/28/99	06/26/99	06/26/99	06/26/99	06/28/99	06/28/99	06/28/99	06/28/99
DEPTH RANGE (inches bgs)	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0

DIOXINS (ug/Kg)

Total as 2,3,7,8-TCDD	0.0014588	0.34984	0.006615	0.068337	0.050441	0.034362	0.002659	0.000182	0.025734
-----------------------	-----------	---------	----------	----------	----------	----------	----------	----------	----------

	31-SSE	31-SSF	31-SSG	31-SSAA	31-SSBB	31-SSCC	31-SSDD	31-SSEE	31-SSFF
	31-SSE	31-SSF	31-SSG	31-SSAA	31-SSBB	31-SSCC	31-SSDD	31-SSEE	31-SSFF
	06/28/99	06/28/99	06/28/99	06/26/99	06/28/99	06/28/99	06/28/99	06/28/99	06/28/99
	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0	3.0-9.0

DIOXINS (ug/Kg)

Total as 2,3,7,8-TCDD	1.36E-05	0.026814	0.003749	0.001716	0.000921	5.41E-05	0.184502	8.34E-05	0.003766
-----------------------	----------	----------	----------	----------	----------	----------	----------	----------	----------

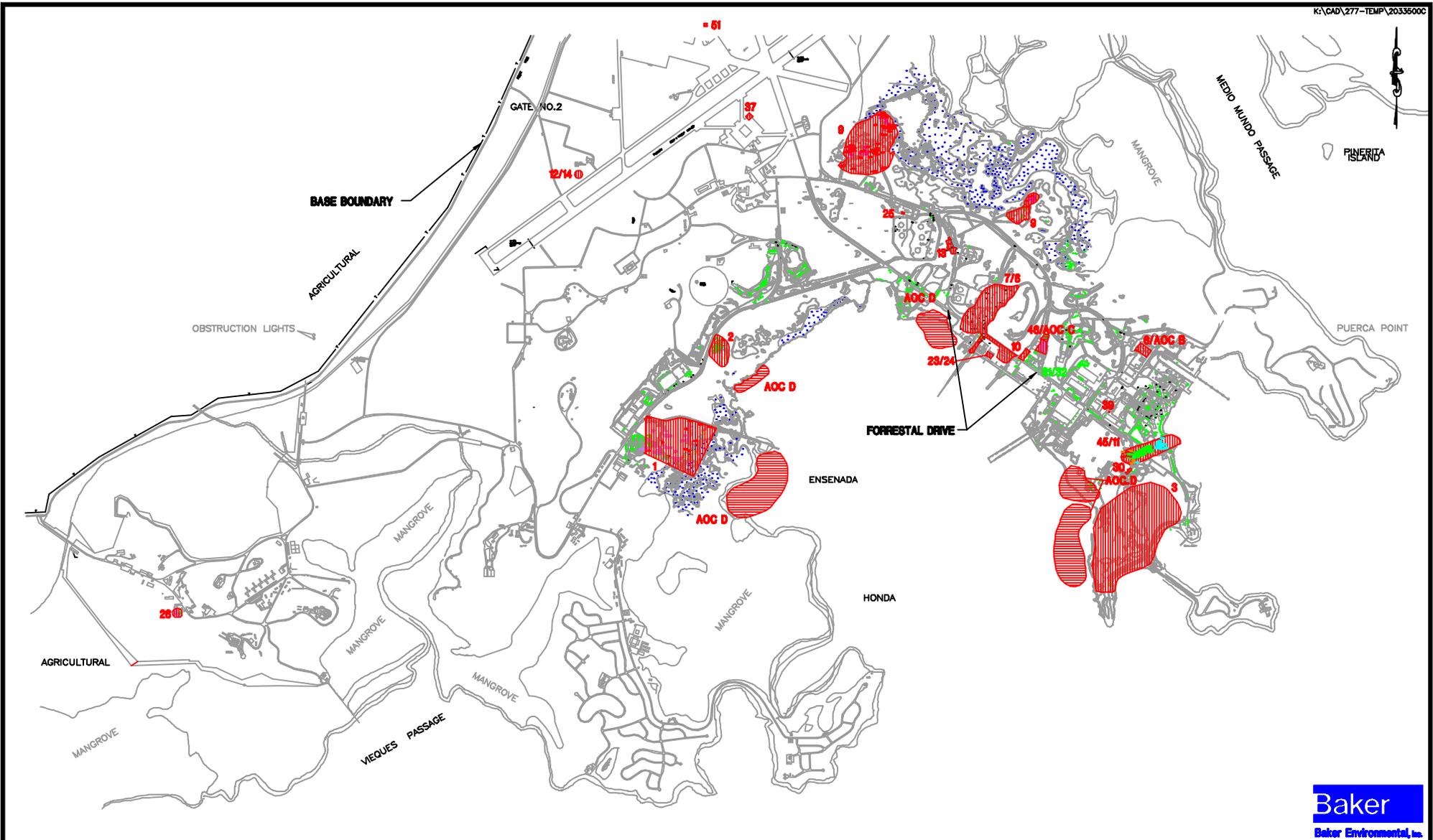
Notes:

TCDD - Tetrachlorodibenzo-p-dioxin

ug/kg - micrograms per kilogram

bgs - below ground surface

FIGURES



LEGEND

-  - SWMUs
 -  - AOCs
 -  - AREA FOR WHICH THIS INVESTIGATION PERTAINS TO
- SOURCE: LANTDIV, FEB. 1992/1997

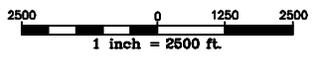
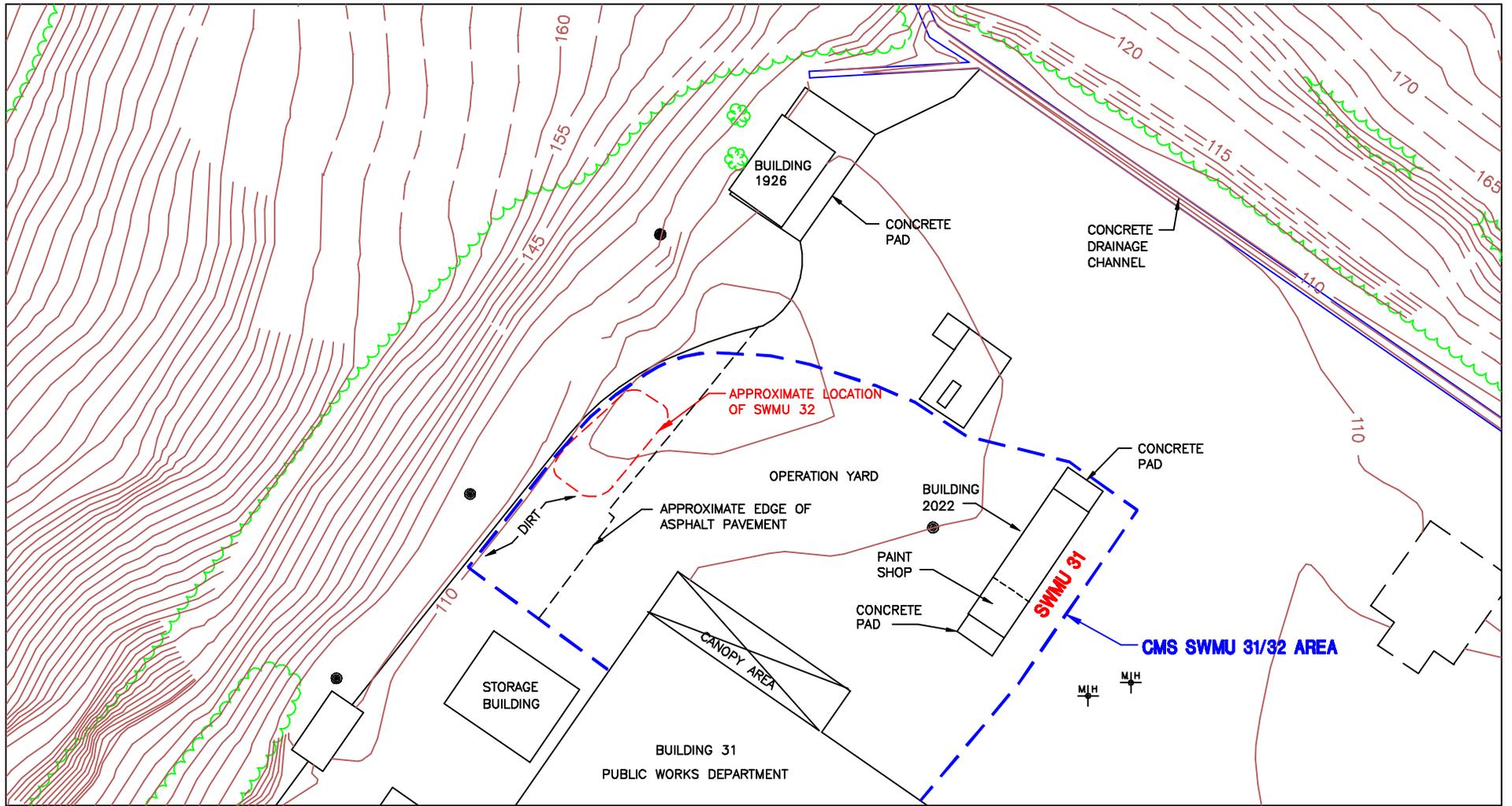


FIGURE 1-1
SWMU/AOC LOCATION MAP
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

- - - SURFACE ELEVATION CONTOUR
- UTILITY POLE
- + MANHOLE
- ~ ~ ~ TREELINE

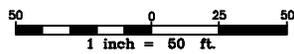
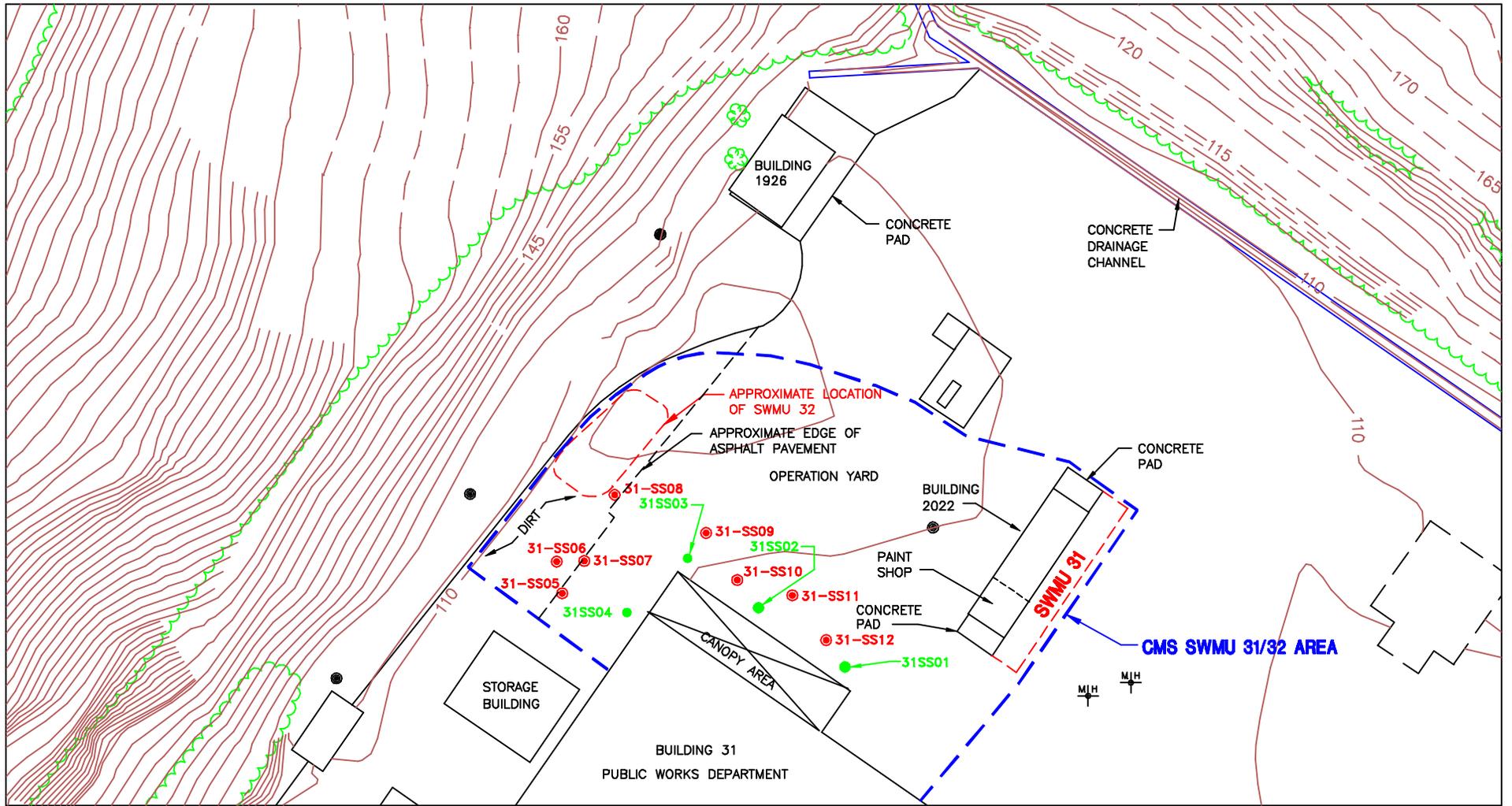


FIGURE 2-1
SWMU 31/32 SITE PLAN
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

- SOIL SAMPLING LOCATION (PHASE I RFI)
- SURFACE SOIL SAMPLING LOCATION (PHASE II RFI)
- 110- SURFACE ELEVATION CONTOUR
- UTILITY POLE
- ⊕ MANHOLE
- ~ TREELINE

SOURCE: LANTDIV, FEB. 1992/1997

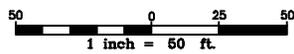
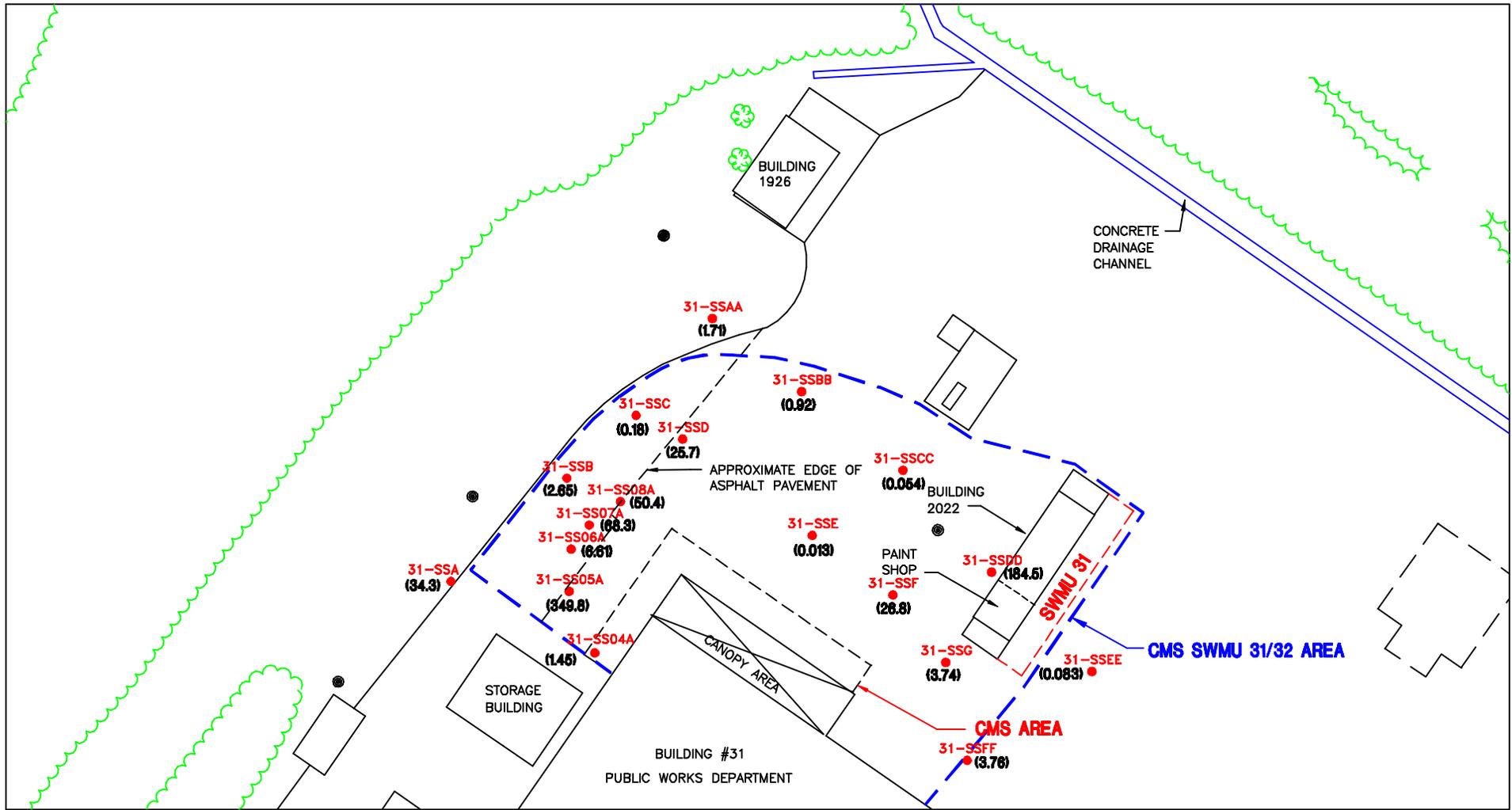


FIGURE 2-2
SWMU 31/32 RFI SAMPLE LOCATIONS
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



NOTE: ALL CONCENTRATIONS ARE IN UNITS OF PARTS PER TRILLION.

- LEGEND**
- SOIL SAMPLING LOCATION
 - UTILITY POLE
 - (0.18) TOTAL TCDD TEQ CONCENTRATION
 - ~ TREELINE

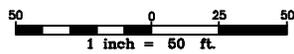
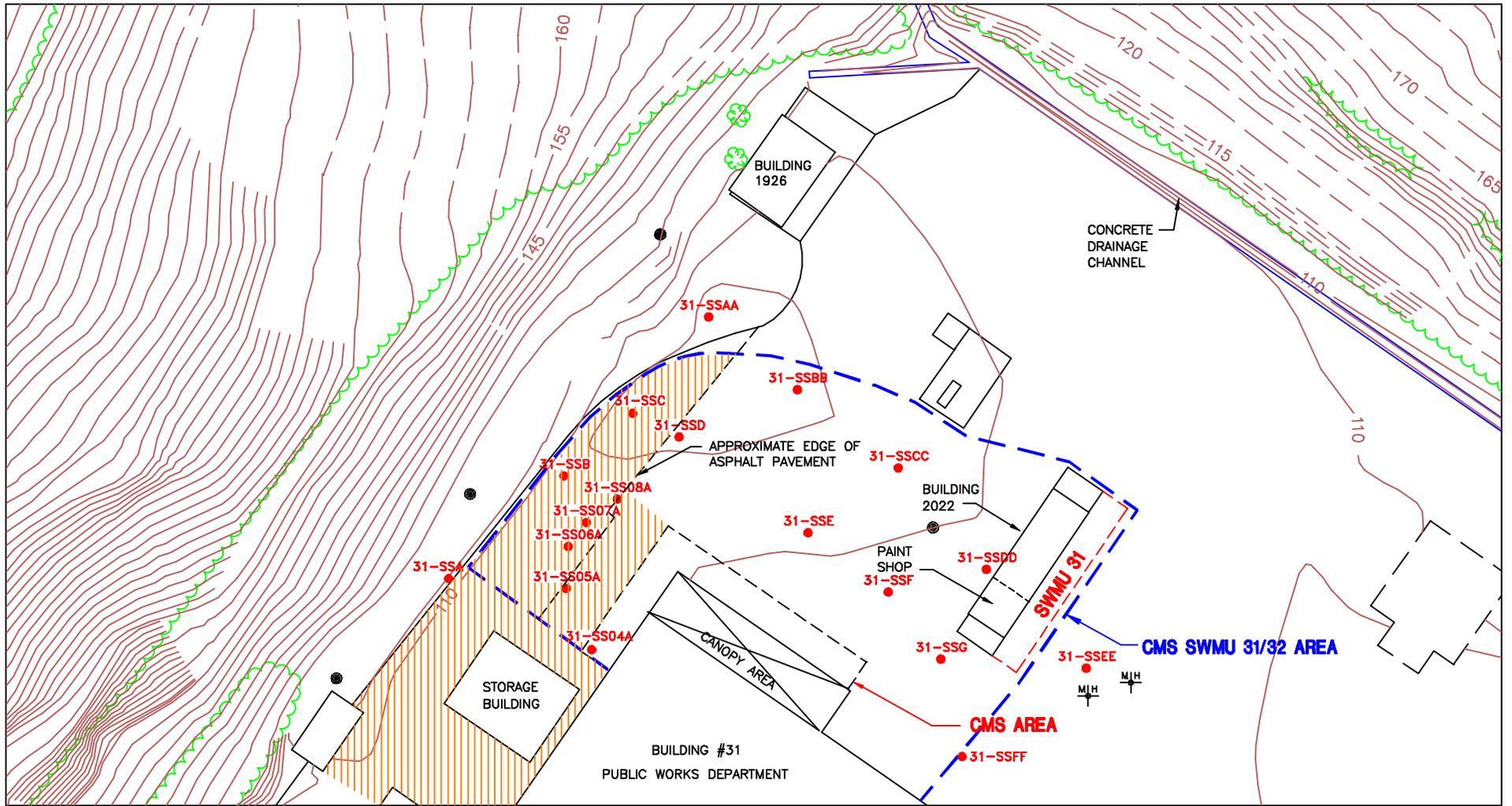


FIGURE 3-1
DETECTED DIOXIN CONCENTRATIONS IN TERMS OF DIOXIN TEQs
SWMU 31/32
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

- SOIL SAMPLING LOCATION
- 110- SURFACE ELEVATION CONTOUR
- UTILITY POLE
- ⊕ MANHOLE
- ~ TREELINE
- ▨ AREA TO BE ASPHALT PAVED

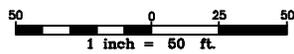


FIGURE 4-1
RECOMMENDED CORRECTIVE ACTION
SWMU 31/32
CORRECTIVE MEASURES STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

APPENDIX A
SWMUs 31/32 PHOTOGRAPHS



Building 31 and Attached Canopy Area, SWMUS 31/32, Naval Station Roosevelt Roads



Building 31 and Edge of Asphalt Pavement, SWMUS 31/32, Naval Station Roosevelt Roads



Dirt Pavement Near Building 31, SWMUS 31/32, Naval Station Roosevelt Roads



**Looking Towards Adjacent Hillside from Building 31 Canopy Area,
SWMUS 31/32, Naval Station Roosevelt Roads**



Adjacent Hillside View, SWMUS 31/32, Naval Station Roosevelt Roads