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ARCS II

REMEDIAL PLANNING ACTIVITIES AT SELECTED UNCONTROLLED HAZARDOUS SUBSTANCE DISPOSAL SITES WITHIN EPA REGION II
(NY, NJ, PR, VI)

CDM Federal Programs Corporation

TUT 007 0747

FINAL ENDANGERMENT ASSESSMENT
TUTU WELLS SITE
ST. THOMAS, VIRGIN ISLANDS
VOLUME IV OF IV

Prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Waste Programs Enforcement
Washington, DC 20460

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ECOLOGICAL ASSESSMENT

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EXECUTIVE SUMMARY OF THE ECOLOGICAL ASSESSMENT

This ecological assessment for the Tutu Wells site provides a qualitative estimate of the potential adverse environmental risk associated with exposure to site-related contaminants in the absence of site remediation. The ecological assessment process included problem formulation, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis. This assessment was prepared in accordance with applicable EPA guidance documents (as listed in Section 1.0).

It was determined that exposure of ecological receptors to site contamination was not likely to occur via groundwater, surface water, or subsurface soil. Exposure to site surface soil, however, was considered a potential route of exposure to ecological receptors. Thus, surface soil is the only medium considered within this ecological assessment.

Although the Tutu Wells site is located in a commercial/industrial zone with associated anthropogenic influence, onsite and adjacent offsite habitat could provide wildlife usage. This was determined by a site visit (March 1994) and through communication with local ecological experts. This habitat consists of grassland with scattered shrub and trees. Wildlife usage was considered to be primarily bird and lizard species, as observed to occur during the site visit. Endangered and threatened species that may occur within the area of the site were determined and included one tree and one reptile, five bird, and two bat species. No threatened or endangered species were observed during the site visit.

Two potential ecological receptor species were chosen as indicator species for the site. The receptor species selected were the red-tailed hawk (*Buteo jamaicensis*), representing a higher order food web consumer, and the anole (*Anolis* sp.), representing a consumer closer to the base of the food web.

Surface soil data used for this evaluation were obtained from the following reports:

- Technical Memorandum II - Results of the Field Program Tutu Service Station Investigation (Geraghty & Miller, 1993a).

- CDM Federal Programs Corporation (CDM Federal's) Comparison and Evaluation Report for Groundwater and Soil Split Samples at the Tutu Wells Site (CDM Federal, June 1993).

- CDM Federal's sampling reports for the September 1988 and June 1989 sampling events (CDM Federal, Sampling Trip Report, September 30, 1988 and Data Comparison and Evaluation Report, June 8, 1993).

Chemicals of potential concern in surface soils were selected for quantitative evaluation. The selection process for each compound involved:

- Evaluation of detection frequency, maximum, and range of concentrations;
- Comparison to background concentrations;
- Comparison to applicable and relevant and appropriate requirements (ARARs);
- Evaluation of physical/chemical properties; and,
- Consideration of potential toxicity.

The chemicals of potential concern included nine volatile organic compounds, sixteen semivolatile organic compounds, one pesticide (Endosulfan I), one polychlorinated biphenyl congener (Aroclor-1242), fifteen inorganic analytes, and cyanide.

Exposure for each of the selected ecological receptors to site-related chemicals in surface soil was determined in the exposure assessment. Ingestion and food web transfer were considered the primary means of exposure to chemicals of potential concern and were the only exposure routes evaluated. Exposure dose estimations were determined in the exposure assessment. First, the level of potential dietary exposures to each chemical of potential concern for each of the receptors was calculated. Then, the potential dietary exposures were modified into total body dose estimates, which are directly comparable to ecotoxicological data used to assess the ecological risks.

The toxicity assessment presents ecotoxicological data for the chemicals of potential concern. For each of the selected ecological receptors, reference toxicity values were derived.

Potential risks to ecological receptors were assessed by comparing estimated exposure levels (total body doses) with toxicological benchmark values (reference toxicity values). Exposure levels were estimated using the worst-case scenario, assuming ecological receptor exposure to maximum concentrations of site-related surface soil chemical concentrations. The potential for adverse health risks were characterized as low to none for the red-tailed hawk and for those anoles that would not come into consistent contact with high or maximum levels of chemicals of potential concern. However, a moderate adverse health risk appears to exist for individual anoles that come into frequent contact with high/maximum concentrations of chemicals of concern which provide considerable levels of potential risk (i.e., arsenic and phenol).

The uncertainty analysis describes the areas of uncertainty associated with this ecological assessment and indicates how these areas of uncertainty affect the estimation of ecological risk. Since the actual area of maximum site surface soil contaminant concentrations is small (and varied throughout the site) in comparison to the rest of the site, the worst-case assumption that ecological receptors contact maximum contaminant concentration levels may have overestimated the potential ecological risk for some receptors.

1.0 INTRODUCTION

Under the Alternative Remedial Contracting Strategy (ARCS) II Contract (Contract No. 68-W9-0024), CDM Federal Programs Corporation (CDM Federal) received work assignment number 073-2P1D for the U.S. Environmental Protection Agency (EPA), Region II, to provide technical assistance by conducting an endangerment assessment to characterize site risk as part of a Remedial Investigation/Feasibility Study (RI/FS) at the Tutu Wells site in St. Thomas, U.S. Virgin Islands (USVI).

This work is a continuation of the work previously started under the Technical Enforcement Support (TES) V Contract (Contract No. 68-W9-0002, work assignment number C02116) which required the submittal of an Endangerment Assessment for the Tutu Wells site. This portion of the Endangerment Assessment presents an Ecological Assessment (EA) for the Tutu Wells site.

The objectives of this EA are to identify, qualitatively and quantitatively (where appropriate), the potential current and future environmental risks associated with the Tutu Wells site that would exist if no action is taken. Additionally, the ecological risk assessment will assist in determining if remedial actions may be warranted.

This report was prepared in accordance with the EPA guidance documents listed below.

- Framework for Ecological Risk Assessment (EPA/630/R-92-001, February 1992);

- Eco Update (Publication 9345.0-05I, Volume I, Numbers 2 and 4, 1991 and 1992);

- Ecological Assessment of Hazardous Waste Sites: Field and Laboratory Reference (EPA/600/3-89/013, March 1989), and;

- Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (EPA/540/1-89/001, March 1989).

As described in the above EPA guidance, the key components of an ecological risk assessment include:

- Problem Formulation (Hazard Identification)
- Exposure Assessment
- Toxicity Assessment (Ecological Effects Assessment)
- Risk Characterization
- Uncertainties and Limitations

This EA is composed of these five components as listed in order.

2.0 PROBLEM FORMULATION

2.1 SITE CHARACTERIZATION

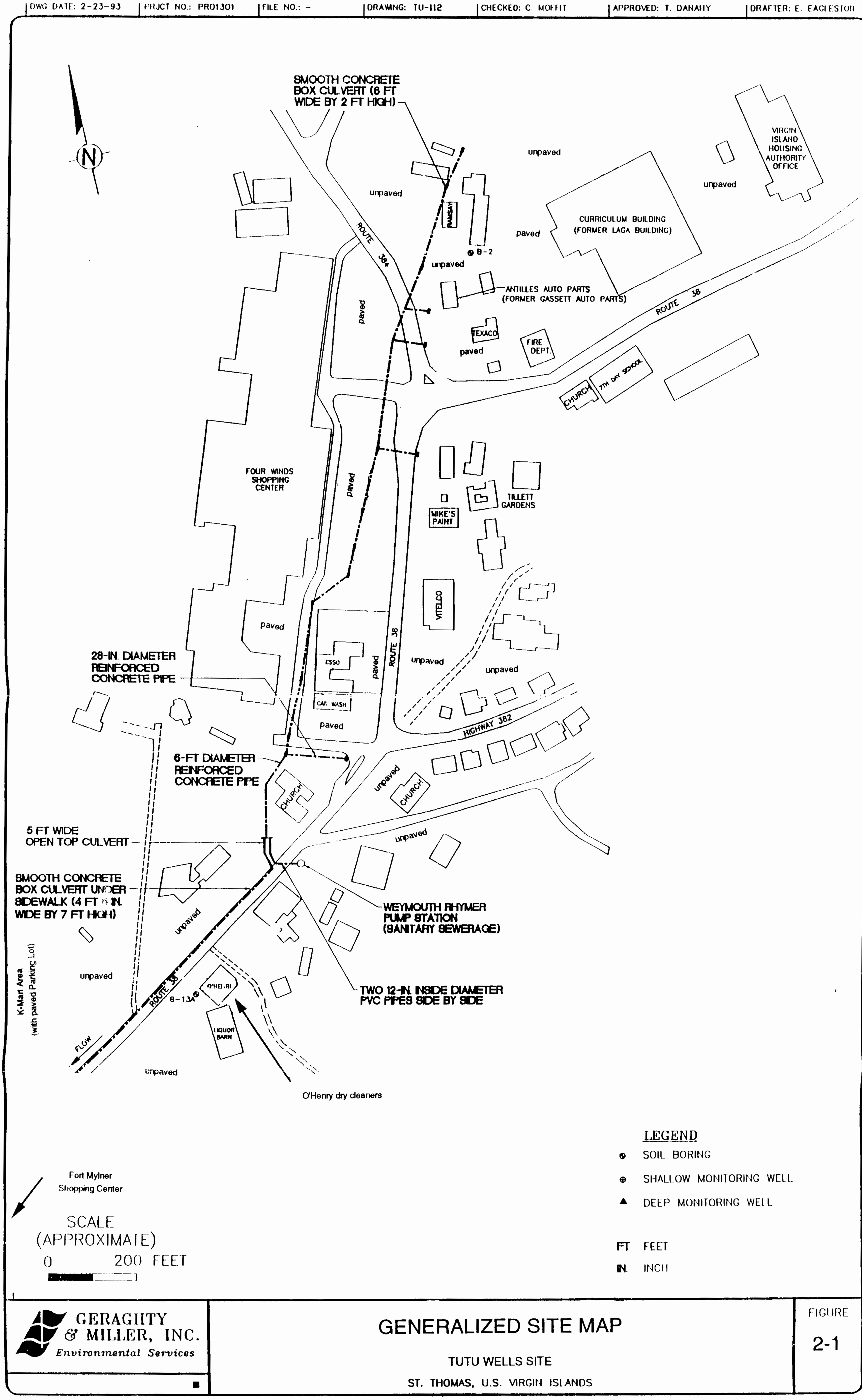
A brief summary of the Tutu Wells site history and the environmental setting is presented below. A more detailed description may be found in the Tutu Service Station Investigation, Work Plan, (Geraghty & Miller, 1992) and the Technical Memorandum II, Results of the Field Program, Tutu Service Station Investigation (Geraghty & Miller, 1993a).

2.1.1 SITE HISTORY

The Tutu Wells site is located in east central St. Thomas (within the Anna's Retreat area). A variety of commercial establishments occupy the properties on each side of the major roads that traverse the site (Figure 2-1). Private homes and multi-family housing units exist on the side roads.

In 1987, an unusual organic odor was reported from well water of a private water supply well (the Tillett well). The USVI Department of Planning and Natural Resources (DPNR) requested EPA's assistance in the contaminant investigation of the well water. In July 1987, the EPA's Technical Assistance Team performed sampling at this well and at other water supply wells in the area. Compounds detected included petroleum products and other hazardous organic constituents. Due to the presence of these compounds, the DPNR closed four of these wells.

Several of the wells in the area belong to major commercial well services and are used for the public drinking water supply, therefore, the incident was classified as significant. The Commissioner of the DPNR requested the EPA to assume the role of lead agency.



Source: Modified from Figure 3-6 in Geraghty & Miller, Inc., 1993a.

EPA REGION II
SCANNING TRACKING SHEET

DOC ID # 64943

DOC TITLE/SUBJECT:

TUTU WELLS SUPERFUND SITE
FIGURE 2-1
GENERALIZED SITE MAP
(Page: TUT 007 0758)

THIS DOCUMENT IS OVERSIZED AND CAN BE LOCATED IN THE ADMINISTRATIVE RECORD FILE AT THE

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Multiple potential contaminant sources to groundwater at the site include the Texaco Tutu service station (at the northern corner of Highways 38 and 384) and the Esso Tutu service station (on Highway 38). In 1990, the EPA issued a Unilateral Administrative Order to Esso Standard Oil Company, Texaco Caribbean, Inc., and O'Henry Cleaners to conduct groundwater monitoring of the drinking water wells in the Tutu aquifer, and to provide water to affected homes until the respondents connected to the water main. Esso and Texaco entered into a RCRA 7003/9003 Order of Consent with EPA to conduct a Remedial Investigation/Feasibility Study at the Tutu Wells site in February 1992. The site was proposed for the National Priorities List in February 1992. Technical Memorandums I and II, submitted to EPA in April 1992 and May 1993, respectively, present the initial results of the studies of the Esso and Texaco gas stations and of volatile organic compounds (VOC) contamination in supply wells at the site. EPA requested the Tutu Environmental Investigation Committee (TEIC) to conduct a more complete RI of the site, and, in December 1993, a Phase II RI work plan was submitted to EPA by Geraghty & Miller, the TEIC's contractor. Phase II RI field work was completed in July 1994.

In addition to groundwater contamination, contamination of the Tutu Wells site surface soil may have occurred via a variety of sources by nature of the current or former operational history. Among the potential sources of surface soil contamination are the service stations, repair shops, paint store, dry cleaners, former textile operation building, artwork manufacturing building(s), and others within the commercial district along routes 38 and 384 (Geraghty & Miller, Inc., 1992; Geraghty & Miller, Inc., 1993b).

2.1.2 ENVIRONMENTAL SETTING

Climate

The climate on St. Thomas is warm and dry (Rivera, et al., 1970). The average annual temperature is 79.7° F, with only small variations of no more than 7° F between the coldest and warmest months. The highest temperatures occur in August and the lowest in January or

February. The warm climate promotes rapid soil development and decomposition of animal and plant remains.

Rainfall on the island is commonly caused by the lifting of moist air over the hilly terrain (Rivera, et al., 1970). Rainfall amounts increase with increasing elevation. The average annual range of rainfall in the vicinity of the site is from 30 to 55 inches. Although rainfall is generally the lightest in February and March and heaviest in September and October, there is not a sharply defined wet or dry season.

Periods of drought occur almost yearly in some parts of the USVI (Rivera, et al., 1970). Most of the soils within the vicinity of the Tutu Wells site have land use limitations due to the potential for drought. Droughts are most prevalent during late fall through early spring.

Geomorphology

The Tutu Wells site is located within the drainage of the upper Turpentine Run basin in the east central portion of the island. There are two primary topographically distinct areas of the site.

- The mostly flat terrace of the valley, generally following the surface water drainage in a north-south orientation. The width of this area is approximately 200 to 400 feet. The elevation of this area above mean sea level (msl) is from about 130 to 180 feet.

- Gently-rolling upland, with approximately 20 to 40% slopes, situated to either side of the flat lowland. The gradation of these slopes generally begins at 200 feet msl and rise to greater than 300 feet msl.

Surface Hydrology

The Tutu Wells site is located within the upper basin of the Turpentine Run. Turpentine Run is an intermittent stream flowing from the northwest to southeast (Figure 2-2). The Turpentine Run basin drains approximately 3.4 square miles and is separated into upper and lower basins. The upper basin (above the stream gaging station near Mount Zion) drains approximately 2.3 square miles. The lower basin drains approximately 1.1 square miles.

The Turpentine Run basin contains Quaternary alluvial and colluvial deposits that appear to thicken southward. Several small catchment areas have been placed along the axis of the basin which trap sediment.

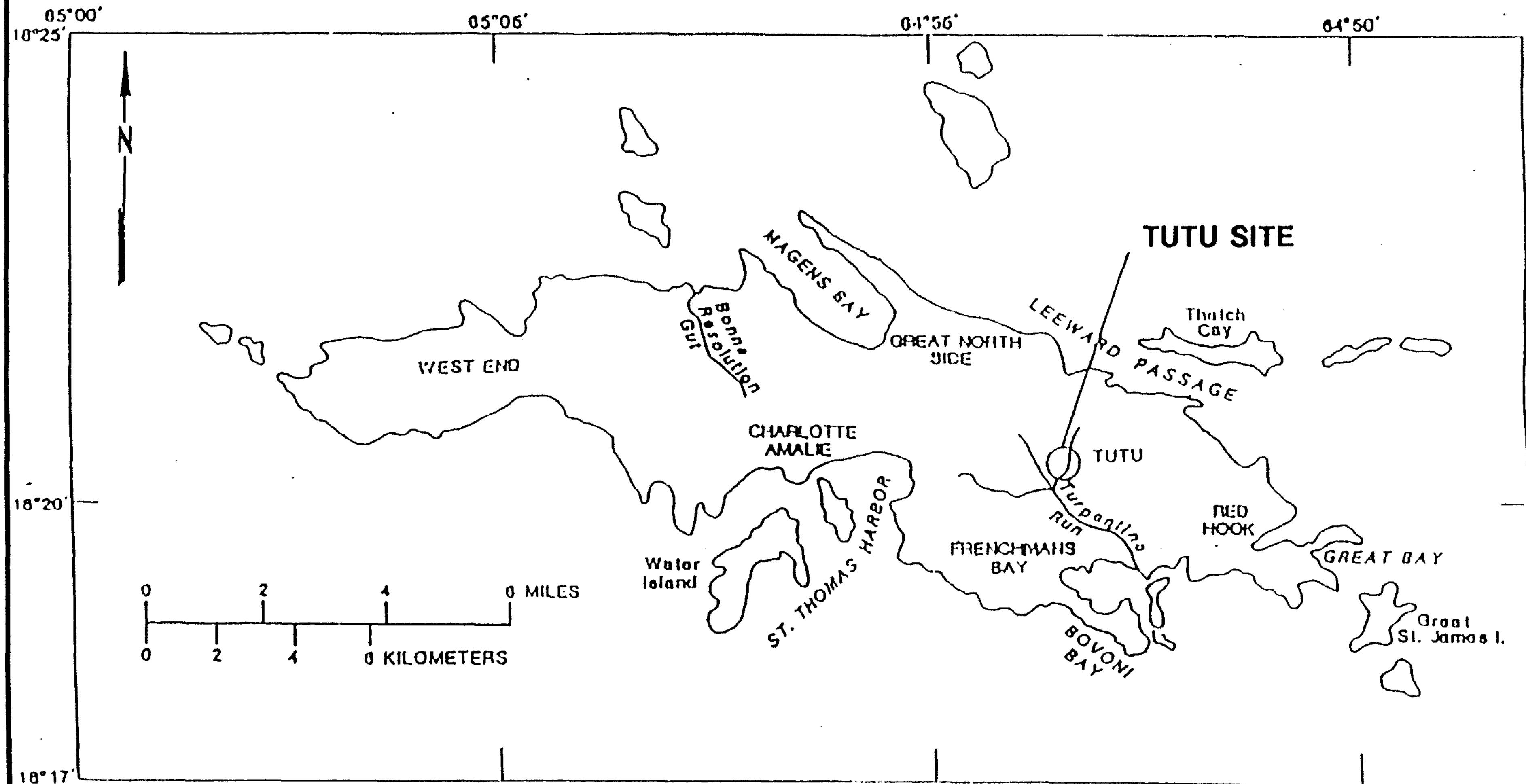
Within the area of the site, the drainage has been culverted into a storm sewer. Most of the storm sewer appears to be channelized in closed concrete pipe which drains to the unculverted portion of Turpentine Run south of the Fort Mylner shopping center. In a few locations within the site the storm sewer is open to the environment.

Hydrogeology

In the Turpentine Run basin, two hydraulically interconnected aquifers are present. Groundwater in both aquifers generally exists under water-table conditions. The groundwater flow direction is to the south/southeast along the valley gut.

Locally, the primary aquifer is comprised of fractured volcanic rock of the following formations: Water Island, Louisenhoj, and Cabes Point Conglomerate. Rainfall of at least 2 inches within a 24-hour period is necessary for recharge to occur in upper basin. The fractured bedrock aquifer is non-homogeneous and anisotropic (i.e., its ability to transmit water is not equal or similar in all directions).

The secondary aquifer consists of the alluvial deposits in the lower basin. The alluvial deposits present in the upper basin are very thin (2 to 20 feet thick) and do not constitute an aquifer capable of supplying useable amounts of water.



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GERAGHTY & MILLER, INC.
Environmental Services

SCALE: SHOWN

TURPENTINE RUN BASIN

TUTU WELLS SITE

ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 2-2

Source: Modified from Figure 1-1 in Geraghty & Miller, Inc., 1993a.

Groundwater from the site does not appear to discharge to surface waters in the area of investigation, except for potential episodic discharge to the storm sewer during periods of highwater table.

<u>Soils</u>

At least five different soil types are present at the Tutu Wells site (Rivera, et al., 1970). The flat lands of the valley areas are composed of Lavallee Gravelly Clay Loam and Glynn Clay Loam (both soils at two to five percent slopes). Soils of the hilly terrain consist of Cramer Gravelly Clay Loam (at 12 to 40 percent slopes), and Dorothea Clay Loam (at 20 to 40 percent slopes). The groundwater table is reported at a depth of greater than ten feet for all of these site soils.

2.1.3 HABITAT CHARACTERIZATION

Information regarding habitat description of the Tutu Wells site area is based upon observations made during the site visit by CDM Federal personnel in March 1994 and information provided by local experts (Appendix A) as well as the literature. No previous written habitat description for the area of the site was available for this EA.

As noted in Section 2.1.1, the site is located along a portion of a major highway and is in a commercial/industrial zone. As with the majority of St. Thomas, the original habitat no longer exist due to anthropogenic influences. A portion of the site (perhaps 50%) is covered in pavement and/or gravel or is occupied by buildings. The rest of the site, and the adjacent offsite areas, include grasslands (former pasture lands) with scattered patches of secondary growth of shrubs and trees. This habitat occurs both on the flat land and on the moderate slopes of the site area. Within the site, the grass is primarily maintained (i.e., mowed). In general, the vegetation present at the site is introduced and includes dry forest woodland species (personal communication with T. Thomas, Appendix A). The identity of the grasses/herbaceous plant species of this habitat were not identified for this EA. Tree and shrub species observed at the site include those species commonly associated with disturbed, dry conditions (personal communication with T. Thomas, Appendix A):

Scientific Name	Common Name
INDIGENOUS TREES	
Acacia tortuosa	casha
Bursera simaruba	turpentine tree
Tabebuia heterophylla	cedar
Ficus citrifolia	weeping fig
INDIGENOUS SHRUBS	
Leucaena leucocephala	tan-tan
Capparis flexuosa	limber caper (also small tree)
INTRODUCED (naturalized) TREES	
Melicoccus bijugatus	genip
Crescentia cujete	calabash

Numerous bird species and several lizards (including an iguana and anoles) were observed onsite during the March 1994 site visit. Wildlife expected to utilize these habitats include lizards and birds (as observed during the site visit) and may also include snakes, rats (introduced to the islands), bats, mongoose (introduced to the islands) and white-tailed deer (introduced to the islands).

Additional offsite habitats exist near the site that may also harbor wildlife species that may utilize areas within the site. These additional habitats include the heavily vegetated/forested areas:

- To the west of the site, behind the K-Mart shopping center, reportedly associated with a ponded wetland,

- To the south of the site, below (south/southeast of) the Fort Mylner shopping center along the Turpentine Run basin, and

- To the northeast of the site, behind the Tutu Park shopping mall.

No detailed habitat description is available for these areas and access to these areas, other than the area below the Fort Mylner shopping center, were limited during the site visit.

The aquatic habitat at the site is expected to be essentially non-existent. Onsite, the Turpentine Run is a culverted storm sewer with minimal access from the above-ground environment and with intermittent water flow. During the site visit, the only portion of the storm sewer observed to have access to the outside environment was an open concrete culvert approximately 10 feet deep and 30 feet long. This open culvert, located along the western side of route 38 at the Lutheran church, had steep (90° angle) sides and was partially fenced off. Weedy vegetation and a large tree were present adjacent to the open culvert. The open culvert appeared to contain less than 2 inches of sediments and water on the cement bottom. No reports of fauna inhabiting the culverted portion of the Run have been found during the search for site information.

In the offsite area adjacent to the site, the major aquatic habitat appears to be the unculverted Turpentine Run below the Fort Mylner shopping center. In this area, the Run is reported to flow throughout the year. It is reported that wastewater discharge from several wastewater treatment plants feed into the Run at this point. The upper basin of Turpentine Run was reported to have had a significant freshwater shrimp and crayfish population in the past, however, anthropogenic pollution has greatly reduced the diversity and richness of this Run (personal communication with H. Wright and with D. Grigg, Appendix A). Cattle egrets have been observed in this portion of the Run (personal communication with H. Wright, Appendix A).

2.1.4 NATURE AND EXTENT OF CONTAMINATION

Sources of analytical data for this EA were:

- Technical Memorandum II - Results of the Field Program Tutu Service Station Investigation (Geraghty & Miller, June 1993a).

- CDM Federal Programs Corporation (CDM Federal's) Comparison and Evaluation Report for Groundwater and Soil Split Samples at the Tutu Wells Site (CDM Federal, June 1993).

- CDM Federal's sampling reports for the September 1988 and June 1989 sampling events (CDM Federal, Sampling Trip Report, September 30, 1988 and Data Comparison and Evaluation Report, June 8, 1993).

The March 1994 site visit provided additional, descriptive information used to distinguish which data were appropriate for evaluation in this EA.

For the purposes of this EA, data from subsurface soils (soil under pavement or from depths greater than two feet) were not evaluated. These depths are greater than that which are considered likely for potential contact with ecological receptors (i.e., burrowing animals or roots of vegetation). Thus, ecological receptors are considered to be isolated from the contaminants contained in the subsurface soils.

Surface water data were also eliminated from consideration in this EA. Although there is a potential for contaminated groundwater to enter into the storm sewer system at the site (personal communication with T. Danahy, 1994), there is highly limited access to the surface water onsite (due to the closed culvert system). Offsite, in the Turpentine Run below Fort Mylner shopping center, where the storm sewer waters combines with other branches of the drainage, other pollutant sources (such as waste water treatment plant discharge, personnal communication with D. Grigg and with J. Wright, Appendix A) are expected to confound potential contaminant levels from the site.

Likewise, groundwater data were not used in this EA as ecological receptors are not likely to consistently contact contaminants associated with the groundwater (thus the exposure to contaminants from groundwater is not considered to be on the same order of magnitude as the exposure through other media).

Surface soil data (which is generally collected from zero to two feet below ground surface) are the only analytical data considered within this EA since surface soil was the only medium considered as a source of exposure to ecological receptors. Due to the similarity of habitat and variety of potential contaminant sources, the surface soil data were considered together (not placed into discrete property groupings) for this EA.

The following data used in this EA are described below and summarized in Table 2-1.

Surface Soils

Surface soils have been collected at the Tutu Wells site via soil boring, hand augering, and hand trowelling during the following sampling events.

Eight surface soil samples (SS-1 through SS-8) were collected by Geraghty & Miller from seven locations in August 1992 (Geraghty & Miller, 1992). These soils were collected by stainless steel trowel. During this sampling event, eight split surface soil samples collected by Geraghty & Miller (one at each of the eight sampling locations) and were accepted by

TABLE 2-1
SUMMARY OF DATA FOR THE ECOLOGICAL ASSESSMENT
TUTU WELLS SITE

Sampling Grouping	Sample Depth (feet)	Sample Identification	Parameters Analyzed
SURFACE SOIL			
Surface soil collected by trowel	0-2	Four sample locations from August 1992: SS-3[1], SS-3-CDM[2] SS-4, SS-4-CDM[2] SS-5, SS-5-CDM[2] SS-6, SS-6-CDM[2] SS-6 FR (otherwise known as SS-7)	TCL VOCs, TCL SVOCs, TAL Metals and CN
		Three background locations from August 1992: SS-1, SS-1-CDM[2] SS-2, SS-2-CDM[2] SS-8, SS-8-CDM[2]	TAL Metals and CN
Surface soil collected from borings by split-spoon sampler	0-2	Two sample locations from August 1992: B-2, B-13A One sample, location from April 1994: MW-16, MW-16 FR	TCL VOCs[1], TCL SVOCs, TAL Metals and CN, TPHs[3]
Surface soil collected by hand auger		Thirteen sample locations from September 1988 and June 1989:	TCL VOCs, TCL SVOCs, TAL Metals and CN, TCL Pest./PCBs, TPHs[5]
	0-2	e-01	
	0-2	eC-09s	
	0.5-1	eC-10s	
	0.25-1	eL-02-01s	
	0-0.5	eL-02-02s	
	0.25-1	eL-02-03s	
	0.5-1.25	eO-02-01	
	0.5-1.25	eO-02-03	
	0.17-1	eR-02-02s	
	0.3-1	eR-07s	
	0.25-0.75	eR-08s	
	0-2	eTT-14	
	0-2	eTT-15	

TABLE C-2
BIOACCUMULATION FACTORS
TUTU WELLS SITE

CHEMICAL	BIOACCUMULATION FACTOR[1]			
	EARTHWORM	SMALL MAMMAL	BIRD	REPTILE/ AMPHIBIAN
VOLATILE ORGANICS				
Benzene	1	1	1	1
2-Butanone	1	1	1	1
Ethylbenzene	1	1	1	1
4-Methyl-2-pentanone	1	1	1	1
Methylene Chloride	1	1	1	1
Tetrachloroethylene	1	1	1	1
Trichloroethylene	1	1	1	1
Toluene	1	1	1	1
Xylenes (Total)	1	1	1	1
SEMI-VOLATILE ORGANICS				
Acenaphthlene	1	1	1	1
Benzo(b)fluoranthene	1	1	1	1
Benzoic acid	1	1	1	1
Benzo(g,h,i)perylene	1	1	1	1
Benzo(a)pyrene	1	1	1	1
Bis(2-ethylhexyl)phthalate	1	1	1	1
Chrysene	1	1	1	1
Di-n-butylphthalate	1	1	1	1
2,4-Dimethylphenol	1	1	1	1
Fluoranthene	1	1	1	1
Fluorene	1	1	1	1
2-Methylphenol	1	1	1	1
4-Methylphenol	1	1	1	1
Naphthalene	1	1	1	1
Phenol	1	1	1	1
Pyrene	1	1	1	1

TABLE C-2
BIOACCUMULATION FACTORS
TUTU WELL SITE

CHEMICAL	BIOACCUMULATION FACTOR[1]			
	INVERTEBRATE	SMALL MAMMAL	BIRD	REPTILE
PESTICIDES/PCB'S				
Endosulfan I	1	1	1	1
Aroclor-1242	5.82[2]	1	1	1
INORGANIC COMPOUNDS				
Aluminum	1	1	1	1
Antimony	1	1	1	1
Arsenic	0.19[3]	1	1	1
Barium	1	1	1	1
Cadmium	4[4]	2[8]	1	1
Chromium	1.26[3]	1	1	1
Cobalt	1	1	1	1
Copper	6.83[5]	1	1	1
Iron	1	1	1	1
Lead	1	1	1	1
Manganese	1	1	1	1
Nickel	1.82[6]	1	1	1
Sodium	1	1	1	1
Vanadium	1	1	1	1
Zinc	8.32[7]	0.77[8]	1	1
Cyanide	-	-	-	-

TABLE C-2
BIOACCUMULATION FACTORS
TUTU WELL SITE

NR =Not reported.

1 Bioaccumulation factors were conservatively estimated as 1 when empirical data were unavailable.

2 Earthworm bioaccumulation factor values (Diercxsens et al., 1985).

3 Earthworm bioaccumulation factor values (Beyer and Chromartie, 1987).

4 Estimation of bioaccumulation factor value for carnivorous invertebrates as reported in invertebrates (Roberts and Johnson (1978) as reported in Hughes et al., 1980).

5 Estimation of isopod bioaccumulation factor value (Wieser et al. (1976) as reported in Hughes et al., 1980).

6 Earthworm bioaccumulation factor value (Kabata-Pendias and Pendias, 1984).
7 Estimation of earthworm bioaccmulation factor value (Hughes et al. 1980).

8 Estimation of bioaccumulation factor values for invertebrate-eating small mammal (Roberts and Johnson (1978) as reported in Hughes et al., 1980).

TABLE C-3
SUMMARY OF INGESTION TOXICITY DATA
TUTU WELLS SITE

CHEMICAL	SPECIES	TEST ENDPOINT	DURATION	MEASURED EFFECT	REPORTED VALUE	REFERENCE	RTV (mg/kg/day)
VOLATILE ORGANICS							
Benzene	Rat	acute LD_{50}	single dose	tremor/convulsion mortality	930 mg/kg	RTECS, 1993	lizard-93 hawk-93
2-Butanone	Rat	chronic NOAEL	NR	birth weight	1771 mg/kg/day	IRIS, 1993	lizard-177.1 hawk-177.1
Ethylbenzene	Rat	subchronic NOAEL	NR	liver and kidney	136 mg/kg/day	IRIS, 1993	lizard-13.6 hawk-13.6
Methylene Chloride	Rat	subchronic NOAEL	NR	liver toxicity	5.85 mg/kg/day	IRIS, 1994	lizard-0.59 hawk-0.59
4-Methyl-2-pentanone	Guinea pig	acute LD_{50}	single dose	NR	1600 mg/kg	RTECS, 1994	lizard-3.2 hawk-3.2
Tetrachloroethylene	Mouse	subchronic NOAEL	6 weeks	liver toxicity	14 mg/kg/day	IRIS, 1994	lizard-1.4 hawk-1.4
Trichloroethylene	Rat	acute LD_{50}	single dose	mortality	7617 mg/kg	RTECS, 1993	lizard-15.23 hawk-15.23
Toluene	Rat	chronic NOAEL	NR	liver and kidney	223 mg/kg/day	IRIS, 1993	lizard-22.3 hawk-22.3
Xylenes	Rat	acute LD_{50}	single dose	liver/kidney/ureter/ bladder, mortality	4300 mg/kg	RTECS, 1993	lizard-8.6 hawk-8.6

TABLE C-3
SUMMARY OF INGESTION TOXICITY DATA
TUTU WELLS SITE

CHEMICAL	SPECIES	TEST ENDPOINT	DURATION	MEASURED EFFECT	REPORTED VALUE	REFERENCE	RTV (mg/kg/day)
SEMI-VOLATILE ORGANICS							
Acenaphthene	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Benzoic Acid	Mouse	acute LD_{50}	single dose	gastrointestinal and respiratory effects	1940 mg/kg	RTECS, 1994	lizard-3.9 hawk-3.9
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	Mouse	chronic NOAEL	NR	NR	30 mg/kg	USEPA, 1980	lizard-3 hawk-3
Bis(2-ethylhexyl)phthalate	Rat	chronic NOAEL	1 year	NR	1300 mg/kg/day	Krauskopf, 1973	lizard-130 hawk-130
Chrysene	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	Rat	chronic NOAEL	NR	mortality	125 mg/kg/day	IRIS, 1993	lizard-12.5 hawk-12.5

TABLE C-3
SUMMARY OF INGESTION TOXICITY DATA
TUTU WELLS SITE

CHEMICAL	SPECIES	TEST ENDPOINT	DURATION	MEASURED EFFECT	REPORTED VALUE	REFERENCE	RTV (mg/kg/day)
SEMI-VOLATILE ORGANICS (Cont'd)							
2,4 Dimethylphenol	Mouse	chronic NOAEL	90 days	blood changes and lethargy	50 mg/kg/day	IRIS, 1994	lizard-9 hawk-9
Fluoranthene	Mouse	chronic NOAEL	13 weeks	kidney effects	125 mg/kg/day	IRIS, 1994	lizard-12.5 hawk-12.5
Fluorene	Mouse	chronic NOAEL	13 weeks	blood changes	125 mg/kg/day	IRIS, 1994	lizard-12.5 hawk-12.5
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA
Phenol	Rat	acute LD_{50}	single dose	behavioral	317 mg/kg	RTECS, 1994	lizard-0.634 hawk-0.634
Pyrene	Mouse	chronic NOAEL	13 weeks	kidney effects	75 mg/kg/day	IRIS, 1994	lizard-7.5 hawk-7.5

TABLE C-3
SUMMARY OF INGESTION TOXICITY DATA
TUTU WELLS SITE

CHEMICAL	SPECIES	TEST ENDPOINT	DURATION	MEASURED EFFECT	REPORTED VALUE	REFERENCE	RTV (mg/kg/day)
PESTICIDES/PCBs							
Aroclor-1242	Mink	acute LD_{50}	single dose	mortality	3000 mg/kg	Eisler, 1986b	lizard-6 hawk-6
Endosulfan I	Duck	acute LD_{50}	single dose	NR	33 mg/kg	RTECS, 1994	lizard-0.07 hawk-0.07

TUT 007 0775

TABLE C-3
SUMMARY OF INGESTION TOXICITY DATA
TUTU WELLS SITE

CHEMICAL	SPECIES	TEST ENDPOINT	DURATION	MEASURED EFFECT	REPORTED VALUE	REFERENCE	RTV (mg/kg/day)
INORGANIC COMPOUNDS							
Aluminum	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA
Arsenic	California Quail	Acute LD_{50}	single dose	mortality	47.6 mg/kg	Eisler, 1988a	lizard-0.1 hawk-0.2
Barium	NA	NA	NA	NA	NA	NA	NA
Cadmium	Mallard	chronic NOAEL	90 days	NR	200 mg/kg/day	Eisler, 1985	lizard-20 hawk-40
Chromium (CR^{+3}) Chromium (CR^{+6})	Rat Black duck	chronic LOAEL chronic NOAEL	840 days 5 months	various effects growth patterns altered	1468 mg/kg/day 8 mg/kg/day	IRIS, 1993 Eisler, 1986a	lizard-146.8 hawk-146.8 lizard-0.8 hawk-1.6
Cobalt	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA

TUT 007 0776

TABLE C-3
SUMMARY OF INGESTION TOXICITY DATA
TUTU WELLS SITE

CHEMICAL	SPECIES	TEST ENDPOINT	DURATION	MEASURED EFFECT	REPORTED VALUE	REFERENCE	RTV (mg/kg/day)
INORGANIC COMPOUNDS (Cont'd)							
Lead	Sheep	chronic NOAEL	NR	NR	5 mg/kg/day	Eisler, 1988b	lizard-0.5 hawk-0.5
Manganese	Rat	acute LD_{50}	single dose	NRA	9000 mg/kg	RTECS, 1994	lizard-18 hawk-18
Nickel	Rat	chronic NOAEL	NR	organ/body weight	5 mg/kg/day	IRIS, 1993	lizard-0.5 hawk-0.5
Sodium	NA	NA	NA	NA	NA	NA	NA
Vandium	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA
Cyanide	Rat	chronic NOAEL	NR	various effects	10.8 mg/kg/day	IRIS, 1993	lizard-1.08 hawk-1.08

RTV = Reference Toxicity Value

NR = Details not reported

NA = Data not available

TABLE 2-1
SUMMARY OF DATA FOR THE ECOLOGICAL ASSESSMENT
TUTU WELLS SITE
(CONTINUED)

CN	denotes cyanide
Pest/PCBs	denotes pesticide/polychlorinated biphenyls
SVOCs	denotes semivolatile compounds
TAL	denotes USEPA Target Analyte List
TCL	denotes USEPA Target Compound List
VOCs	denotes volatile compounds

1 Additional volatile compound list analyzed: 1,2-dibromoethane, tertiary-butyl methyl ether, n-propylbenzene.

2 Split sample accepted by CDM Federal.

3 Soil samples B-2, MW-16, and MW-16 FR only.

4 Soil samples eL-02-01s, eL-02-02s, eL-02-03s, eO-02-01, eO-02-03, and eR-02-02s only.

5 Soil samples eO-02-01 and eO-02-03 were analyzed twice for TPH.

CDM Federal for analysis. Surface soil samples collected at locations SS-1, SS-2, and SS-8 were analyzed for TAL metals and cyanide only and are considered background samples.

Several surface soil samples were collected by Geraghty & Miller during a soil investigation to identify source areas of petroleum hydrocarbon products and selected chlorinated compounds. Surface soil samples were collected from borings made during August 1992. The soil samples applicable to this EA are the surface soil samples (0-2 foot depth) from soil borings B-2 and B-13A.

Surface soil samples were collected by CDM Federal in September 1988 and June 1989 by hand auger. Seven of the nine surface soil samples collected during the September 1988 sampling event can be used as surface soil data:

Sample	General Location
e-01	O'Henry dry cleaners
eR-07s, eR-08s	Ramsay motor company
eC-09s, eC-10s	Antilles auto parts
eTT-14, eTT-15	Tillett Gardens

Two soil samples collected at the Texaco gas station (eT-02s and eT-02sd) can no longer be considered as surface soil, as the sample locations were observed to be paved over during a recent site visit (March 1994).

Six surface soil samples were collected during the June 1989 sampling event:

Sample	General Location
eO-02-01, eO-02-03	O'Henry dry cleaners
eL-02-01s, eL-02-02s, eL-02-03s	Curriculum center building

These samples were collected at various depths (up to two feet) and for numerous analytes, refer to Table 2-1.

Several surface soil samples were collected from one location (MW-16) by Geraghty & Miller during the installation of additional monitoring wells. Surface soil samples were collected from borings made during April 1994. These soil samples, MW-16 and MW-16FR, were collected from the following depths: 0-2 feet for VOCs and 0-3 feet for all other parameters.

Analytical results for site surface soil are summarized in Table 2-2 and includes a number of organic and inorganic analytes. Analytical results for surface soils considered background are summarized in Table 2-3 and includes only two inorganic analytes.

Prior to the tabulation of data, results were averaged for surface soil locations with duplicate and/or split sample results. Sample locations that were affected included SS-3, SS-4, SS-5, and SS-6. Results were averaged in the following manner:

- If both results were not detected values, the "non-detect" results were averaged.

- If both results were detected values, the results were averaged unless one of the results was 2.5 times or greater than the other. In that instance, the larger value was used.

- If one of the results had been rejected (i.e., qualified with an "R"), the value for the non-rejected result was used.

DATA SUMMARY OF CHEMICALS IN SITE SURFACE SOILS
TUTU WELLS SITE

	Frequency of Detection	Range of Detected Concentrations Minimum	-	Maximum	Location of Maximum	Range of Non-Detect Concentrations Minimum	-	Maximum
CHEMICALS								
VOCs (ug/kg)								
Methylene Chloride	1/16	---	-	1.0 J	MWS-16-AVD	8 UJ	-	14000 UB
2-Butanone	1/17	---	-	44.5 J	SS-3-AVS	11 UJ	-	11000 U
Trichloroethylene	2/19	1.0 J	-	65 J	SS-3-AVS	6.0 U	-	14000 U
Benzene	2/19	6.0 J	-	45 J	eC-10S	6.0 U	-	14000 U
4-Methyl-2-pentanone	2/19	8.0 J	-	33 J	eC-10S	11 U	-	27000 U
2-Hexanone	1/19	---	-	55 J	eR-07S	11 U	-	27000 U
Tetrachloroethylene	5/19	15	-	440000	e-01	6.0 U	-	880 U
Toluene	5/19	2.0 J	-	1300	eC-10S	6.0 U	-	14000 UJ
Ethylbenzene	5/19	3.0 J	-	2100	eC-10S	6.0 U	-	14000 UJ
Xylenes(Total)	9/20	1.0 J	-	5600	eC-10S	6.0 UJ	-	14000 UJ
SVOCs (ug/kg)								
Phenol	2/12	39 NJ	-	900000	eL-02-01S	350 U	-	11000 UJ
2-Methylphenol	1/12	---	-	320000	eL-02-01S	350 U	-	11000 UJ
4-Methylphenol	1/12	---	-	1300000 J	eL-02-01S	350 U	-	11000 UJ
2,4-Dimethylphenol	1/12	---	-	42000 J	eL-02-01S	350 U	-	11000 UJ
Benzoic acid	1/7	---	-	63 JN	SS-6-AVS	1800 U	-	380000 U
Naphthalene	3/13	4100	-	7700 J	eL-02-01S	350 U	-	1300 UJ
2-Methylnaphthalene	2/13	750 J	-	6100	eR-02-02S	350 U	-	78000 U
Acenaphthene	1/13	---	-	190 J	eR-02-02S	350 U	-	78000 U
Fluorene	1/13	---	-	420 J	eR-02-02S	350 U	-	78000 U
Di-n-butylphthalate	3/13	52 J	-	9400 J	SS-3-AVS	34 J	-	78000 U
Fluoranthene	2/13	100 J	-	740 J	eR-02-02S	350 U	-	78000 U
Pyrene	3/13	76 J	-	2000	eR-02-02S	350 U	-	78000 U
Chrysene	1/13	---	-	59 J	SS-5-AVS	350 U	-	78000 U
Bis(2-ethylhexyl)phthalate	1/13	---	-	5400	eR-02-02S	136 UBJ	-	78000 U
Benzo(b)fluoranthene	2/13	84 J	-	870 J	eR-02-02S	350 U	-	78000 U
Benzo(a)pyrene	2/13	270 J	-	770 J	eR-02-02S	350 U	-	78000 U
Benzo(g,h,i)perylene	3/13	82 J	-	430 J	eR-02-02S	350 U	-	78000 U

DATA SUMMARY OF CHEMICALS IN SITE SURFACE SOILS
TUTU WELLS SITE

	Frequency of	Range of Detected Concentrations		Location of	Range of Non-Detect Concentrations	
	Detection	Minimum	Maximum	Maximum	Minimum	Maximum
CHEMICALS						
PESTICIDES/PCBs (ug/kg)						
Endosulfan I	1/13	---	92	eL-02-01S	9 U	1700 UJ
Aroclor-1242	1/13	---	120000 J	eTT-15S	90 U	1100 UJ
INORGANICS and CYANIDE (mg/kg)						
Aluminum	3/7	21100	27350	MWS-16-AVD	21300	26950
Antimony	1/7	---	5.90 BJ	B-2	4.08 UBNJ	6.35 UBNJ
Arsenic	2/7	2.1	13.7	B-13A	1.46 UBWJ	18.65 UJ
Barium	3/7	33.9 B	67.2	B-2	44.20 UB	96.25 U
Beryllium	4/7	0.19 B	0.27 B	MWS-16-AVD	0.18 U	0.23 UJ
Cadmium	1/7	---	0.7 B	MWS-16-AVD	0.48 U	0.7 U
Calcium	3/7	47200	73200 *	B-13A	35900	56050
Chromium	3/7	23.6	42.2 J	MWS-16-AVD	19.93 UNJ	33.95 UNJ
Cobalt	3/7	16.3	25.55 J	MWS-16-AVD	13.85 UJ	22.75 UJ
Copper	3/7	52	108.7	MWS-16-AVD	54.95 UJ	79.65 UNJ
Iron	3/7	29400	38400	B-2	27725 J	48800
Lead	4/7	3.1	86.35 SJ	SS-5-AVS	11.30 J	19.95 J
Magnesium	3/7	17100	23550	MWS-16-AVD	9742.50 J	18900
Manganese	3/7	834	872	MWS-16-AVD	699.50 UJ	886 U
Nickel	3/7	14.7	21.7	MWS-16-AVD	11.50 UJ	18.15 U
Potassium	7/7	125.25 B	7625 UJ	SS-3-AVS	---	---
Silver	6/7	0.75 BJ	2.2 J	B-2	---	0.64 U
Sodium	2/7	319 B	470 B	B-13A	273.25 UBJ	488.50 UB
Vanadium	3/7	83.1	119	B-2	72.65 UNJ	96.50 UNJ
Zinc	3/7	52.0	108	B-2	95.75 UJ	318
Cyanide, total	1/7	---	1.1	B-2	0.53 U	0.64 U
TOTAL PETROLEUM HYDROCARBONS (TPH) (mg/kg)						
TPH	9/15	15.70 J	23400	eR-02-02S	0.17 J	1.93 J

DATA SUMMARY OF CHEMICALS IN SITE SURFACE SOILS
TUTU WELLS SITE

Sample Group for VOCs:	e-01	eL-02-01S	eO-02-01	eR-07S	eTT-14S	SS-3-AVS
B-2	eC-09S	eL-02-02S	eO-02-03	eR-08S	eTT-15S	SS-4-AVS
B-13A	eC-10S	eL-02-03S		eR-02-02S		SS-5-AVS
MWS-16-AVD						SS-6-AVS
Sample Group for SVOCs:	B-2	eL-02-01S	eO-02-01	SS-3-AVS	SS-5-AVS	
	B-13A	eL-02-02S	eO-02-03	SS-4-AVS	SS-6-AVS	
	MWS-16-AVD	eL-02-03S	eR-02-02S			
Sample Group for Pesticides/PCBs:		e-01	eL-02-01S	eO-02-01	eR-07S	eTT-14S
		eC-09S	eL-02-02S	eO-02-03	eR-08S	eTT-15S
		eC-10S	eL-02-03S		eR-02-02s	
Sample Group for Inorganics and Cyanide:		B-2	MWS-16-AVD	SS-3-AVS	SS-5-AVS	
		B-13A		SS-4-AVS	SS-6-AVS	
Sample Group for TPH:	B-2	eC-09S	eL-02-01S	eO-02-01	eR-07S	eTT-14S
	MWS-16-AVD	eC-10S	eL-02-02S	eO-02-03	eR-08S	eTT-15S
	e-01		eL-02-03S		eR-02-02s	

NOTE: Two TPH result values were reported for eO-02-01 and eO-02-03. The two values were averaged to create the representative result for the two samples.

EPA Data Qualifiers:
U - Analyte was analyzed for but not detected
J - Estimated value
B - For organic parameters:
Compound found in the associated blank as well as in the sample
For inorganic parameters:
Reported value was obtained from a reading that was less than the Contract Required Detection Limit, but greater than or equal to the Instrument Detection Limit
N - Presumptive evidence of a compound
S - The reported value was determined to by the Method of Standard Additions
W - Post-digestion spike for Furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance
* - *Duplicate analysis not within control limits*

DATA SUMMARY OF CHEMICALS IN SURFACE SOILS CONSIDERED BACKGROUND
TUTU WELLS SITE

	Frequency of Detection	Range of Detected Concentrations Minimum		Range of Detected Concentrations Maximum	Location of Maximum	Range of Non-Detect Concentrations Minimum		Range of Non-Detect Concentrations Maximum
CHEMICALS								
INORGANICS and CYANIDE (mg/kg)								
Beryllium	3/3	0.16 B	-	0.24 B	SS-8-AVS	---	-	---
Silver	2/3	1.44 B	-	1.60 B	SS-2-AVS	---	-	1.33 UJ

Sample Group:
SS-1-AVS, SS-2-AVS, SS-8-AVS

EPA Data Qualifiers:
U - Analyte was analyzed for but not detected
J - Estimated value
B - Reported value was obtained from a reading that was less than the Contract Required Detection Limit, but greater than or equal to the Instrument Detection Limit

- When one of the results was a non-detected result and the other a detected result, the average of the sum of the detected result plus half the non-detected result was used, unless half of the non-detected result was greater than the detected value. In this instance, only the value of the detected result was used.

Additionally, the results were adjusted to account for the results of blank samples (i.e., trip blanks and field blanks) in accordance with the EPA guidance Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Interim Final), OSWER Directive 9285.7-Ola, September 29, 1989. Briefly, the procedure used to account for contaminants found in blanks is twofold:

- The concentration of the parameter detected in the blank is multiplied by a factor of five (a parameter that is not considered by EPA to be a common laboratory contaminant) or ten times (a parameter that is considered by EPA to be common laboratory contaminant). This is the blank comparison value.

- This value is then compared to the detected sample results for that parameter. If a sample result value is less than the blank comparison value, then that parameter is now considered not detected for that particular sample and the blank-related concentration of the chemical is considered the new sample quantitation limit.

Site surface soil samples were analyzed, for TCL organic compounds, TAL inorganic analytes and cyanide, and total petroleum hydrocarbons, although not all samples for all analytes (Table 2-2). Ten VOCs were detected in site surface soils. Detected concentrations range from approximately 1.0 to 440,000 micrograms/kilogram (μg/kg). Detection frequencies ranged from approximately 6 (1/16) to 45 percent (9/20).

Seventeen SVOCs were detected in site surface soils. Detected concentrations ranged from nearly 40 to 1,300,000 μg/kg. Detection frequencies for SVOCs were from approximately 8

(1/13) to 23 percent (3/13).

One pesticide, Endosulfan I, was detected at a concentration of 92 μg/kg and at only one location of thirteen surface soil sample locations (detection frequency of approximately 8 percent).

One PCB congener, Aroclor-1242, was detected at a concentration of 120,000 μg/kg, and at only one location of thirteen surface soil sample locations (detection frequency of approximately 8 percent).

Twenty TAL inorganics and cyanide were detected in site surface soils. Concentrations of the inorganic analytes ranged from 0.19 to 73,200 milligrams/kilogram (mg/kg). The detection frequencies for the inorganic analytes ranged from approximately 14 (1/7) to 100 percent (7/7). Cyanide was detected in only one surface soil location where was tested for (detection frequency of 1/7) and at a concentration of 1.1 mg/kg.

Total petroleum hydrocarbons were detected at eight of the fifteen surface soil locations where it was tested for and at a concentration ranging from 15.7 to 23,400 mg/kg.

Surface soil samples considered as background were analyzed for TAL inorganic analytes and cyanide. As presented in Table 2-3, two TAL inorganic analytes, beryllium and silver, were detected in the background surface soil. Beryllium was detected in all of the background surface soil locations (detection frequency of 3/3) at a concentration range of 0.16 to 0.24 mg/kg. Silver was detected at a frequency of approximately 67 percent (2/3) at a concentration range of 1.44 to 1.6 mg/kg.

2.2 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

The selection of chemicals of potential concern (COCs) is used to narrow the focus of the ecological risk assessment. The selection process serves to identify dominant site risk and to guide future remediation selection decisions. The selection process used was based upon methodology present in EPA's Risk Assessment Guidance for Superfund (RAGs), Volume II: Ecological Evaluation Manual (USEPA, 1989). The selection process for each compound involved:

- Evaluation of detection frequency, maximum, and range of concentrations;
- Comparison to background concentrations;
- Comparison to applicable and relevant and appropriate requirements (ARARs);
- Evaluation of physical/chemical properties; and,
- Consideration of potential toxicity.

The COC selection process is discussed further below.

2.2.1 DETECTION FREQUENCY

Chemicals not detected in the sampled media at frequencies greater than five percent (i.e., one detection per twenty samples) may be eliminated from the COC selection process as the likelihood of receptor exposure to these chemicals is considered remote.

Due to the small number of site surface soil samples collected and subsequently analyzed, no chemicals were detected at frequencies of five percent or less.

2.2.2 BACKGROUND CONCENTRATIONS

As discussed in Section 2.1.4, a limited number of samples were obtained from locations considered to be upgradient of the Tutu Wells site contamination. These locations provided background site surface soil inorganic analyte levels for this Endangerment Assessment. In this EA, Inorganic analyte concentrations detected from the Tutu Wells site that were within two times the detected background concentrations were not considered as potential COCs.

After comparison with the background sample analytes, both beryllium and silver were considered to have been detected at background levels in the site surface soils. Thus, beryllium and silver have been removed from consideration as potential COCs.

2.2.3 ARARS AND MEDIA QUALITY GUIDELINES

Applicable or Relevant and Appropriate Requirements (ARARs) are those standards or limitations which specifically address media and chemical contaminants that may require remediation and regulations that may apply to remedial action.

The National Contingency Plan (NCP) and Section 121 (d) of CERCLA (cleanup standard) requires that the selected remedial actions at Superfund sites attain or exceed ARARs of Federal laws and more stringent promulgated state laws.

The EPA divides ARARs into three categories: chemical-specific, location-specific, and action-specific. This distinction is based on whether the requirement is triggered by the presence or emission of a chemical, by a sensitive or protected location, or by a particular remedial action, respectively.

Chemical-specific ARARs are useful in identifying chemicals that may pose ecological risks and require remediation. Chemical-specific requirements set concentration limits or ranges in various environmental medial for specific hazardous substances, pollutants or contaminants. These requirements may present protective levels for designated media. Chemical-specific Federal and Territorial ARARs relating to the protection of ecological inhabitants have been evaluated in this EA. These ARARs exist for surface water only, thus will not be considered in this EA.

Ecologically-based Federal or Territorial criteria/guidance values do not currently exist for chemicals in soil. Thus, no surface soil COCs were eliminated from consideration due to ARARs.

2.2.4 TOXICITY CHARACTERISTICS

In a preliminary assessment of ecological toxicity characteristics for the list of chemicals in site surface soils, databases/literature (as described in Section 4.0) containing ecotoxicological data were checked. No data on the adverse effects of 2-hexanone and 2-methylnaphthalene were located. Additionally, no data were found for the adverse effects of the essential nutrients calcium, magnesium, and potassium. Due to the lack of ecotoxicity data for these chemicals, and thus their expected lack of contribution to the risk at this site, these chemicals were removed from consideration as potential COCs.

Due to the make-up and complex nature of total petroleum hydrocarbons (TPHs), the toxicity of TPHs were evaluated via the compounds xylenes, benzene, toluene, and ethylbenzene (common constituents of TPHs).

2.2.5 FINAL COC SELECTION

Chemicals of potential concern for this Tutu Wells site EA surface soils were determined to include VOCs, SVOCs, a pesticide, a PCB congener, inorganic analytes, and cyanide. These COCs are provided in Table 2-4.

2.3 RECEPTOR SPECIES AND ENDPOINTS

Indicator species for the ecological assessment were chosen to be representative of trophic levels and habitats at and surrounding the Tutu Wells site. The selection was based on an integration of the types and distribution of COCs, habitats, range and feeding habits of potential ecological receptors, and relationships between the observed/expected species in the area of concern. Other considerations in receptor species selection included species that may have beneficial uses to humans and species that are of Trustee or regulatory concerns. Selected indictor species, their habitats, diet, and trophic levels are presented below.

CHEMICALS OF POTENTIAL CONCERN FOR SITE SURFACE SOILS
TUTU WELLS SITE

	Frequency of Detection	Range of Detected Concentrations Minimum	-	Maximum	Location of Maximum	Range of Non-Detect Concentrations Minimum	-	Maximum
CHEMICALS								
VOCs (ug/kg)								
Methylene Chloride	1/16	---	-	1.0 J	MWS-16-AVD	8 UJ	-	14000 UB
2-Butanone	1/17	---	-	44.5 J	SS-3-AVS	11 UJ	-	11000 U
Trichloroethylene	2/19	1.0 J	-	65 J	SS-3-AVS	6.0 U	-	14000 U
Benzene	2/19	6.0 J	-	45 J	eC-10S	6.0 U	-	14000 U
4-Methyl-2-pentanone	2/19	8.0 J	-	33 J	eC-10S	11 U	-	27000 U
Tetrachloroethylene	5/19	15	-	440000	e-01	6.0 U	-	880 U
Toluene	5/19	2.0 J	-	1300	eC-10S	6.0 U	-	14000 UJ
Ethylbenzene	5/19	3.0 J	-	2100	eC-10S	6.0 U	-	14000 UJ
Xylenes(Total)	9/20	1.0 J	-	5600	eC-10S	6.0 UJ	-	14000 UJ
SVOCs (ug/kg)								
Phenol	2/12	39 NJ	-	900000	eL-02-01S	350 U	-	11000 UJ
2-Methylphenol	1/12	---	-	320000	eL-02-01S	350 U	-	11000 UJ
4-Methylphenol	1/12	---	-	1300000 J	eL-02-01S	350 U	-	11000 UJ
2,4-Dimethylphenol	1/12	---	-	42000 J	eL-02-01S	350 U	-	11000 UJ
Benzoic acid	1/7	---	-	63 JN	SS-6-AVS	1800 U	-	380000 U
Naphthalene	3/13	4100	-	7700 J	eL-02-01S	350 U	-	1300 UJ
Acenaphthene	1/13	---	-	190 J	eR-02-02S	350 U	-	78000 U
Fluorene	1/13	---	-	420 J	eR-02-02S	350 U	-	78000 U
Di-n-butylphthalate	3/13	52 J	-	9400 J	SS-3-AVS	34 J	-	78000 U
Fluoranthene	2/13	100 J	-	740 J	eR-02-02S	350 U	-	78000 U
Pyrene	3/13	76 J	-	2000	eR-02-02S	350 U	-	78000 U
Chrysene	1/13	---	-	59 J	SS-5-AVS	350 U	-	78000 U
Bis(2-ethylhexyl)phthalate	1/13	---	-	5400	eR-02-02S	136 UBJ	-	78000 U
Benzo(b)fluoranthene	2/13	84 J	-	870 J	eR-02-02S	350 U	-	78000 U
Benzo(a)pyrene	2/13	270 J	-	770 J	eR-02-02S	350 U	-	78000 U
Benzo(g,h,i)perylene	3/13	82 J	-	430 J	eR-02-02S	350 U	-	78000 U

CHEMICALS OF POTENTIAL CONCERN FOR SITE SURFACE SOILS
TUTU WELLS SITE

	Frequency of	Range of Detected Concentrations			Location of	Range of Non-Detect Concentrations		
	Detection	Minimum		Maximum	Maximum	Minimum		Maximum
CHEMICALS								
PESTICIDES/PCBs (ug/kg)								
Endosulfan I	1/13	---	-	92	eL-02-01S	9 U	-	1700 UJ
Aroclor-1242	1/13	---	-	120000 J	eTT-15S	90 U	-	1100 UJ
INORGANICS and CYANIDE (mg/kg)								
Aluminum	3/7	21100	-	27350	MWS-16-AVD	21300	-	26950
Antimony	1/7	---	-	5.9 BJ	B-2	4.08 UBNJ	-	6.35 UBNJ
Arsenic	2/7	2.1	-	13.7	B-13A	1.46 UBWJ	-	18.65 UJ
Barium	3/7	33.9 B	-	67.2	B-2	44.2 UB	-	96.25 U
Cadmium	1/7	---	-	0.7 B	MWS-16-AVD	0.48 U	-	0.7 U
Chromium	3/7	23.6	-	42.2 J	MWS-16-AVD	19.93 UNJ	-	33.95 UNJ
Cobalt	3/7	16.3	-	25.55 J	MWS-16-AVD	13.85 UJ	-	22.75 UJ
Copper	3/7	52	-	108.7	MWS-16-AVD	54.95 UJ	-	79.65 UNJ
Iron	3/7	29400	-	38400	B-2	27725 J	-	48800
Lead	4/7	3.1	-	86.35 SJ	SS-5-AVS	11.3 J	-	19.95 J
Manganese	3/7	834	-	872	MWS-16-AVD	699.5 UJ	-	886 U
Nickel	3/7	14.7	-	21.7	MWS-16-AVD	11.5 UJ	-	18.15 U
Sodium	2/7	319 B	-	470 B	B-13A	273.25 UBJ	-	488.50 UB
Vanadium	3/7	83.1	-	119	B-2	72.65 UNJ	-	96.50 UNJ
Zinc	3/7	52.0	-	108	B-2	95.75 UJ	-	318
Cyanide, total	1/7	---	-	1.1	B-2	0.53 U	-	0.64 U

CHEMICALS OF POTENTIAL CONCERN FOR SITE SURFACE SOILS
TUTU WELLS SITE

EPA Data Qualifiers:
U - Analyte was analyzed for but not detected
J - Estimated value
B - For organic parameters:
  Compound found in the associated blank as well as in the sample
  For inorganic parameters:
  Reported value was obtained from a reading that was less than the Contract Required Detection Limit, but greater than or equal to the Instrument Detection Limit
N - Presumptive evidence of a compound
S - The reported value was determined to by the Method of Standard Additions
W - Post-digestion spike for Furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance
* - Duplicate analysis not within control limits

Endpoints define the environmental values to be protected and form the basis of what constitutes adverse health effects for ecological receptors in this assessment. Assessment endpoints selected for this EA are described in Section 2.3.2.

2.3.1 **RECEPTOR SPECIES**

Selection of site receptors as a subset of all potential ecological receptors at the site, is an important part of the EA. Since it is not feasible to evaluate every species which may be impacted, the selection of indicator species is an accepted step to focus the EA and allow for characterization of site risk. Receptor selection is guided by the results of the site habitat characterization, resident species information and the following selection criteria. Consideration should be given to:

- Receptors having economic and/or cultural value, such as game birds or game fish;

- Species of statutory concern (such as Trustee species and those protected under Federal/state/territorial law);

- Rare, threatened, or endangered species; and

- Receptors which represent site trophic levels (to assess food chain impact and potential concern for bioaccumulation).

In addition to the considerations presented above, receptor species should meet the following additional guidelines to allow for quantification of impacts at hazardous waste site:

•Habitat Suitability. Species chosen as receptors should inhabit habitats as found onsite and/or within the area of impact. Adequate habitat must be available for species consideration.

•Occurrence. Species chosen as receptors should have been observed (or expected to occur) with some frequency on-site or within the area of site impact.

•Home Range. Species chosen as receptors should have limited ranges (largely confined to the area impacted). Species with large ranges or migrants reduce or eliminate the ability to attribute risk to site-related contamination.

Receptor species selected for the EA were chosen to be representative of trophic levels and habitats of the Tutu Wells site.

Endangered, Threatened or Special Concern Species

The status of threatened, endangered, or special concern flora and fauna at and within the vicinity of the Tutu Wells site was investigated by consulting the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Services Caribbean Field Office has identified two endangered species that may occur within the area of the site, Appendix B. These endangered species include one tree species and one reptile species, respectively:

Common name	Scientific name
St. Thomas prickly ash	*Zanthoxylum thomasianum*
Virgin Island tree boa	*Epicrates monensis granti*

Additionally, the endangered species coordinator for the St. Thomas Division of Fish and Wildlife was able to provide an additional list of endangered animals which he believed had the potential to be found in the Upper Turpentine Run basin/Tutu area. The list is composed of five bird species and two bat species and is as follows:

Common name	Scientific name
Antillean mango	*Anthracothorax dominicus*

Great (common) egret	*Casmerodius albus*
Snowy egret	*Egretta thula*
Brown-throated parakeet	*Aratinga pertinax*
Bridled quail dove	*Geotrygon mystacea*
Red fruit bat	*Stenoderma rufum*
Cave bat	*Brachyphylla cavernarum*

Receptor Species

As discussed in Section 2.1.3, birds and reptiles were observed to utilize the site habitat and additional wildlife species at the site may include snakes, rodents (rats), bats, mongoose, and white-tailed deer.

Receptor species were selected to represent the habitat and trophic levels of the Tutu Wells site. Two receptor species were chosen for the Tutu Wells site, in order to assess the potential adverse ecological risk of site chemicals in the surface soil. These are the red-tailed hawk (*Buteo jamaicensis*) and the anole lizard (*Anolis* sp.).

The red-tailed hawk was selected as an indicator species because it is expected to utilize all of the onsite habitat, is reported to be a year round resident of the Virgin Islands, and will assist in accessing contaminant bioaccumulation effects (as this species represents a higher trophic level). This species represents a secondary and tertiary consumer for the avian community for Tutu Wells site habitats.

The anole was chosen as an indicator species due to its wide expected usage of the onsite habitat, limited home range, diet of invertebrates, and its position at the base of the terrestrial foodchain. This species represents a secondary reptilian consumer within the Tutu Wells site.

The following are receptor profiles:

Red-tailed Hawk (*Buteo jamaicensis*)

Habitat: Mixed landscape, preferring old fields, pastures, and wetlands interspersed with woodland groves, bluffs, and streamside trees (USEPA, 1993).

Home: 192-1376 acres (approximately 78-556 hectares) (DeGraaf and Rudis, 1986)

Weight: 1-1.2 kg (Johnsgard, 1990)

Red-tailed hawks feed primarily on small rodents (Bull and Farrand, Jr. 1977), but will vary foods depending upon availability as this species is opportunistic and will feed on whatever species are most abundant (USEPA, 1993). Red-tailed hawks are generally territorial during the breeding period for migratory birds and all year for resident birds. Red-tailed hawk territories may range in size from one-half a square mile to greater than two square miles, depending upon the food resources and number of perching/nesting sites (Stokes and Stokes, 1989).

Anole (*Anolis* sp.)

Habitat: General preference for shrubs and trees.

Home: Details not found. Estimated as approximately the territorial size reported for *Anolis sagrei* of 400 square feet (approximately 0.0037 hectares) (Milstead, 1967).

Weight: Inferred from Ruibal et al. (1972) as 0.005 kg.

Anoles are diurnal and arboreal, yet they also forage on the ground. Their food consists primarily of insects and spiders (Connant, 1958).

Five species of anoles have been reported as inhabiting the Virgin Islands (Schwartz and Henderson, 1985), three of which *(Anolis pulchellus, A. statulus*, and *A. cristatellus*) have been reported on St. Thomas (Schwartz and Thomas, 1975).

2.3.2 ASSESSMENT ENDPOINTS

For this EA, endpoints used to evaluate potential ecological impacts were benchmark toxicity values from the literature. Individual toxicity endpoints such as survival, reproductive effects, and growth impacts were considered.

3.0 EXPOSURE ASSESSMENT

The purpose of this section is to evaluate the potential for receptor exposure to chemical constituents at the site. This evaluation involves the identification of contaminant exposure pathways that may be of concern for ecological receptors and the determination of the magnitude of exposure to selected ecological receptors.

3.1 EXPOSURE PATHWAYS

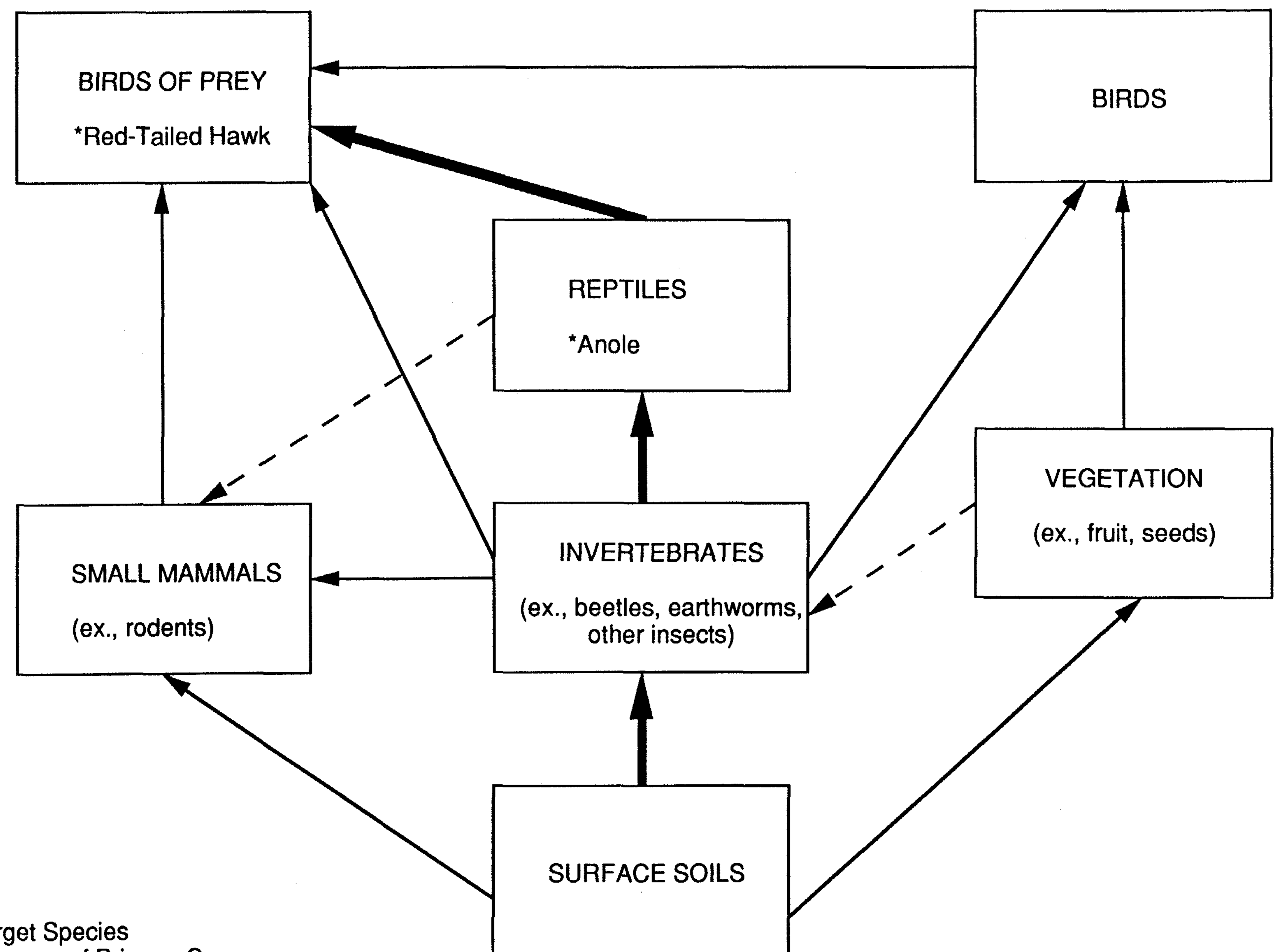
An environmental exposure pathway is the means by which contaminants are transported from a source to ecological receptors. As described in Section 2.1.4 of this report, site-related chemicals of potential concern have been detected in the surface soils of the Tutu Wells site.

Direct ecological exposure pathways to chemicals of the Tutu Wells site within the groundwater, surface water and subsurface soils are not considered to exist, since receptor contact is either absent or quite limited. The important exposure pathway to ecological receptors is that involving surface soil. Ecological receptors are those that are likely to be exposed to chemicals in surface soil onsite. Direct exposure may occur through absorption upon contact and through incidental ingestion of contaminated food items. Indirect exposure may occur through the ingestion of contaminated food items.

3.2 FOOD WEB

Several of the Tutu Wells site COCs, such as the PCB congener and some inorganics, have the potential to bioaccumulate and biomagnify through the food web. The food web is, therefore, a means of exposure for higher feeding (trophic) level to these COCs. A simplified hypothetical terrestrial food web displays suspected exposure relations for the Tutu Wells site and is presented in Figure 3-1.

FIGURE 3-1
CONCEPTUAL FOOD WEB OF THE TERRESTRIAL EXPOSURE PATHWAYS AT THE TUTU WELLS SITE



* Target Species
■ Pathways of Primary Concern

3.3 EXPOSURE SCENARIOS

Exposure scenarios were constructed for receptor species selected for Tutu Wells site COCs. Factors taken into consideration in the selection of scenarios were the spatial and temporal variations in exposure, mechanisms of migration, points of exposure, behavioral characteristics and trophic relationships. Table 3-1 presents these scenarios and includes the likelihood of individual receptor exposure for the surface soil exposure pathway. The following exposure routes will be evaluated in this EA:

Anole (lizard)

- Incidental ingestion of soil
- Ingestion of foodstuffs

Red-tailed Hawk

- Incidental ingestion of soil
- Ingestion of prey

3.4 EXPOSURE DOSE ESTIMATION

This subsection discussed the methods by which chemical exposures are estimated for the terrestrial target species. The models used to estimate exposure doses, in milligrams of chemical intake per kilogram of body weight per day (mg/kg/day), are presented here.

The level of potential dietary exposure (PDE) was determined by multiplying the estimated contaminant concentration in food items by the portion of the food item in the diet, summing these values, including soil exposure, and multiplying the summed value by the receptor species site foraging frequency (SFF). The following equation expresses the method of PDE determination:

TABLE 3-1
EXPOSURE SCENARIOS
TUTU WELLS SITE

Exposure Pathway	Chemicals of Potential Concern[1]	Target Receptor	
		Anole	Red-Tailed Hawk
SURFACE SOIL			
Absorption	VOCs SVOCs Endosulfan I Pesticides Aroclor-1242	Moderate: Frequent Contact	Low: Infrequent Contact
Ingestion	VOCs SVOCs Endosulfan I Pesticides Aroclor-1242 Inorganics	Moderate: Incidental while foraging	Moderate: Incidental while foraging
Food Web Transfer	Aroclor-1242 Inorganics	High: Forages primarily on terrestrial invertebrates	High: Forages primarily on terrestrial prey

"Low" denotes infrequent probability of exposure, due to habitat requirements and/or receptor behavior.

"Moderate" denotes probability of exposure occasional, due to limited migration and/or foraging range.

"High" denotes high probability of exposure due to frequency of contact and/or extent of foraging opportunities largely confined to site.

[1]Refer to Section 2.2.4 of text for complete COC listings.

$$PDE = [P_1 \times C_1 + P_2 \times C_2 + P_n \times C_n + SE] \times SFF$$

Where

PDE	=	potential dietary exposure (mg/chemical/kg diet)
P_n	=	percent of diet for food item n
C_n	=	chemical concentration of food item n (mg chemical/kg diet), calculated by multiplying the soil chemical concentration by a bioaccumulation factor.
SE	=	soil exposure (mg/soil/kg diet), calculated by soil chemical concentration by 0.05
SFF	=	Site Foraging Frequency (unitless), calculated by the area of contaminated soil (hectares) within the home range (hectares)

The percent of the receptor diet that a specific prey item represents is given in Table C-1, of Appendix C.

To be conservative, the soil chemical concentration used for the dietary exposure determination was the maximum concentration detected in site soil samples (as given in Table 2-2).

The contaminant concentration of a food item (C_n) was calculated by multiplying the soil contaminant concentration by the food group-specific bioaccumulation factor. The bioaccumulation factors used are presented in Table C-2, of Appendix C.

Incidental soil ingestion, which is associated with foraging, preening, and cleaning activities, was conservatively assumed to represent five percent of the total dietary intake for both of the modeled receptors (i.e., lizard and hawk).

The SFF was calculated using an estimated site area of 16 hectares. The home range for each of the modeled receptor is given in Table C-1, of Appendix C.

After calculating the PDE for each COC and modeled receptor, total body doses (TBDs) were calculated. TBD estimates are directly comparable to available toxicological data (as presented in Section 4.0) and are used with the toxicological data to assess ecological risks. The TBDs were estimated using the following equation:

$$TBD = PDE \times IR \times \frac{1}{BW}$$

Where

TBD	=	total body dose (mg/kg body weight/day)
PDE	=	potential dietary exposure (mg/ diet/kg)
IR	=	ingestion rate (kg diet/day)

EXPOSURE VALUES FOR THE ANOLE
TUTU WELLS SITE

	POTENTIAL DIETARY EXPOSURES (mg chemical/kg diet)	TOTAL BODY DOSES (mg/kg body weight/day)
CHEMICALS		
VOCs (ug/kg)		
Methylene Chloride	0.001	2.56 E-05
2-Butanone	0.445	1.14 E-02
Trichloroethylene	0.065	1.66 E-03
Benzene	0.045	1.15 E-03
4-Methyl-2-pentanone	0.033	8.45 E-04
Tetrachloroethylene	440	11.26
Toluene	1.3	3.33 E-02
Ethylbenzene	2.1	5.38 E-02
Xylenes(Total)	5.6	0.143
SVOCs (ug/kg)		
Phenol	900	23.04
2-Methylphenol	320	8.19
4-Methylphenol	1300	33.28
2,4-Dimethylphenol	42	1.08
Benzoic acid	0.63	1.61 E-02
Naphthalene	7.7	0.197
Acenaphthene	0.19	4.86 E-02
Fluorene	0.42	1.08 E-02
Di-n-butylphthalate	9.4	0.241
Fluoranthene	0.74	1.89
Pyrene	2.0	5.12 E-02
Chrysene	0.59	1.51 E-02
Bis(2-ethylhexyl)phthalate	5.4	0.138
Benzo(b)fluoranthene	0.87	2.23 E-02
Benzo(a)pyrene	0.77	1.97 E-02
Benzo(g,h,i)perylene	0.43	1.1 E-02

EXPOSURE VALUES FOR THE ANOLE
TUTU WELLS SITE

	POTENTIAL DIETARY EXPOSURES (mg chemical/kg diet)	TOTAL BODY DOSES (mg/kg body weight/day)
CHEMICALS		
PESTICIDES/PCBs (ug/kg)		
Endosulfan I	0.092	2.36 E-03
Aroclor-1242	669.48	17.14
INORGANICS and CYANIDE (mg/kg)		
Aluminum	27350	700.16
Antimony	5.9	0.151
Arsenic	3.18	8.08
Barium	67.2	1.72
Cadmium	2.7	6.9 E-02
Chromium	52.62	1.35
Cobalt	25.55	0.654
Copper	710.74	18.2
Iron	38400	983.04
Lead	86.35	2.21
Manganese	872	22.32
Nickel	38.6	0.988
Sodium	470	12.03
Vanadium	119	3.05
Zinc	859.03	21.99
Cyanide, total	0.055	1.41 E-03

EXPOSURE VALUES FOR THE RED-TAILED HAWK
TUTU WELLS SITE

	POTENTIAL DIETARY EXPOSURES (mg chemical/kg diet)	TOTAL BODY DOSES (mg/kg body weight/day)
CHEMICALS		
VOCs (ug/kg)		
Methylene Chloride	5 E-05	5 E-06
2-Butanone	0.2225	2.23 E-02
Trichloroethylene	3.25 E-03	3.25 E-04
Benzene	2.25 E-03	2.25 E-04
4-Methyl-2-pentanone	1.65 E-03	1.65 E-04
Tetrachloroethylene	22	2.2
Toluene	6.5 E-02	6.5 E-03
Ethylbenzene	0.105	1.05 E-02
Xylenes(Total)	0.28	2.8 E-02
SVOCs (ug/kg)		
Phenol	45	4.5
2-Methylphenol	16	1.6
4-Methylphenol	65	6.5
2,4-Dimethylphenol	2.1	0.21
Benzoic acid	3.15 E-03	3.15 E-04
Naphthalene	0.385	3.85 E-02
Acenaphthene	9.5 E-03	9.5 E-04
Fluorene	2.1 E-02	2.1 E-03
Di-n-butylphthalate	0.47	4.7 E-02
Fluoranthene	3.7 E-02	3.7 E-03
Pyrene	0.1	1 E-02
Chrysene	2.95 E-03	2.95 E-04
Bis(2-ethylhexyl)phthalate	0.27	2.7 E-02
Benzo(b)fluoranthene	4.35 E-02	4.35 E-03
Benzo(a)pyrene	3.85 E-02	3.85 E-03
Benzo(g,h,i)perylene	2.15 E-02	2.15 E-03

EXPOSURE VALUES FOR THE RED-TAILED HAWK
TUTU WELLS SITE

CHEMICALS	POTENTIAL DIETARY EXPOSURES (mg chemical/kg diet)	TOTAL BODY DOSES (mg/kg body weight/day)
PESTICIDES/PCBs (ug/kg)		
Endosulfan I	4.6 E-03	4.6 E-04
Aroclor-1242	6.87	0.687
INORGANICS and CYANIDE (mg/kg)		
Aluminum	1367.5	136.75
Antimony	0.295	2.95 E-02
Arsenic	0.668	6.68 E-02
Barium	3.36	0.336
Cadmium	6.265 E-02	6.27 E-03
Chromium	2.13	0.213
Cobalt	25.55	2.56
Copper	6.39	0.639
Iron	1920	192
Lead	4.32	0.432
Manganese	43.6	4.36
Nickel	1.11	0.111
Sodium	23.5	2.35
Vanadium	5.95	0.595
Zinc	5.72	0.572
Cyanide, total	2.75 E-03	2.75 E-04

BW	=	body weight (kg)

Species-specific ingestion rates and body weights used in this assessment are reported in Table C-1.

Calculated exposure values (PDEs and TBDs) for each of the target receptor species (anole, red-tailed hawk) are presented in Tables 3-2 and 3-3.

4.0 TOXICITY ASSESSMENT

The goal of the toxicity assessment is to determine of the toxic effects of COCs of the Tutu Wells site on the selected ecological receptors. As part of an ecological toxicity assessment, site-specific toxicity study results are important to consider. However, site-specific toxicity results were not available for the Tutu Wells Site.

Benchmark toxicity values were sought and utilized in this assessment. A comprehensive literature/database search was performed to identify benchmark toxicity values for COCs. Data sources reviewed included:

- Hazardous Substance Database (HSDB)
- Registry of Toxic Effects of Chemical Substances (RTECS)
- Integrated Risk Information System (IRIS)

Additionally, toxicity values were obtained from several primary literature sources (as referenced).

Where possible, toxicity values from the literature were selected using closely-related species. When available, chronic toxicity data were preferentially used. The no observed adverse effect levels (NOAEL) for COCs were preferentially selected as the reference toxicity values (RTVs) used in this assessment.

Often, toxicity data were not available for terrestrial wildlife species and the extrapolation of toxicity values from other animal studies. A correction factor of 0.2 was used to determine the RTV when the available toxicity value was within the same taxonomic class as the target receptor. When the available toxicity value represented a different taxonomic class that the target receptor, a correction factor of 0.1 was applied.

To protect the individual ecological receptor, unadjusted NOAEL values are the preferred RTV. Often, toxicity values were not available as chronic NOAELs, but as acute or chronic lowest observed adverse effects level (LOAEL) or median lethal doses (LD_{50}). Adjustments were made to these available toxicity values using safety factors to reflect levels of uncertainty. Currently, there is little guidance available for the appropriate value for safety factor (correction factors). Based upon guidance provided by the EPA (1986), an acute LD_{50} was extrapolated to an acute no observable effect level (NOEL) by dividing by a correction factor of 0.2. This safety factor is based on an analysis of dose-response data for pesticides. For the purposes of this assessment, a correction factor of 0.1 was applied to other toxicological values in each area of uncertainty (USEPA, 1989). Table 4-1 presents the safety factors used in this assessment for the derivation of RTVs. Terrestrial RTVs for the Tutu Wells site COCs are presented in Table C-3 of Appendix C.

TABLE 4-1
SAFETY FACTORS USED TO DERIVE REFERENCE
TOXICITY VALUES
TUTU WELLS SITES

Available Toxicity Value[1]	Approximation of Toxicological Uncertainty[2]			Toxicity Value Correction Factor[4]
	LD_{50} to LOAEL	LOAEL to NOAEL	Acute to Chronic	
Acute LD_{50}	0.2[3]		0.1	0.02
Chronic LOAEL	-	0.1	-	0.1
Chronic NOAEL	-	-	-	-

1 For purposes of this assessment, the following benchmarks were considered equivalent:

LD_{50} = LC_{50} (or EC_{50})
LOAEL = LOEL
NOAEL = NOEL

2 USEPA, 1989
3 USEPA, 1986

4 Additional factors were used to derive reference toxicity values when values did not exist for target species, as follows:

a. Given value within taxonomic class, correction factor of 0.2 (i.e., toxicity value x 0.2).

b. Given value of different taxomonic class, correction factor of 0.1 (i.e., toxicity value x 0.1).

5.0 RISK CHARACTERIZATION

The potential risk to ecological receptors at the Tutu Wells site (i.e., target receptors) was assessed by comparing estimated exposure levels (TBDs) with toxicological benchmarks (RTVs). Risks to each of the selected receptors were evaluated using hazard indices (HIs) which were determined for each surface soil COC by dividing the estimated TBDs by the RTVs.

Cumulative HIs were determined by summing all of the COC HIs for each target ecological receptor. Cumulative HIs were ranked in accordance with a USEPA (1986) ranking scheme that was used to evaluate potential ecological risks to individual organisms. The ranking scheme is as follows:

$HI < 0.1$	no adverse effects
$0.1 \leq HI < 10$	possible adverse effects
$HI \geq 10$	probable adverse effects

It is important to note that this methodology is not a measure of and cannot be used to determine absolute quantitative risk. Use of this technique, however, can indicate the potential for the target ecological receptor to be at risk to an adverse effect from exposure to site surface soil chemicals through the ingestion pathway.

Individual hazard indices are provided in Table 5-1.

<u>**Anole**</u>

The potential risk to the anole was estimated by comparing the estimated daily doses (TBDs) with toxicity values (RTVs) derived for the lizard. The potential risk from the Tutu Wells site surface soil chemicals was assumed to arise from the exposure via ingestion of soil and invertebrates.

TABLE 5-1

SUMMARY OF HAZARD INDICES
TUTU WELLS SITE

CHEMICAL	HAZARD INDEX	
	Anole (lizard)	Red-Tailed Hawk
VOLATILE ORGANICS		
Benzene	1.24 E-05	2.42 E-06
2-Butanone	6.44 E-05	1.26 E-04
Ethylbenzene	3.96 E-03	7.72 E-04
Methylene Chloride	4.34 E-05	8.47 E-06
4-Methyl-2-pentanone	2.64 E-03	5.16 E-05
Tetrachloroethylene	8.04	1.57
Trichloroethylene	1.09 E-04	2.14 E-05
Toluene	1.49 E-03	2.91 E-04
Xylenes (Total)	1.66 E-02	3.26 E-03
SEMI-VOLATILE ORGANICS		
Acenaphthene	NE	NE
Benzo(b)fluoranthene	NE	NE
Benzoic Acid	4.13 E-03	8.08 E-05
Benzo(g,h,i)perylene	NE	NE
Benzo(a)pyrene	6.57 E-03	1.28 E-03
Bis(2-ethylhexyl)phthalate	1.06 E-03	2.08 E-04
Chrysene	NE	NE
Di-n-butylphthalate	1.93 E-02	3.76 E-03
2,4-Dimethylphenol	0.12	2.3 E-02
Fluoranthene	0.151	2.96 E-04
Fluorene	8.64 E-04	1.68 E-04

TABLE 5-1

SUMMARY OF HAZARD INDICES
TUTU WELLS SITE
CONTINUED

CHEMICAL	HAZARD INDEX	
	Anole (lizard)	Red-Tailed Hawk
SEMI-VOLATILES (Cont'd)		
2-Methylphenol	NE	NE
4-Methylphenol	NE	NE
Naphthalene	NE	NE
Phenol	36.34	0.6
Pyrene	6.83 E-03	1.33 E-03
PESTICIDES/PCB'S		
Endosulfan I	3.37 E-02	6.57 E-03
Aroclor-1242	2.86	0.115
INORGANICS AND CYANIDE		
Aluminum	NE	NE
Antimony	NE	NE
Arsenic	80.8	0.334
Barium	NE	NE
Cadmium	3.45 E-03	1.57 E-04
Chromium, trivalent (Cr^{+3})	9.2 E-03	1.45 E-03
Chromium, hexavalent (Cr^{+6})	1.69	0.133
Cobalt	NE	NE
Copper	NE	NE

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TABLE 5-1

SUMMARY OF HAZARD INDICES
TUTU WELLS SITE
CONTINUED

CHEMICAL	HAZARD INDEX	
	Anole (lizard)	Red-Tailed Hawk
INORGANICS AND CYANIDE (Cont'd)		
Iron	NE	NE
Lead	4.42	0.864
Manganese	1.24	0.242
Nickel	1.98	0.222
Sodium	NE	NE
Vanadium	NE	NE
Zinc	NE	NE
Cyanide	1.31 E-03	2.55 E-04

NE denotes "not evaluated" due to lack of toxicity data.

[1] The most conservative chromium hazard index (i.e., Cr +6) was used in the determination of these cumulative indices.

The estimated cumulative hazard index is 138. The greatest contribution to the cumulative hazard index was from arsenic (at approximately 59%), with phenol (at approximately 26%) as the next most dominant contribution. Other notable contributions were from tetrachloroethylene (at approximately 6%), lead (at approximately 3%), and Aroclor-1242 (at approximately 2%).

The cumulative hazard index result of this risk evaluation indicates that the potential for adverse effects to the anole exists as a result of exposure to site-related chemicals in soil (primarily arsenic) if the receptor and its food sources are consistently exposed to maximum surface soil concentrations at the Tutu Wells site. This evaluation considered worst-case scenarios. Considering the limited home range expected for the anole (of less than 1% of the site area), it is conceivable that some anoles may be exposed to maximum surface soil concentrations. This is particularly true in the O'Henry dry cleaners area, where the maximum concentration for arsenic and tetrachloroethylene were found, and in the Curriculum Center area, where the maximum concentration for phenol was found. It is also probable that most of the anoles on and adjacent to the site would contact much lower levels of site-related chemicals, as the majority of site-related chemicals have low detection frequencies and thus have not been found uniformly throughout the site.

As noted in Section 6.0, Uncertainty, this EA has evaluated the potential for toxicological risks to individual anoles utilizing the site. While the potential for adverse health effect is indicated for some individual anoles, there may or may not resulting adverse effect on the anole population or ecological community as a whole.

Red-Tailed Hawk

The potential risk to the red-tailed hawk was estimated by comparing the estimated daily doses (TBDs) with toxicity values (RTVs) derived for the hawk. The potential risk from the Tutu Wells site surface soil chemicals was assumed to arise from exposure via ingestion of small mammals, reptiles/amphibians, birds, invertebrates, and soil.

The estimated cumulative hazard index is approximately 4. The greatest contribution to the cumulative hazard index was from tetrachloroethylene (at approximately 41%) followed by lead (at approximately 23%). Phenol (at approximately 16%), nickel (at approximately 6%), and manganese (at approximately 6%) also contribute to the cumulative hazard index.

The cumulative hazard index result of this risk evaluation indicates that there is a relatively low potential for adverse effects to the red-tailed hawk as a result of exposure to site-related chemicals in soil if the receptor and its food sources are consistently exposed to maximum surface soil concentrations at the Tutu Wells site. The hawk appears to have a markedly reduced risk potential compared to that of the lizard. This difference can be primarily attributed to the large range of the bird as compared to the area of the site-related chemicals in surface soil. This evaluation has considered the worst-case scenario, that the receptor will be consistently utilizing foodstuffs from the portion of the site where maximum surface soil chemical concentrations are available. Due to the limited distribution of the majority of surface soil COCs (as noted by the detection frequencies), it is highly likely that the actual adverse risk to the red-tailed hawk is less than as projected by the current cumulative hazard index.

6.0 UNCERTAINTY ANALYSIS

For any risk assessment, it is necessary to make assumptions. Assumptions carry with them associated uncertainties which must be identified to put risk estimates in perspective. The following describes the major assumptions used in this EA and their associated uncertainties.

Receptors were characterized as consistently contacting the maximum concentrations of contaminants. However, the maximum surface soil contaminant concentration locations of the site appear to be highly localized and represent small areas with regard to the rest of the site. This assumption may have overestimated the ecological risks.

Receptor risks were characterized as possible impacts from individual contaminants without regard to interactions between contaminants. However, ecological receptors are simultaneously exposed to a range of contaminants. These compounds may interact synergistically or antagonistically to either mitigate or aggravate adverse health effects. This assumption may overestimate or underestimate ecological risks.

Neither inhalation nor dermal contact exposure routes were evaluated. This was due to lack of appropriate wildlife uptake rate information as well as the assumption that the primary risk exist from ingestion exposure. The total ecological exposure may be greater than the predicted risk, as the predicted risk was estimated for ingestion only.

The exposure model used assumed that receptors will spend equal amounts of time in all habitats within their home ranges. In actuality, receptors may spend varying amounts of time in each habitat. The variation in habitat usage would likely affect the overall exposure. Depending upon the variation in usage receptor exposures may be overestimated or underestimated by the model.

Bioaccumulation factors used to estimate the exposure of receptors via diet were limited. Actual bioaccumulation into food items is variable, depending upon such factors as chemical state, soil composition, and chemical concentration in media of exposure. Thus, the bioaccumulation factors used may have over - or underestimated receptor exposure.

In selecting RTVs, the lowest available toxicity value was selected from the literature searched. The use of these values may overestimate ecological risk.

In determining the RTVs, safety factors were employed to account for differences in toxicity between species and between toxicological endpoints (i.e., NOAELs, LOAELs, LD_{50}s). Uncertainties associated with the safety factors used may have resulted in over- or underestimation of risks to receptors. Additionally, the absence of toxicity values or guidance criteria resulted in some chemicals not being included in the risk evaluation. This may have underestimated receptor exposure.

Potential toxicological risks to individual receptors have been evaluated in the EA. Sometimes, adverse effects on individuals will not be reflected on the population and community level. The predicted risks may overestimate the actual population or community level effects.

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ECOLOGICAL ASSESSMENT APPENDICIES

APPENDIX A

CORRESPONDENCE FOR ECOLOGICAL INFORMATION
ON THE SITE

INFORMATION SOURCES CONTACTED REGARDING ECOLOGICAL INFORMATION FOR THE TUTU WELLS SITE

Contact: Jorge Saliva
Agency: U.S. Fish and Wildlife Service
Address and Telephone: P.O Box 491
Boqueron, Puerto Rico 00622
(809) 851-7297
Contact Date: 3/29/94 and 4/1/94
Response: He relayed the request for information on the presence of sensitive environments and threatened/endangered species within two miles of the site to James Oland. Mr. Oland replied by sending a letter (dated 5/5/94) indicating that the St. Thomas prickly ash and the Virgin Island tree boa are endangered species that may occur within this area.

Contact: Ralf Boulon
Agency: U.S. Fish and Wildlife Service
Address and Telephone: 6291 Estate Nazareth
St. Thomas, USVI 00802
(809) 775-6762
Contact Date: 6/14/94 and 7/7/94
Response: 6/14/94 - He was not aware of any species list or natural resource surveys for the site. The site had value as an archeological site. Suggested contacting Holly Righter, state historical archeologist at the Department of Planning and Natural Resources. She is most familiar with the site.

7/7/94 - He sent a copy of the Virgin Islands bird checklist (titled "Caribbean CBC Form") and a list of endangered animals he expected may be found in the vicinity of the Tutu Wells site. He is the endangered species coordinator for St. Thomas.

Contact: Holly Righter
Agency: Virgin Islands Department of Planning and Natural Resources
Division of Environmental Protection
Address and Telephone: 800 Nasky Center
St. Thomas, USVI 00802
(809) 774-3320
Contact Date: 6/14/94
Response: She is not aware of any flora or fauna descriptions of the site area. She is aware of and described a wetland area to the west (behind) K-Mart.

Contact: Felix Lopez
Agency: U.S. Fish and Wildlife Service
Address and Telephone: San Juan, Puerto Rico

(809) 851-7297

Contact Date: 4/8/94

Response: He was familiar that the Tutu Wells site had a groundwater contamination problem, but did not know of any habitat descriptions, or other ecological information about the site. Suggested contacting Ralf Boulon of the U.S. Fish and Wildlife field office on St. Thomas, the Island Resources Foundation in St. Thomas, and a local biological consultant (David Grigg of Grigg & Associates in St. Thomas).

Contact: David Grigg
Agency: Grigg & Associates
Address and Telephone: St. Thomas, USVI
(809) 775-1566
Contact Date: 6/17/94

Response: He was not aware of any natural resource assessments in the Tutu area, (no faunal or floral studies or surveys). He has seen several incidental faunal studies performed in the general area of Tutu. One such study was on midges of a pond performed some years ago. He believed that there were many groundwater studies and some surface water studies conducted. He reported that Turpentine Run was an intermittent stream with 3 to 4 (possibly up to 6) small streambead pools in its upper basin that exist all year. The original fauna of the Run has been severally reduced within the last 20 to 30 years. He attributed this reduction in diversity/richness of the Run to pollution. He mentioned that the primary chronic pollution was from the discharge of 3 to 4 wastewater treatment plants. He noted that a branch of the Run constantly flows, due to the discharge of 1 treatment plant. He suggested contacting the cooperative extension agency in lieu of the local biologist.

Contact: Head Assistant
Agency: Island Resources Foundation
Address and Telephone: 6296 Estate Nazareth No. 11
St. Thomas, USVI 00802
(809) 775-6225
Contact Date: 6/14/94

Response: The Foundation has something of a library set up that can be accessed directly if one were on St. Thomas to access it. Suggested contacting Adrian Schottroff with the VI Department of Planning and Natural Resources for assistance. Ed Towle with the Island Resources Foundation followed up with a call on June 29, 1994. He provided citations to several publications of the island which turned out not to contain any information about the Tutu area.

Contact: Adrian Schottroff
Agency: Virgin Islands Department of Planning and Natural Resources
Division of Environmental Protection
Address and Telephone: 800 Nasky Center, Suite 45
St. Thomas, USVI 00802

(809) 774-3320

Contact Date: 7/6/94

Response: Try the U.S. Fish and Wildlife Service for endangered species and bird species lists. He does not know of any detailed ecological work of the Tutu area. He has no description of the habitats in the Tutu area, but suspects that a general habitat description for St. Thomas may be possible to find.

Contact: Toni Thomas
Agency: Cooperative Extension Service
Address and Telephone: University of the Virgin Islands
#2 John Brewer's Bay
St. Thomas, USVI 00802-9990
(809) 774-0210
Contact Date: 7/8/94

Response: She is botanist for the extension service. She notes that the Tutu area is disturbed with mostly exotic plant species and secondary growth forms. It is used frequently for grazing. The area is a subtropical dry forest. She has a listing a plant species observed at the K-Mart area created during the archeological investigation of the site (this was never sent). She sent a list of plant species (7/22/94) that she observed at the Tutu site while making a site visit in response to this request. Suggested contacting Julie Wright for additional information on the area.

Contact: Julie Wright
Agency: Cooperative Extension Service
Address and Telephone: University of the Virgin Islands
#2 John Brewer's Bay
St. Thomas, USVI 00802-9990
(809) 774-0210
Contact Date: 7/20/94

Response: The only site reports that she is aware of are the U.S. Geological Survey reports which have some information on flow rates and well sites. The Turpentine Run is typically intermittent and wastewater from waste treatment plants feed into it. The Run is dry right now as there is a drought. There is no other real water body that she is aware of in the Tutu site area except for a pond that used to be behind K-Mart. It is gradually filling or filled. It was not more than an acre in size with dense vegetation surrounding it. She reported that the Run is the largest gut on the island. It used to have a significant freshwater shrimp/crayfish in the upper portion. Cattle egrets have been observed in the Run in both the unpaved and paved portions.

APPENDIX B

THREATENED AND ENDANGERED SPECIES
SIGNIFICANT HABITATS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
CARIBBEAN FIELD OFFICE
P.O. BOX 491
BOQUERON, PUERTO RICO 00622

May 5, 1994

Ms. Nancy Zygmont
CDM Federal Programs Corporation
107-F Corporate Boulevard
South Plainfield, New Jersey 07080

Dear Ms. Zygmont:

Thank you for your letter of April 1, 1994, concerning a project in east central portion of St. Thomas in the upper portion of the Turpentine Run basin. Your letter requested information concerning the presence of sensitive environments and threatened/endangered species within two miles of the site.

Based on information available in this office the following endangered species may occur within this area:

St. Thomas prickly ash	Zanthoxylum thomasianum
Virgin Island tree boa	Epicrates monensis granti

If you have any questions, please call Susan R. Silander of this office.

Sincerely,

James P. Oland
Field Supervisor

ss
cc:
EPA, New York

TUT 007 0829

List of endangered species provided by Ralf Boulon, Endangered Species Coordinator, U.S. Fish and Wildlife Service, St. Thomas, USVI on July 8, 1994
(Marked species only.)

Endangered Plants and Animals of the U.S.Virgin Islands (Cont.)

Virgin Islands List		
Mabuya mabouia	Slipperyback skink	Resident, breeding
Otus nudipes newtoni	VI Screech owl	Resident, breeding
Chordeiles gundlachii	West Indian nighthawk	Resident, breeding?
* Anthracothorax dominicus	Antillean mango	Resident, breeding?
Podiceps dominicus	Least grebe	Resident, breeding?
Sterna antillarum	Least tern	Migrant, breeding
Phaethon lepturus	White-tailed tropicbird	Resident, breeding
Ardea herodius	Gt. blue heron	Resident, breeding
* Casmerodius albus	Great (common) egret	Resident, breeding
* Egretta thula	Snowy egret	Resident, breeding
Nycticorax nycticorax	Black-cr. night heron	Resident, breeding
Ixobrychus exilis	Least bittern	Resident, breeding?
Anas bahamensis	Bahama duck	Resident, breeding
Oxyura jamaicensis	Ruddy duck	Peripheral resident
Rallus longirostris	Clapper rail	Resident, breeding
Fulica caribea	Caribbean coot	Resident, breeding
Charadrius alexandrinus	Snowy plover	Resident, breeding?
Catoptrophorus semipalmatus	Willet	Resident, breeding
Puffinus lherminieri	Audubon shearwater	Migrant, breeding
* Aratinga pertinax	Brown-throated parakeet	Resident, breeding
Columba leucocephala	White-crowned pigeon	Resident, breeding
* Geotrygon mystacea	Bridled Quail dove	Resident, breeding
Myiarchus stolidus	Stolid flycatcher	Resident, breeding
Noctilio leporinus	Fisherman bat	Resident, breeding
* Stenoderma rufum	Red fruit bat	Resident, breeding
* Brachyphylla cavernarum	Cave bat	Resident, breeding
Order Antipatharia	Black coral	Marine benthic, high demand
Epinephelus itajara	Jewfish	Marine

* - Possibly found in Upper Turpentine Run/Tutu area.

The above list represents plants and animals occuring in the US Virgin Islands which are protected by either the US Endangered Species Act of 1973 or the VI Endangered and Indigenous Species Act of 1990 (Act No. 5665). This list is promulgated under Act 5665, Section 104(g) and may be revised as new information becomes available.

Roy E. Adams

Roy E. Adams, Commissioner, DPNR

5 June 1991

Date

TUT 007 0830

APPENDIX C

ECOLOGICAL EXPOSURE AND TOXICITY

TABLE C-1
ECOLOGICAL EXPOSURE PARAMETERS
TUTU WELLS SITE

Species	Exposure Parameter	Reported Value	Reference	Assessment Value
Anole (*Anolis* sp.)	Home Range	Approximately 0.0037 hectares	Milstead, 1967 (as reported for *Anolis sagrei* territory)	0.004 hectares
	Diet	Invertebrates		Invertebrates: 95% Soil: 5%
	Ingestion Rage	4-30 mg dry weight of food/g wet body weight/day	Heatwole, 1976 (as reported for lizards)	1.28×10^{-4} kg/day (assuming 17 mg dry weight of food/g wet body weight/day x 5g wet body weight + additional 50% for wet weight) of food
	Body Weight	Adult males 0.118 g/mm of snout to vent length Audlt female: 0.055 g/mm of snout to vent length	Rubial et al., 1972 (as reported for *Anolis acutus*)	0.005 kg (assuming an average snout to vent length of approximately 55 mm)
Red-tailed Hawk (*Buteo jamaicensis*)	Home Range	approximately 78-556 hectares	DeGraaf and Rudis, 1986	317 hectares
	Diet	Small mammals, amphibians, reptiles,insects, birds, carrion, domestic animals	DeGraaf and Rudis, 1986	Small mammals[1]: 70% Invertebrates: 3% Reptiles/Amphibians: 15% Birds: 7% Soil: 5%
	Ingestion Rate	0.055-0.12 kg/day	Stalmuster, 1987 (as reported for bald eagle and adjusted for 1 kg bird)	0.1 kg/day
	Body Weight	1.028 kg (males) 1.224 kg (females)	Johnsgard, 1990	1 kg