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SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION AND REMEDIAL INVESTIGATION REPORT FOR EIGHT SITES APPENDICES A THROUGH E NAS KEY WEST FL

1/1/1998

BROWN AND ROOT ENVIRONMENTAL

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Supplemental RCRA Facility Investigation and Remedial Investigation Report

Appendices A-E

for

Eight Sites Naval Air Station Key West, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0007

January 1998

Brown & Root Environmental

Revision 2

7046-PC

APPENDICES A - E

AIK-98-0001

SUPPLEMENTAL RCRA FACILITY INVESTIGATION
AND
REMEDIAL INVESTIGATION REPORT

EIGHT SITES
NAVAL AIR STATION
KEY WEST, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
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North Charleston, South Carolina 29406

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CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0007

JANUARY 1998

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APPENDIX A, PART 1
TOXICOLOGICAL PROFILES FOR NAS KEY WEST COPCS

A.1 ACETONE

Noncarcinogenic Toxicity

Studies of workers exposed to acetone revealed irritation of the ocular and respiratory tract mucosa, and, at high concentrations, central nervous system (CNS) effects (American Conference of Governmental Industrial Hygienists [ACGIH], 1991). Rats exposed by inhalation to high concentrations exhibited narcosis and slight decreases in organ and body weight, compared with controls, but no clinical pathological or histopathological evidence of organ damage. Inhalation reference concentration (RfC) values were not located for acetone. Oral toxicity data are limited to a comprehensive 90-day gavage study in rats, in which 100 mg/kg/day was a no observed effect level (NOEL) and 500 mg/kg/day was the lowest observed adverse effect level (LOAEL) associated with increased liver and kidney weight and tubular nephropathy (EPA, 1994c). A verified reference dose (RfD) for chronic oral exposure of 0.1 mg/kg/day was derived by applying an uncertainty factor of 1000 to the NOEL of 100 mg/kg/day. The U.S. Environmental Protection Agency (EPA, 1992b) presented a provisional subchronic oral RfD of 1 mg/kg/day, based on the same NOEL and an uncertainty factor of 100. The target organs for inhalation exposure to acetone are the CNS and the respiratory and ocular mucosa. Target organs for oral exposure are the liver and kidney.

Carcinogenicity

Data regarding the carcinogenicity of acetone were not located.

A.2 ALUMINUM

Noncancer Toxicity

Aluminum is not generally regarded as an industrial poison. Inhalation of finely divided powder has been reported as a cause of pulmonary fibrosis. Aluminum in aerosols has been implicated in Alzheimer's disease. As with other metals, the powder and dust are the most dangerous forms (Sax and Lewis, 1989).

Most hazardous exposures to aluminum occur in refining and smelting processes. Aluminum dust is a respiratory and eye irritant (Genium, 1990).

A.3 ALDRIN/DIELDRIN

Both aldrin and dieldrin are carcinogens, causing increases in a variety of tumors in rats at low but not at high doses and producing a higher incidence of liver tumors in mice. The reason for this reversed dose-response relationship is unclear. Neither appears to be mutagenic when tested in a number of systems. Aldrin and dieldrin are both toxic to the reproductive system and teratogenic. Reproductive effects include decreased fertility, increased fetal death, and effects on gestation; while teratogenic effects include cleft palate, webbed foot, and skeletal anomalies. Chronic effects attributed to aldrin and dieldrin include liver toxicity and central nervous system abnormalities. Both chemicals are acutely toxic; the oral LD_{50} is around 50 mg/kg, and the dermal LD_{50} is about 100 mg/kg.

A.4 ANTIMONY

Pharmacokinetics

Ingested antimony is absorbed slowly and incompletely from the gastrointestinal (GI) tract (Iffland, 1988). Within a few days of acute exposure, highest tissue concentrations are found in the liver, kidney, and thyroid. Organs of storage include skin, bone, and teeth. Highest concentrations in deceased smelter workers (inhalation exposure) occurred in the lungs and skeleton. Excretion is largely via the urine or feces, although some is incorporated into the hair.

Noncancer Toxicity

Acute intoxication from ingestion of large doses of antimony induces GI disturbances, dehydration, and cardiac effects in humans (Iffland, 1988). Chronic effects from occupational exposure include irritation of the respiratory tract, pneumoconiosis, pustular eruptions of the skin called "antimony spots," allergic contact dermatitis, and cardiac effects, including abnormalities of the electrocardiograph (ECG) and myocardial changes. Cardiac effects were also observed in rats and rabbits exposed by inhalation for six weeks and in animals (dogs, and possibly other species) treated by intravenous injection (Elinder and Friberg 1986a).

Chronic oral exposure studies in laboratory animals include two briefly reported lifetime drinking water studies in rats and mice (Kanisawa and Schroeder, 1969; Schroeder et al., 1970). The only dose tested, 5 parts per million (ppm) potassium antimony tartrate, resulted in reduced longevity in both species and in reduced mean heart weight in the rats. The EPA (1997a) verified an RfD of 0.0004 mg/kg/day for chronic oral exposure to antimony from the LOAEL of 5 ppm potassium antimony tartrate (0.35 mg antimony/kg body weight-day) in the lifetime study in rats (Schroeder et al., 1970). An uncertainty factor of 1000 was applied; factors of 10 each for inter- and intraspecies variation and to estimate a no observed adverse effects level (NOAEL) from a LOAEL. The heart is considered a likely target organ for chronic oral exposure of humans.

Carcinogenicity

Data were not located regarding the carcinogenicity of antimony to humans. Antimony fed to rats did not produce an excess of tumors (Goyer, 1991), but a high frequency of lung tumors was observed in rats exposed by inhalation to antimony trioxide for one year (Elinder and Friberg 1986a). Antimony is classified in EPA cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) (EPA, 1987).

A.5 ARSENIC

Pharmacokinetics

Several studies confirm that soluble inorganic arsenic compounds and organic arsenic compounds are almost completely (>90 percent) absorbed from the GI tract in both animals and humans (Ishinishi et al., 1986). The absorption efficiency of insoluble inorganic arsenic compounds depends on particle size and stomach pH. Initial distribution of absorbed arsenic is to the liver, kidneys, and lungs, followed by redistribution to hair, nails, teeth, bone, and skin, which are considered tissues of accumulation. Arsenic has a longer half-life in the blood of rats, compared with other animals and humans, because of firm binding to the hemoglobin in erythrocytes.

Metabolism of inorganic arsenic includes reversible oxidation-reduction so that both arsenite (valence of 3) and arsenate (valence of 5) are present in the urine of animals treated with arsenic of either valence (Ishinishi et al., 1986). Arsenite is subsequently oxidized and methylated by a saturable mechanism to form mono- or dimethylarsenate; the latter is the predominant metabolite in the urine of animals or humans. Organic arsenic compounds (arsenilic acid, cacodylic acid) are not readily converted to inorganic arsenic. Excretion of organic or inorganic arsenic is largely via the urine, but considerable species variation exists. Continuously exposed humans appear to excrete 60 to 70 percent of their daily intake of arsenate or arsenite via the urine.

Noncancer Toxicity

A lethal dose of arsenic trioxide in humans is 70 to 180 mg (approximately 50 to 140 mg arsenic; Ishinishi et al., 1986). Acute oral exposure of humans to high doses of arsenic produce liver swelling, skin lesions, disturbed heart function, and neurological effects. The only noncancer effects in humans clearly attributable to chronic oral exposure to arsenic are dermal hyperpigmentation and keratosis, as revealed by studies of several hundred Chinese exposed to naturally occurring arsenic in well water (Tseng, 1977; Tseng et al. 1968; EPA 1997a). Similar effects were observed in persons exposed to high levels of arsenic in water in Utah and the northern part of Mexico (Cebrian et al. 1983; Southwick et al., 1983). Occupational (predominantly inhalation) exposure is also associated with neurological deficits, anemia, and cardiovascular effects (Ishinishi et al., 1986), but concomitant exposure to other chemicals cannot be ruled out. The EPA (1997a) derived an RfD of 0.3 mg/kg/day for chronic oral exposure, based on a NOAEL of 0.8 mg/kg/day for skin lesions from the Chinese data. The principal target organ for arsenic appears to be the skin. The nervous system and cardiovascular systems appear to be less significant target organs. Inorganic arsenic may be an essential nutrient, exerting beneficial effects on growth, health, and feed conversion efficiency (Underwood, 1977).

Carcinogenicity

Inorganic arsenic is clearly a carcinogen in humans. Inhalation exposure is associated with increased risk of lung cancer in persons employed as smelter workers, in arsenical pesticide applicators, and in a population residing near a pesticide manufacturing plant (EPA 1997a). Oral exposure to high levels in well water is associated with increased risk of skin cancer (Tseng 1977; EPA 1997a). Extensive animal testing with various forms of arsenic given by many routes of exposure to several species, however, has not demonstrated the carcinogenicity of arsenic (International Agency for Research on Cancer [IARC] 1980). The EPA (1997a) classifies inorganic arsenic in cancer weight-of-evidence Group A (human carcinogen) and derived an oral slope factor of 1.5 per mg/kg/day. The EPA (1997a) notes that the uncertainties associated with the oral unit risk are considerably less than those for most carcinogens, so that the unit risk might be reduced an order of magnitude. An inhalation unit risk of 0.0043 per mg/m^3 was derived for inorganic arsenic from the incidence of lung cancer in occupationally exposed men (EPA 1997a), which is equivalent to a RfD of 15.1 per mg/kg/day, assuming a 70 kg adult inhales 20 m^3 of air/day.

A.6 BARIUM

Noncancer Toxicity

Barium is a naturally occurring alkaline earth metal that comprises approximately 0.04 percent of the earth's crust (Reeves 1986a). Acute oral toxicity was manifested by GI upset, altered cardiac performance, and transient hypertension, convulsions, and muscular paralysis. Repeated oral exposures were associated with hypertension. Occupational exposure to insoluble barium sulfate induced benign pneumoconiosis (ACGIH, 1991). The EPA (1995) presented a verified chronic oral RfD of 0.07 mg/kg/day, based on a NOAEL of 0.21 mg/kg/day in a ten-week study in humans exposed to barium in drinking water and an uncertainty factor of 3. The EPA (1993) presented the same value as a provisional RfD for subchronic oral exposure. A provisional chronic inhalation RfC of 0.0005 mg/m^3 and a provisional subchronic inhalation RfC of 0.005 were based on a NOEL for fetotoxicity in a four-month intermittent-exposure inhalation study in rats (EPA 1995). Uncertainty factors of 1000 and 100 were used for the chronic and subchronic RfC values, respectively. The chronic and subchronic inhalation RfC values are equivalent to 0.0001 and 0.001 mg/kg/day, assuming a human inhalation rate of 20 m^3/day and body weight of 70 kg. Barium is principally a muscle toxin. Its targets are the GI system, skeletal muscle, the cardiovascular system, and the fetus.

Carcinogenicity

The EPA (1995) classifies barium as a cancer weight-of-evidence Group D substance (not classifiable as to carcinogenicity in humans). Cancer risk is not estimated for Group D substances.

A.7 BERYLLIUM

Noncancer Toxicity

Beryllium has a low order of toxicity when ingested because it is poorly absorbed from the GI tract (Reeves 1986b). Occupational exposure was associated with dermatitis, acute pneumonitis, and chronic pulmonary granulomatosis (berylliosis). Berylliosis was also observed in humans living in the vicinity of a beryllium plant. Similar pulmonary effects were observed in laboratory animals subjected to inhalation exposure. A verified chronic oral RfD value of 0.005 mg/kg/day was based on a NOAEL in a lifetime drinking water study in rats and an uncertainty factor of 100 (EPA 1995). The EPA (1995) presented the same value as a provisional subchronic oral RfD. The target organ for inhalation exposure appears to be the lung; a target organ is not identified for oral exposure.

Carcinogenicity

The EPA (1995) classifies beryllium in cancer weight-of-evidence Group B2 (probable human carcinogen) based on inadequate human (occupational) cancer data and sufficient animal data. A significant increase in lung tumors occurred in rats and in rhesus monkeys subjected to inhalation exposure or intratracheal instillation of a variety of beryllium compounds. Osteogenic sarcomas were induced in rabbits and mice, but not in rats or guinea pigs, injected intravenously with various beryllium compounds. Oral studies in animals yielded inconclusive results. The EPA (1997a) derived an oral slope factor of 4.3 per mg/kg/day from a statistically nonsignificant increase in total tumors in a lifetime drinking water study in rats. An inhalation unit risk of 0.0024 per mg/m^3, equivalent to 8.4 per mg/kg/day (assuming an inhalation rate of 20 m^3/day and body weight of 70 kg for humans), was derived from an occupational study.

A.8 BIS(2-ETHYLHEXYL)PHTHALATE (DI[2-ETHYLHEXYL]PHTHALATE)

Non-carcinogenic Toxicity

The acute oral toxicity of bis(2-ethylhexyl)phthalate is very low; oral $LD_{50/30}$ (lethal dose to 50 percent of population within 30 days without medical treatment) values in rats and mice were 33,800 and 26,300 mg/kg, respectively (ACGIH, 1991). Repeated high-dose oral exposures were associated with decreased growth, altered organ weights, testicular degeneration, and developmental effects. The EPA (1997a) presented a verified chronic oral RfD of 0.02 mg/kg/day based on a LOAEL for increased relative liver weight in guinea pigs and an uncertainty factor of 1,000. The EPA (1994b) adopted the chronic oral RfD as the provisional subchronic oral RfD. The principal target organs for the toxicity of bis(2-ethylhexyl)phthalate are the liver and testis.

Carcinogenicity

The EPA (1997a) classifies bis(2-ethylhexyl)phthalate in cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate human cancer data (one limited occupational study) and sufficient cancer data in laboratory animals. An oral slope factor of 0.014 per mg/kg/day (EPA 1997a) was based on the increased incidence of liver tumors in a dietary study in male mice.

A.9 CADMIUM

Pharmacokinetics

Estimates of cadmium uptake by the respiratory tract range from 10 to 50 percent; uptake is greatest for fumes and small particles and least for large dust particles (Friberg et al., 1986; Goyer, 1991). GI absorption of ingested cadmium is ordinarily 5 to 8 percent, but may reach 20 percent in cases of serious dietary iron deficiency. Highest tissue levels are normally found in the kidneys followed by the liver, although levels in the liver may exceed those in the kidneys of persons suffering from cadmium-induced renal dysfunction. The half-life of cadmium in the kidneys and liver may be as long as 10 to 30 years. Fecal and urinary excretion of cadmium are approximately equivalent in normal humans exposed to small amounts. Urinary excretion increases markedly in humans with cadmium-induced renal disease.

Noncancer Toxicity

Acute inhalation exposure to fumes or particles of cadmium induces respiratory symptoms, general weakness, and, in severe cases, respiratory insufficiency, shock, and death (Friberg et al., 1986). Acute oral exposure induces GI disturbances. Chronic inhalation exposure induces pulmonary emphysema, and chronic exposure by either route consistently produces renal tubular disease in humans and laboratory animals. Proteinuria is a reliable early indicator of cadmium-induced kidney disease. The combination of pulmonary emphysema and renal tubular disease, if severe, may result in early mortality. Painful osteomalacia and osteoporosis may arise from altered metabolism of bone minerals secondary to renal damage. The combination of renal and skeletal damage is called itai-itai disease in Japan. Cadmium exposure has been associated with liver damage, but the liver appears to be less sensitive than the kidney. The kidney is the primary target organ of cadmium toxicity. The EPA (1997a) derived chronic oral RfD values of 0.5 mg/kg/day for cadmium ingested in water and 1 mg/kg/day for cadmium ingested in food, based on a toxicokinetic model that predicted NOAELs from renal cortical concentrations of cadmium. The different RfD values reflect assumed differences in GI absorption of cadmium from water (5 percent) and food (2.5 percent).

Carcinogenicity

Carcinogenicity data in humans consist of several occupational studies that associate cadmium exposure with lung cancer, but concomitant exposure to other carcinogenic chemicals and smoking were not adequately controlled. Other occupational studies reported significantly increased risk of prostatic cancer, but this effect was not observed in the largest occupational study of workers exposed to high levels (Thun et al., 1985). The animal data consist of an inhalation study in rats that showed a significant increase in lung tumors, and several parenteral injection studies that produced injection site tumors. No evidence of carcinogenicity, however, was observed in seven oral studies in rats and mice. The EPA (1995) classifies cadmium a cancer weight-of-evidence Group B1 substance for inhalation exposure on the basis of limited evidence of carcinogenicity in humans and sufficient evidence in animals. The data were insufficient to classify cadmium as carcinogenic to humans exposed by the oral route. The EPA (1997a) derived an inhalation unit risk of 0.0018 mg/m^3 from the occupational exposure study by Thun et al. (1985).

A.10 CHLOROBENZILATE

Non-carcinogenic Toxicity

Chronic oral exposure through gastric intubation of pregnant rabbits to chlorobenzilate resulted in significantly reduced feed consumption, decreased stool quantity, body weight gains and hyperirritability. The EPA (1997a) presented a verified RfD for chronic oral exposure of 0.02 mg/kg/day based on a maternal NOEL of 5 mg/kg/day in the rabbit teratology study.

Carcinogenicity

Chlorobenzilate is classified as a cancer weight-of-evidence Group B2 compound (probable human carcinogen) based on liver tumors in mice (EPA, 1995). An oral slope factor of 0.27 per mg/kg-day was derived from the incidence of liver tumors in mice treated with chlorobenzilate for 82 weeks through gavage. The inhalation slope factor was assumed to be equal to the oral slope factor of 0.27 per mg/kg/day (EPA, 1995).

A.11 CHROMIUM

Noncancer Toxicity

In nature, chromium (III) predominates over chromium (VI) (Langård and Norseth, 1986). Little chromium (VI) exists in biological materials, except shortly after exposure, because reduction to chromium (III) occurs rapidly. Chromium (III) is considered a nutritionally essential trace element and is considerably less toxic than chromium (VI). No effects were observed in rats consuming 1800 mg chromium (III)/kg/day in the diet for over two years (EPA 1995). The NOEL of 1800 mg/kg/day and an uncertainty factor of 1000 was the basis for a verified chronic oral RfD of 1 mg/kg/day (EPA 1997a). The same NOEL and an uncertainty factor of 100 was the basis for a provisional subchronic oral RfD of 1 mg/kg/day (EPA 1995).

Acute oral exposure of humans to high doses of chromium (VI) induced neurological effects, GI hemorrhage and fluid loss, and kidney and liver effects. Parenteral dosing of animals with chromium (VI) is selectively toxic to the kidney tubules. A NOAEL of 2.4 mg chromium (VI)/kg/day in a one-year drinking water study in rats and an uncertainty factor of 500 was the basis of a verified RfD of 0.005 mg/kg/day for chronic oral exposure (EPA 1997a). The same NOAEL and an uncertainty factor of 100 was the basis of a provisional subchronic oral RfD of 0.02 mg/kg/day (EPA 1995).

Occupational (inhalation and dermal) exposure to chromium (III) compounds induced dermatitis (ACGIH, 1991). Similar exposure to chromium (VI) induced ulcerative and allergic contact dermatitis, irritation of the upper respiratory tract including ulceration of the mucosa and perforation of the nasal septum, and possibly kidney effects. Inhalation RfC values were not located.

A target organ was not identified for chromium (III). The kidney appears to be the principal target organ for repeated oral dosing with chromium (VI). Additional target organs for dermal and inhalation exposure include the skin and respiratory tract.

Carcinogenicity

Data were not located regarding the carcinogenicity of chromium (III). The EPA (1997a) classifies chromium (VI) in cancer weight-of-evidence Group A (human carcinogen), based on the consistent observation of increased risk of lung cancer in occupational studies of workers in chromate production or the chrome pigment industry. Parenteral dosing of animals with chromium (VI) compounds consistently induced injection-site tumors. There is no evidence that oral exposure to chromium (VI) induces cancer. An inhalation unit risk of 0.012 per mg/m^3, equivalent to 42 per mg/kg/day, assuming humans inhale 20 m^3/day and weigh 70 kg, was based on increased risk of lung cancer deaths in chromate production workers.

A.12 COPPER

Noncancer Toxicity

Copper is a nutritionally essential element that functions as a cofactor in several enzyme systems (Aaseth and Norseth, 1986). Acute exposure to large oral doses of copper salts was associated with GI disturbances, hemolysis, and liver and kidney lesions. Chronic oral toxicity in humans has not been reported. Chronic oral exposure of animals was associated with an iron-deficiency type of anemia, hemolysis, and lesions in the liver and kidneys. Occupational exposure may induce metal fume fever, and, in cases of chronic exposure to high levels, hemolysis and anemia (ACGIH, 1991). Neither oral nor inhalation RfD or RfC values were located for copper. The target organs for copper are the erythrocyte, liver, and kidney, and, for inhalation exposure, the lung.

Carcinogenicity

Copper is classified in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) (EPA 1997a). Quantitative risk estimates are not derived for Group D chemicals.

A.13 DIBROMOMETHANE

Non-carcinogenic Toxicity

Chronic inhalation exposure to dibromomethane increased carboxyhemoglobin in rats. Oral toxicity data is limited to a 90 day inhalation study in rats in which 11 mg/kg/day was a NOAEL associated with increased carboxyhemoglobin (EPA, 1995). A verified oral reference dose of 0.01 mg/kg/day was derived using a route to route extrapolation and applying an uncertainty factor of 1000 to the NOAEL of 11 mg/kg/day. The target organ for exposure to dibromomethane is the blood.

Carcinogenicity

Data was not located on the carcinogenicity of dibromomethane.

A.14 DDD [1,1-BIS(4-CHLOROPHENYL)-2,2-DICHLOROETHANE]

Noncancer Toxicity

DDD is considered a poison through ingestion. Moderately toxic by skin contact (Sax and Lewis, 1989).

Short-term exposure to high doses of DDT primarily affects the nervous system. Rashes, irritation to the eyes, nose and throat were observed in some people exposed to DDT. People exposed a long time to DDT exhibited changes in the level of liver enzymes. Tests in animals have suggested that short term exposure to DDT may have a harmful effect on reproduction (ATSDR, 1989).

No RfDs or RfCs were established for DDD.

Carcinogenicity

With respect to carcinogenicity, EPA (1997a) has assigned DDD a weight-of evidence of B2, meaning the EPA regards DDD as a "possible" human carcinogen. This classification is based of an increased incidence of lung tumors in male and female mice, liver tumors in male mice and thyroid tumors in male rats. DDD is structurally similar to, and is a known metabolite of DDT, a probable human carcinogen (EPA, 1997a). The evidence for carcinogenicity in humans of DDT is based on autopsy studies relating tissue levels of DDT to cancer incidence. Human epidemiological data are not available for DDD.

Tomatis et al. (1974) fed DDD for 130 weeks at 250 ppm to mice. A statistically significant increase in incidence of lung tumors was observed. In males, a statistically significant increase in incidence of liver tumors was also observed. An increased incidence of thyroid tumors was observed in male rats fed DDD (EPA 1997a).

An oral slope factor for DDD is 0.24 per mg/kg/day (EPA 1997a). An inhalation slope factor is not available.

A.15 DDE [2,2-BIS(P-CHLOROPHENYL)-1,1-DICHLOROETHYLENE]

Noncancer Toxicity

DDE is considered a poison through ingestion. Reproductive effects were observed in DDE studies (Sax and Lewis, 1989). Refer to the discussion on DDT for systemic effects.

RfDs and RfCs are not available for this compound.

Carcinogenicity

DDE is classified as cancer weight-of-evidence B2, a "probable" human carcinogen based on increased incidence of liver tumors (Tomatis, 1974), including carcinomas in two strains of mice and in hamsters and the presence of thyroid tumors in female rats fed DDE in the diet. Rossi et al. (1983) administered DDE in feed to hamsters and a statistically significant increase in incidence of neoplastic nodules of the liver were observed. An increased incidence of thyroid tumors was observed in females (NCI, 1978).

The oral slope factor derived is 0.34 per mg/kg/day. An inhalation slope factor is not available.

DDE was mutagenic in mouse lymphoma cells and chinese hamster cells. DDE is structurally similar to and a metabolite of DDT which is a probable human carcinogen.

A.16 DDT (4,4'-DICHLORODIPHENYL-TRICHLOROETHANE)

Pharmacokinetics

Dichlorodiphenyltrichlorothane (DDT) is readily absorbed when dissolved in oils, fats, or lipid solvents, but is poorly absorbed as dry powder or aqueous suspension. Once absorbed, DDT concentrates in adipose tissue. Storage in fat is protective because it decreases the amount of chemicals at the site of toxic action, the brain. At a constant rate of intake, concentrations in adipose tissue reach a steady state and remain relatively constant. When exposure ceases, DDT is slowly eliminated. The rate of elimination is estimated to be 1 percent of stored DDT excreted per day (Gartrell et al., 1985).

After absorption in mammals, DDT degrades by dehydrochlorination to unsaturated DDE and by substitution of hydrogen for one chlorine atom yielding DDD. DDD is further metabolized through a series of intermediates yielding DDA. DDA is relatively water soluble and excreted primarily in the urine. Ingestion studies of DDT administered to volunteers demonstrated that within 24 hours, urinary DDA excretion increased detectably. Excretion of DDT as DDA appeared to be totally dependent on preferential reductive dechlorination of DDT to DDD (rather than DDE) and then to DDA (Clayton, 1981).

Noncancer Toxicity

The CNS is an important target organ in humans acutely exposed to DDT. Symptoms include altered sensory perception, headache, nausea, disequilibrium, confusion, tremors, and convulsions (Hayes 1982; ATSDR, 1989). Tremors and hyperirritability were observed in chronically exposed animals (NCI, 1978; Rossi et al., 1977). The liver appears to be the other important target organ, at least in animals. Liver effects include enzyme induction, increased liver weight, increased serum levels of liver enzymes, hepatocellular hypertrophy, and necrosis (ATSDR, 1989). The EPA (1997a) derived an RfD of 0.5 mg/kg/day for chronic oral exposure from an NOEL of 0.05 mg/kg/day for liver effects in a 15- to 27-week feeding study in rats (Laug et al., 1950). An uncertainty factor of 100 was applied with factors of 10 each for inter- and intraspecies variation.

Dermal exposure has been associated with no illness and usually no irritation. Subcutaneous injection of colloidal suspensions of DDT in saline up to 30 ppm caused no irritation. Studies of DDT-impregnated clothing have found it to cause no irritation (Hayes, 1982). The earliest symptom of acute DDT poisoning is paresthesia of the mouth and lower part of the face. This is followed by paresthesia of same areas and of the tongue and then dizziness, and tremors of extremities, confusion, malaise, headache, fatigue, and delayed vomiting. Vomiting is probably of central origin and not due to local irritation. Convulsions occur only in severe poisoning. Onset may be as soon as 30 minutes after ingestion of a large dose or as late as six hours after smaller but still-toxic doses. Recovery from mild poisoning usually is essentially complete in 24 hours, but recovery from severe poisoning requires several days (Hayes, 1982).

There is no documented evidence that dietary absorption of DDT, alone or in combination with insecticides of the aldrin-toxaphene group, has caused cancer in the general population. No evidence has been presented that DDT has caused cancer among the millions of individuals (almost entirely men) who have been handling or spraying DDT (as dust, solution, and suspension) in all parts of the world and under all possible climatic conditions.

DDT is a mixture of p,p'-DDT and related compounds. One of the more important of the DDT isomers is o,p'-DDT. These agents have prominent estrogenic effects that have been well-characterized in a number of assay systems (Johnson et al., 1988). The estrogenicity of DDT has lead to the supposition that it may adversely affect reproductive outcome by causing birth defects, increasing pregnancy complications, or affecting fertility (RTC, 1990).

A verified chronic oral RfD value of 0.0005 mg/kg/day (EPA 1997a) was based on a NOEL of 0.05 mg/kg/day in a 27-week rat feeding study and on an uncertainty factor of 100.

<u>Carcinogenicity</u>

The EPA (1995) has classified DDT in cancer weight-of-evidence Group B2 (probable human carcinogen) based on the observation of tumors (generally of the liver) in seven studies in various mouse strains and in three studies in rats. The EPA (1997a) derived an oral slope factor of 0.34 per mg/kg/day from liver tumors in oral (diet) studies in the mouse and the rat. An inhalation unit risk of 9.7E-05 per mg/m^3, equivalent to 0.34 per mg/kg/day (assuming a 70 kg adult inhales 20 m^3 of air/day), was derived from the same oral (diet) studies.

A.17 HEPTACHLOR/HEPTACHLOR EPOXIDE

Noncancer Toxicity

Results from mutagenicity bioassays suggest that these compounds may have genotoxic activity. Reproductive and teratogenic effects in rats include decreased litter size, shortened life span of suckling rats, and development of cataracts in offspring.

Tests with laboratory animals, primarily rodents, demonstrate acute and chronic toxic effects due to heptachlor exposure. Although heptachlor and heptachlor epoxide are absorbed most readily through the gastrointestinal tract, inhalation and skin contact are also potential routes of exposure. Acute exposure by various routes can cause development of hepatic vein thrombi and can effect the central nervous system and cause death. Chronic exposure induces liver changes, affects hepatic microsomal enzyme activity, and causes increased mortality in offspring. The oral LD50 in the rat is 40 mg/kg for heptachlor and 47 mg/kg for heptachlor epoxide. A two-year dietary study with rats derived a chronic oral RfD of 0.5 µg/kg/day from a NOEL of 0.15 mg/kg/day for heptachlor. A chronic oral RfD of 0.0125 mg/kg/day was derived from a 60-week dog feeding study with a LOAEL of 0.013 µg/kg/day and uncertainty factor of 1,000 for heptachlor epoxide.

Although there are reports of acute and chronic toxicity in humans, with symptoms including tremors, convulsions, kidney damage, respiratory collapse, and death, details of such episodes are not well documented. Heptachlor epoxide has been found in a high percentage of human adipose tissue samples, and also in human milk samples and biomagnification of heptachlor/heptachlor epoxide occurs. This compound also has been found in the tissues of stillborn infants, suggesting an ability to cross the placenta and bioaccumulate in the fetus.

Carcinogenicity

Heptachlor and heptachlor epoxide are liver carcinogens when administered orally to mice. EPA classifies both with a cancer weight-of-evidence B2. Heptachlor has an oral slope factor of 4.5 per mg/kg/day based on the observation of liver carcinomas in mice exposed during an oral diet study. An inhalation unit risk of 0.0013 µg/m^3 which is equivalent to 4.55 per mg/kg/day assuming a 70 kg adult inhales 20 m^3/day. Heptachlor epoxide in an 18- to 24-month dietary study in two strains of mice derived an oral slope factor of 9.1 per mg/kg/day and an inhalation slope factor of 9.1 per mg/kg/day through route extrapolation.

A.18 DELTA-BENZENE HEXACHLORIDE (BHC)

Health Effects

The alpha, beta, and gamma isomers of benzene hexachloride (BHC) have all been shown to cause liver tumors in mice but not in other tested species. BHC has not been thoroughly tested for genotoxic effects but does not appear to be mutagenic. The alpha, beta, and delta isomers have not been tested for their teratogenic or reproductive toxicological potential. Lindane (gamma-BHC) has been tested and was not teratogenic, but in two studies it decreased the number of live young produced (Earl et al., 1973). Alpha-BHC has been shown to cause nonmalignant lesions in the liver of test animals at doses below those required to induce tumors. Lindane has been associated with the development of aplastic anemia in humans (West, 1967).

Noncancer Toxicity

Neither an oral nor an inhalation RfD has been determined for this material. The gamma isomer (lindane) has been more extensively evaluated and its toxicologic characteristics are described below. Delta-BHC has been generically described as a CNS depressant with an unknown mechanism of action (Ecobichon, 1996). There was a reported rat study in which 78 weeks of treatment with 1000 mg/kg in the diet produced liver hypertrophy (EPA, 1980b).

Exposure to lindane causes tremors, ataxia, convulsions, respiratory stimulation, and prostration (Ecobichon, 1996). In a subchronic dietary study (rat), 12 to 18 weeks of exposure produced liver hypertrophy, kidney tubular degeneration, hyaline droplets, tubular distension, interstitial nephritis, and basophilic tubules (EPA 1997a). The LOAEL was 20 ppm (1.55 mg/kg/day). No significant effects were reported at 4 ppm (0.29 to 0.33 mg/kg/day). Rats dosed with gamma-BHC in the diet for two years developed slight liver and kidney damage (100 ppm) and a NOAEL was determined to be 50 ppm (2.5 mg/kg/day). In dogs, two years of dietary inclusion resulted in increased alkaline phosphatase and enlarged dark friable livers at a level of 100 ppm. A dose level of 50 ppm (1.6 mg/kg/day) was determined to be the NOAEL. Based on the 0.33 mg/kg/day NOAEL from the subchronic rat study, and applying an uncertainty factor of 1,000, the oral RfD for Lindane was calculated to be 3E-4 mg/kg/day.

Carcinogenicity

Delta-BHC is classified as a cancer weight of evidence Group D compound (not classifiable as to human carcinogenicity) based on the lack of definitive carcinogenicity data (EPA 1997a). In two reported mouse studies, with treatment periods of 26 or 110 weeks, 400 to 600 mg/kg in the diet resulted in hepatic tumors and lung metastases (EPA 1980b). The oral slope factor for gamma-BHC (lindane) is under review by the EPA, but is listed by HEAST (EPA 1995) as 1.3 E+0 per mg/kg/day based on a 2-year mouse study (EPA 1997a). The dietary inclusion study was reported to produce tumors in the livers of treated mice. The weight of evidence Group B2-C (possible to probably human carcinogen) was assigned to gamma-BHC.

A.19 IRON

Noncancer Toxicity

Iron is moderately toxic through ingestion and inhalation of iron dusts and powders. Inhalation may be irritating to the respiratory tract. The inhalation of large amounts of iron dust results in iron pneumoconiosis (arc welders lung) (Sax and Lewis, 1989). Chronic inhalation can produce mottling (spotting) of lungs (siderosis). Ingestion of greater than 50 to 100 mg of iron per day may result in pathological iron deposition in body tissues the symptoms of which are fibrosis of the pancreas, diabetes mellitus, and liver cirrhosis. Eye contact may cause conjunctivitis. The LDLO intraperitoneal for rabbits is 20 mg/kg with no toxic effect observed. The ACGIH TLV for iron oxide fumes is 5 mg/m^3.

Carcinogenicity

IARC, National Toxicology Program (NTP), and Occupational Safety and Health Association (OSHA) do not list iron as a carcinogen although the mining of one particular ore, hematite, may be associated with an increased risk of lung cancer in miners. No other iron ores are identified specifically as a carcinogen.

A.20 LEAD

Pharmacokinetics

Studies in humans indicate that an average of 10 percent of ingested lead is absorbed, but estimates as high as 40 percent were obtained in some individuals (Tsuchiya 1986). Nutritional factors have a profound effect on GI absorption efficiency. Children absorb ingested lead more efficiently than adults; absorption efficiencies up to 53 percent were recorded for children three months to eight years of age. Similar results were obtained for laboratory animals; absorption efficiencies of 5 to 10 percent were obtained for adults and ³50 percent were obtained for young animals. The deposition rate of inhaled lead averages approximately 30 to 50 percent, depending on particle size, with as much as 60 percent deposition of very small particles (0.03 mm) near highways. All lead deposited in the lungs is eventually absorbed.

Approximately 95 percent of the lead in the blood is located in the erythrocytes (EPA 1990). Lead in the plasma exchanges with several body compartments, including the internal organs, bone, and several excretory pathways. In humans, lead concentrations in bone increase with age (Tsuchiya, 1986). About 90 percent of the body burden of lead is located in the skeleton. Neonatal blood concentrations are about 85 percent of maternal concentrations (EPA 1990). Excretion of absorbed lead is principally through the urine, although GI secretion, biliary excretion, and loss through hair, nails, and sweat are also significant.

Noncancer Toxicity

The noncancer toxicity of lead to humans has been well characterized through decades of medical observation and scientific research. The principal effects of acute oral exposure are colic with diffuse paroxysmal abdominal pain (probably due to vagal irritation), anemia, and, in severe cases, acute encephalopathy, particularly in children (Tsuchiya 1986). The primary effects of long-term exposure are neurological and hematological. Limited occupational data indicate that long-term exposure to lead may induce kidney damage. The principal target organs of lead toxicity are the erythrocyte and the nervous system. Some of the effects on the blood, particularly changes in levels of certain blood enzymes, and subtle neurobehavioral changes in children, appear to occur at levels so low as to be considered nonthreshold effects.

EPA (1995) presents no inhalation RfC for lead, but referred to the National Ambient Air Quality Standard (NAAQS) for lead, which could be used in lieu of an inhalation RfC. The NAAQSs are based solely on human health considerations and are designed to protect the most sensitive subgroup of the human population. The NAAQS for lead is 1.5 mg/m^3, averaged quarterly (EPA 1995). The NAAQS is equivalent to 0.00043 mg/kg/day, assuming a body weight of 70 kg and an inhalation rate of 20 m^3/day.

The EPA (1990) determined that it is inappropriate to derive an RfD for oral exposure to lead for several reasons. First, the use of an RfD assumes that a threshold for toxicity exists, below which adverse effects are not expected to occur; however, the most sensitive effects of lead exposure, impaired neurobehavioral development in children and altered blood enzyme levels associated with anemia, may occur at blood lead concentrations so low as to be considered practically nonthreshold in nature. Second, RfD values are specific for the route of exposure for which they are derived. Lead, however, is ubiquitous, so that exposure occurs from virtually all media and by all pathways simultaneously, making it practically impossible to quantify the contribution to blood lead from any one route of exposure. Finally, the dose-response relationships common to many toxicants, and upon which derivation of an RfD is based, do not hold true for lead. This is because the fate of lead within the body depends, in part, on the amount and rate of previous exposures, the age of the recipient, and the rate of exposure. There is, however, a reasonably good correlation between blood lead concentration and effect. Therefore, blood lead concentration is the appropriate parameter on which to base the regulation of lead.

The EPA Integrated Exposure and Uptake Biokinetic (IEUBK) lead model is an iterated set of equations that estimate blood lead concentration in children aged 0 to 7 years (EPA 1990; 1994b). The biokinetic part of the model describes the movement of lead between the plasma and several body compartments and estimates the resultant blood lead concentration. The rate of the movement of lead between the plasma and each compartment is a function of the transition or residence time (i.e., the mean time for lead to leave the plasma and enter a given compartment, or the mean residence time for lead in that compartment). Compartments modeled include the erythrocytes, liver, kidneys, all the other soft tissue of the body, cortical bone, and trabecular bone. Excretory pathways and their rates are also modeled. These include the mean time for excretion from the plasma to the urine, from the liver to the bile, and from the other soft tissues to the hair, skin, sweat, etc. The model permits the user to adjust the transition and residence times.

EPA guidance (EPA 1994a) recommends a residential screening level for lead of 400 ppm to be applied at Superfund and RCRA sites. This value is considered by EPA to be protective for direct contact with lead-contaminated soils in residential settings. The guidance adopts recommendations of the Centers for Disease Control and is to be followed when current or predicted land use is residential.

The residential screening level for lead described in this directive has been calculated with the EPA's new IIEUBK using default parameters (EPA 1994b).

Carcinogenicity

EPA (1997a) classifies lead in cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate evidence of cancer in humans and sufficient animal evidence. The human data consist of several epidemiologic occupational studies that yielded confusing results. All of the studies lacked quantitative exposure data and failed to control for smoking and concomitant exposure to other possibly carcinogenic metals. Rat and mouse bioassays showed statistically significant increases in renal tumors following dietary and subcutaneous exposure to several soluble lead salts. Various lead compounds were observed to induce chromosomal alterations in vivo and in vitro, sister chromatid exchange in exposed workers, and cell transformation in Syrian hamster embryo cells; to enhance simian adenovirus induction;

and to alter molecular processes that regulate gene expression. EPA (1997a) declined to estimate risk for oral exposure to lead because many factors (e.g., age, general health, nutritional status, existing body burden and duration of exposure) influence the bioavailability of ingested lead, introducing a great deal of uncertainty into any estimate of risk.

A.21 MANGANESE

Noncancer Toxicity

Manganese is nutritionally required in humans for normal growth and health (EPA 1997a) Humans exposed to approximately 0.8 mg manganese/kg/day in drinking water exhibited lethargy, mental disturbances (1/16 committed suicide), and other neurologic effects. The elderly appeared to be more sensitive than children. Oral treatment of laboratory rodents induced biochemical changes in the brain, but rodents did not exhibit the neurological signs exhibited by humans. Occupational exposure to high concentrations in air induced a generally typical spectrum of neurological effects, and increased incidence of pneumonia (ACGIH 1986).

Very recently, a chronic oral water RfD of 0.005 mg/kg/day has been made available for manganese based on a drinking water study (EPA 1997a) and a chronic oral food RfD of 0.14 mg/kg/day (EPA 1997a) was adopted based on a NOAEL of 0.14 mg/kg/day for humans in a dietary study. An inhalation RfD of 0.0143 µg/kg/day was presented for manganese. The subchronic oral RfDs presented by EPA (1995) was the same value as the chronic oral RfDs. The EPA (1997a) presented a verified chronic inhalation RfC of 0.00005 mg/m^3 based on a LOAEL for respiratory symptoms and psychomotor disturbances in occupationally exposed humans and an uncertainty factor of 1000. The EPA (1997a) presented the same value as a subchronic inhalation RfC. The inhalation RfC is equivalent to 0.000014 mg/kg/day, assuming humans inhale 20 m^3 of air/day and weigh 70 kg. The CNS and respiratory tract are target organs of inhalation exposure to manganese.

Carcinogenicity

The EPA (1997a) classifies manganese in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans). Quantitative cancer risk estimates are not derived for Group D chemicals.

A.22 MERCURY

Mercury occurs in three forms: elemental, organic, and inorganic. Although the toxicity of all forms is mediated by the mercury cation, the extent of absorption and pattern of distribution within the body, which determines the effects observed, depends on the form to which the organism is exposed (Goyer 1991). Bacterial activity in the environment converts inorganic mercury to methyl mercury (Berlin 1986). It is likely that either inorganic mercury or methyl mercury may be taken up by plants and enter the food chain, and this discussion will focus on inorganic and methyl mercury. Exposure to elemental mercury, which is more likely to occur in an occupational setting, is not discussed herein.

Pharmacokinetics

The GI absorption of inorganic mercury salts is about 2 to 10 percent in humans, and slightly higher in experimental animals (Berlin 1986; Goyer 1991). Inorganic mercury in the blood is roughly equally divided between the plasma and erythrocytes. Distribution is preferentially to the kidney, with somewhat lower concentrations found in the liver, and even lower levels found in the skin, spleen, testes, and brain (Berlin 1986). Inorganic mercury is excreted principally through the feces and urine, with minor pathways including the secretions of exocrine glands and exhalation of elemental mercury vapor.

Methyl mercury is nearly completely (90 to 95 percent) absorbed from the GI tract (Berlin 1986). The concentration of methyl mercury in the erythrocytes is about 10 times that in the plasma. Methyl mercury leaves the blood slowly, showing particular affinity for the brain, particularly in primates. In rats, 1 percent of the body burden of methyl mercury is found in the brain, but in humans, 10 percent of the body burden is found in the brain. Somewhat lower levels are found in the liver and kidney. During pregnancy, methyl mercury accumulates in the fetal brain, often at levels higher than in the maternal brain. Most tissues except the brain transform methyl mercury to inorganic mercury. Excretion of methyl mercury is principally via the bile, with a half-life of 70 days in humans not suffering from toxicity. Following exposure to methyl mercury, some of the mercury in the bile exists as methyl mercury and some as the inorganic form. The inorganic form is largely passed in the feces, but the methyl mercury is subject to enterohepatic recirculation. Another important excretory pathway for methyl mercury is lactation.

Noncancer Toxicity

Target organs for inorganic or methyl mercury include the kidney, nervous system, fetus, and neonate. Acute oral exposure to high doses of inorganic mercury causes severe damage to the GI mucosa because of the corrosive nature of mercury salts, which may lead to bloody diarrhea, shock, circulatory collapse, and death (Berlin 1986; Goyer 1991). Acute sublethal poisoning induces severe kidney damage. Chronic exposure induces an autoimmune glomerular disease and renal tubular injury. The EPA (1995) presented a verified RfD of 0.3 mg/mg-day for chronic oral exposure to inorganic mercury, based on kidney effects in rats.

Acute or chronic exposure to methyl mercury leads to neurologic dysfunction (Berlin 1986; Goyer 1991). The region of the nervous system affected is species-dependent. Methyl mercury poisoning in rats induces peripheral nerve damage and kidney effects. In humans, the sensory cortex appears to be the most sensitive. The brain of the fetus and the neonate may be unusually sensitive to methyl mercury; retarded neurologic development was observed in prenatally exposed children whose mothers showed no clinical signs of poisoning. An inhalation RfC of 0.0003 mg/kg/day (uncertainty factor of 30) has been established for inorganic mercury based on neurotoxic effects in humans. This translates into a chronic RfD of 0.000086 mg/kg/day (EPA, 1995).

Carcinogenicity

The EPA (1997a) classifies inorganic mercury in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans), based on no data regarding cancer in humans, and inadequate animal and supporting data. In an intraperitoneal injection study with metallic mercury in rats, sarcomas developed only in those tissues in direct contact with the test material (Druckrey et al. 1957). A two-year dietary study in rats with mercuric acetate (inorganic mercury) yielded no evidence of carcinogenicity (Fitzhugh et al. 1950). In mice, however, dietary exposure to high doses of mercury chloride for up to 78 weeks induced renal adenomas and adenocarcinomas (Mitsumori et al. 1981). The EPA has not yet evaluated the carcinogenicity of organic mercury. No carcinogenic effect, however, was observed in a two-year feeding study with phenylmercuric acetate in rats (Fitzhugh et al. 1950).

A.23 NICKEL

Noncancer Toxicity

In a subchronic gavage study with nickel chloride in water, clinical signs of toxicity in rats included lethargy, ataxia, irregular breathing, reduced body temperature, salivation, and discolored extremities (EPA 1997a). Inhalation exposure was associated with asthma and pulmonary fibrosis in welders using nickel alloys (ACGIH 1986). Lung effects were observed in laboratory animals exposed by inhalation. The EPA (1997a) presented a verified RfD of 0.02 mg/kg/day for chronic oral exposure to nickel, based on a NOAEL for decreased organ and body weights in a two-year dietary study with nickel in rats and an uncertainty factor of 300. The EPA (1995) presented the same value as a provisional subchronic oral RfD. The CNS appears to be the target organ for the oral toxicity of nickel. The lung is the target organ for inhalation exposure.

Carcinogenicity

Occupational exposure to nickel was associated with increased risk of nasal, laryngeal and lung cancer (ATSDR 1991b). Inhalation exposure of rats to nickel subsulfide increased the incidence of lung tumors. The EPA (1997a) presents a cancer weight-of-evidence Group A classification (human carcinogen) for nickel, and presents an inhalation unit risk of 0.00024 per mg/m^3 for nickel refinery dust. The unit risk is equivalent to 0.84 per mg/kg/day, assuming humans inhale 20 m^3 of air/day and weigh 70 kg. The quantitative estimate was derived from the human occupational studies.

A.24 N-NITROSO-DI-N-PROPYLAMINE

Non-carcinogenic Toxicity

Information on the non-carcinogenic effects of N-nitroso-di-n-propylamine was not available in IRIS or HEAST.

Carcinogenicity

N-nitroso-di-n-propylamine is classified as a cancer weight-of-evidence Group B2 compound (probable human carcinogen) based on several tumor types in two rodent species and in monkeys (IRIS 5/97).An oral slope factor of 7.0 per mg/kg-day was derived from the incidence of liver and esophageal tumors in rats treated with N-nitroso-di-n-propylamine in drinking water for life. An inhalation unit risk was not reported in IRIS or HEAST.

A.25 POLYAROMATIC HYDROCARBONS

Polynuclear aromatic hydrocarbons (PAHs) are a large class of ubiquitous natural and anthropogenic chemicals, all with similar chemical structures (ATSDR 1990). There are eleven individual PAHs listed among the chemicals of potential concern (COPCs) for Key West.

Pharmacokinetics

Although quantitative absorption data for the PAHs were not located, benzo(a)pyrene was readily absorbed across the GI (Rees et al. 1971) and respiratory epithelia (Kotin et al. 1969; Vainich et al. 1976). The high lipophilicity of other compounds in this class suggests that other PAHs also would be readily absorbed across GI and respiratory epithelia.

Benzo(a)pyrene was distributed widely in the tissues of treated rats and mice, but primarily to tissues high in fat, such as adipose tissue and mammary gland (Kotin et al. 1969; Schlede et al. 1970a). Patterns of tissue distribution of other PAHs would be expected to be similar because of the high lipophilicity of the members of this class.

Studies of the metabolism of benzo(a)pyrene provide information relevant to other PAHs because of the structural similarities of all members of the class. Metabolism involves microsomal mixed function oxidase hydroxylation of one or more of the phenyl rings with the formation of phenols and dihydrodiols, probably via formation of arene oxide intermediates (EPA 1979a). The dihydrodiols may be further oxidized to diol epoxides, which, for certain members of the class, are known to be the ultimate carcinogens (LaVoie et al. 1982). Conjugation with glutathione or glucuronic acid, and reduction to tetrahydrotetrols are important detoxification pathways. Metabolism of naphthalene resulted in the formation of 1,2-naphthoquinone, which induced cataract formation and retinal damage in rats and rabbits.

Excretion of benzo(a)pyrene or dibenzo(a,h)anthracene residues was reported to be rapid, although quantitative data were not located (EPA 1979b). Excretion occurred mainly via the feces, probably largely due to biliary secretion (Schlede et al. 1970a, 1970b). The EPA (1980a) concluded that accumulation in the body tissues of PAHs from chronic low level exposure would be unlikely.

Noncancer Toxicity

Oral noncancer toxicity data are available for acenaphthene, anthracene, fluoranthene, fluorene, and naphthalene. Newborn infants, children, and adults exposed to naphthalene by ingestion, inhalation, or possibly by skin contact developed hemolytic anemia with associated jaundice and occasionally renal disease (EPA 1979c). In a 13-week gavage study in rats, treatment with 50 mg naphthalene/kg, 5 days/week for 13 weeks (35.7 mg/kg/day) induced no effects; higher doses presumably reduced the growth rate (NTP 1980). Application of an uncertainty factor of 1000 yielded a provisional RfD for chronic oral exposure of 0.04 mg/kg/day (EPA 1995) which has recently been withdrawn. The very mild effect (decreased growth rate) apparently observed at higher doses suggests that the RfD is very conservatively protective.

Acenaphthene appears to be a mild hepatotoxicant, and possibly a nephrotoxicant, in rodents (EPA 1997a). In a comprehensive 90-day toxicity study in mice, gavage treatment with 175 mg/kg/day was a NOAEL; liver weight changes accompanied by hepatocellular hypertrophy and elevated cholesterol levels occurred in mice treated with 350 or 700 mg/kg/day (EPA 1989a). Oral treatment of rats and mice for 32 days with 2,000 mg/kg/day resulted in weight loss and mild liver and kidney lesions (Knobloch et al. 1969). The EPA (1997a) verified a chronic oral RfD for acenaphthene of 0.06 mg/kg/day based on a NOAEL for liver effects in a subchronic gavage study in mice and an uncertainty factor of 3000. An uncertainty factor of 3000 was used with factors of 10 each for inter- and intraspecies variation and to expand from subchronic to chronic exposure, and a factor of 3 to reflect gaps in the database, namely lack of adequate data in a second species and lack of developmental and reproductive data. Confidence in the database was low because of the data gaps. Confidence in the critical study was low because the effects were considered adaptive, rather than adverse, which implies that the RfD is extremely conservative. The EPA (1995) presented a provisional subchronic oral RfD of 0.6 based on the same NOAEL and an uncertainty factor of 300. Target organs for acenaphthene include the liver and kidney.

The toxic potency of anthracene appears to be very low. In a chronic study in rats, doses of 5 to 15 mg/rat (16 to 48 mg/kg/day) via the diet had no effect on longevity or gross or histopathologic appearance on unspecified tissues (Schmahl 1955). Gavage treatment of mice with 1000 mg/kg/day for at least 90 days had no effects on a comprehensive range of toxicologic parameters. The NOEL of 1000 mg/kg/day in mice and an uncertainty factor of 3000 (10 each for inter- and intraspecies variation, and 30 for the use of a subchronic study and an incomplete database) yielded a verified RfD for chronic oral exposure of 0.3 mg/kg/day (EPA 1997a). The EPA (1995) presented a subchronic oral RfD of 3 mg/kg/day based on the same NOEL and an uncertainty factor of 300. The data were inadequate to define target organs for the toxicity of anthracene.

Fluoranthene appears to be toxic to the liver, kidney, and blood. In a comprehensive 13-week gavage study in mice, 125 mg/kg/day was a NOAEL and 250 mg/kg/day was a LOAEL (EPA 1988). The verified chronic oral RfD for fluoranthene is 0.04 mg/kg/day, based on the NOAEL in a comprehensive 13-week gavage study of 125 mg/kg/day in mice and an uncertainty factor of 3000 (EPA 1997a). The uncertainty factor of 3000 includes factors of 10 each for inter- and intraspecies variation, and a factor of 30 to expand from subchronic to chronic exposure and to reflect an incomplete database. A provisional subchronic oral RfD of 0.4 mg/kg/day was derived from the same NOAEL and an uncertainty factor of 300. The liver, kidney, and blood appear to be the target organs for the toxicity of fluoranthene.

The critical effects of oral exposure to fluorene appear to be hemolytic anemia and CNS effects. In mice treated by gavage for 13 weeks, 125 mg/kg/day was a NOAEL and 250 mg/kg/day was a LOAEL (EPA 1989b). A verified chronic oral RfD for fluorene of 0.04 mg/kg/day was based on the NOAEL of 125 mg/kg/day for hemolytic anemia in mice (EPA 1997a). An uncertainty factor of 3000 was used with factors of 10 each for inter- and intraspecies variation and to expand from subchronic to chronic exposure, and a factor of 3 to reflect gaps in the database. The EPA (1995) presented a provisional subchronic oral RfD of 0.4 mg/kg/day based on the same NOAEL and an uncertainty factor of 300. The target organs of fluorene toxicity are the erythrocyte and the CNS.

Newborn infants, children, and adults exposed to naphthalene by ingestion, inhalation, or possibly by skin contact developed hemolytic anemia with jaundice and, occasionally, renal disease (EPA 1980a). In a 13-week gavage study in rats, treatment with naphthalene reduced the growth rate (EPA 1992a). Application of an uncertainty factor of 1000 to the rat NOEL yielded a provisional RfD for subchronic and chronic oral exposure of 0.04 mg/kg/day (EPA 1992a). The erythrocyte and the kidney appear to be the target organs for the toxicity of naphthalene.

Mild kidney lesions appear to be the critical effects of pyrene. In mice treated by gavage for 13 weeks, 75 mg/kg/day was a NOAEL and 125 mg/kg/day was a LOAEL (EPA 1989c). Even in mice treated with 250 mg/kg/day the lesions were considered minimal to mild. The EPA (1993) verified a chronic oral RfD for pyrene of 0.03 mg/kg/day based on the NOAEL in mice and an uncertainty factor of 3000 (10 each for inter- and intraspecies variation and to expand from subchronic to chronic exposure, and a factor of 3 to reflect gaps in the database). The EPA (1995) presented a provisional subchronic oral RfD of 0.3 mg/kg/day based on the same NOAEL and an uncertainty factor of 300. The kidney is the target organ for the toxicity of pyrene.

Carcinogenicity

The PAHs are ubiquitous, being released to the environment from anthropogenic as well as from natural sources (ATSDR 1987). Benzo(a)pyrene is the most extensively studied member of the class, inducing tumors in multiple tissues of virtually all laboratory species tested by all routes of exposure. Although epidemiology studies suggested that complex mixtures that contain PAHs (coal tar, soots, coke oven emissions, cigarette smoke) are carcinogenic to humans, the carcinogenicity cannot be attributed to PAHs alone because of the presence of other potentially carcinogenic substances in these mixtures (ATSDR 1987). In addition, recent investigations showed that the PAH fraction of roofing tar, cigarette smoke, and coke oven emissions accounted for only 0.1 to 8 percent of the total mutagenic activity of the unfractionated complex mixture in *Salmonella* (Lewtas 1988). Aromatic amines, nitrogen heterocyclic compounds, highly oxygenated quinones, diones, and nitrooxygenated compounds, none of which would be expected to arise from in vivo metabolism of PAHs, probably accounted for the majority of the mutagenicity of coke oven emissions and cigarette smoke. Furthermore, coal tar, which contains a mixture of many PAHs, has a long history of use in the clinical treatment of a variety of skin disorders in humans (ATSDR 1987).

Because of the lack of human cancer data, assignment of individual PAHs to EPA cancer weight-of-evidence groups was based largely on the results of animal studies with large doses of purified compound. Frequently, unnatural routes of exposure, including implants of the test chemical in beeswax and trioctanoin in the lungs of female Osborne-Mendel rats, intratracheal instillation, and subcutaneous or intraperitoneal injection, were used. Of the PAHs of concern, no EPA cancer weight-of-evidence group classification was provided for acenaphthene (EPA 1997a). Anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, and naphthalene were classified in Group D (not classifiable as to carcinogenicity to humans), and benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were classified in Group B2 (probable human carcinogens).

The EPA (1997a) verified a slope factor for oral exposure to benzo(a)pyrene of 7.3 per mg/kg/day, based on several dietary studies in mice and rats. Neither verified nor provisional quantitative risk estimates were available for the other PAHs in Group B2. The EPA (1980a) promulgated an ambient water quality criterion for "total carcinogenic PAHs," based on an oral slope factor derived from a study with benzo(a)pyrene, as being sufficiently protective for the class. Largely because of this precedent, the quantitative risk estimates for the other carcinogenic PAHs were based on benzo(a)pyrene when quantitative estimates were needed.

Recent reevaluations of the carcinogenicity and mutagenicity of the Group B2 PAHs suggest that there are large differences between individual PAHs in cancer potency (Krewski et al., 1989). Based on the available cancer and mutagenicity data, and assuming that there is a constant relative potency between different carcinogens across different bioassay systems and that the PAHs under consideration have similar dose-response curves, Thorslund and Charnley (1988) derived relative potency values for several PAHs. A more recent Relative Potency Factor (RPF) scheme for the Group B2 PAHs was based only on the induction of lung epidermoid carcinomas in female Osborne-Mendel rats in the lung-implantation experiments (Clement International 1990). The most defensible RPFs and the associated oral and inhalation slope factors are presented in Table C.3-5 in Appendix C of the Supplemental RCRA Facility Investigation/Remedial Investigation (RFI/RI) Report.

Listed below are individual PAH toxicological profiles, if available.

ACENAPHTHYLENE

Non-carcinogenic Toxicity

Non-carcinogenic toxicity data were not located for acenaphthylene, but the chemical is structurally very similar to acenaphthene. Acenaphthene appears to be a mild hepatotoxicant, and possibly a nephrotoxicant, in rodents (EPA 1997a). It is reasonable to suspect that acenaphthylene may induce similar effects.

Carcinogenicity

The EPA (1993) classifies acenaphthylene as a cancer weight-of-evidence Group D compound (not classifiable as to carcinogenicity to humans), based on no human cancer data and inadequate cancer data in animals. The animal data consist of an inadequately reported lifetime skin painting study in which skin tumors were not observed in mice treated with acenaphthylene (Cook 1932). Tumors were observed in mice treated with other PAHs.

BENZO(B)FLUORANTHENE

Noncancer Toxicity

Little information is available on benzo(b)fluoranthene. However based on the similarities of chemical structures, most properties should be similar to benzo(a)pyrene.

Carcinogenicity

A Clement's RFP has been developed (Clement International, 1990) for benzo(b)fluoranthene which allows the estimation of Slope Factors (SFs) of 7.3E-01 and 6.1E-01 per mg/kg/day for the oral and inhalation routes respectively. The EPA (1995) has classified benzo(b)fluoranthene in cancer weight-of-evidence Group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans) based on lung tumors in mice.

BENZO(G,H,I)PERYLENE

Noncancer Toxicity

Little information is available on benzo(g,h,i)perylene. However based on the similarities of chemical structures, most properties should be similar to benzo(a)pyrene.

Carcinogenicity

The EPA (1995) has classified benzo(g,h,i)perylene in cancer weight-of-evidence Group D (Not classifiable as to Human Carcinogenicity, inadequate or no evidence).

BENZO(K)FLUORANTHENE

Noncancer Toxicity

Little information is available on benzo(k)fluoranthene. However, based on the similarities of the chemical structures, most properties should be similar to benzo(a)pyrene.

Carcinogenicity

A Clement's RFP has been developed (Clement International, 1990) for benzo(k)fluoranthene which allows the estimation of 7.3E-02 and 6.1E-02 per mg/kg/day for the SF for the oral and inhalation route respectively. The EPA (1997a) has classified benzo(k)fluoranthene in cancer weight-of-evidence Group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans) based on lung tumors in mice.

CHRYSENE

Noncancer Toxicity

Chrysene is absorbed by the oral route of exposure. Absorption may also occur following dermal exposure. Data are not available to determine whether chrysene is absorbed via the lungs. Absorbed chrysene is distributed to several tissues, i.e. it was found in five tissues in a study reported in 1983. It is accumulated preferentially in the adipose and mammary tissue.

There is no information on other toxic effects of chrysene in human and laboratory animals following inhalation, oral and dermal exposures. (ATSDR 1987).

Carcinogenicity

A Clement's RFP has been developed for chrysene. This allows the estimation of SFs of 7.3E-03 and 6.1E-03 per mg/kg/day for the oral and inhalation routes respectively.

The EPA (1997a) has classified chrysene in cancer weight-of-evidence Group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans) based on tumors and malignant lymphoma in mice and chromosomal abnormalities in hamsters.

INDENO(1,2,3-CD)PYRENE

Noncancer Toxicity

Little information was found on the toxicity of indeno(1,2,3-cd)pyrene. Because of its structural similarity its properties should resemble benzo(a)pyrene.

Carcinogenicity

A Clement's RFP has been developed for indeno(1,2,3-cd)pyrene. This allows the estimation of SFs of 7.3E-01 and 6.1E-01 per mg/kg/day for the oral and inhalation routes respectively. The EPA (1997a) has classified indeno(1,2,3-cd)pyrene in cancer weight-of-evidence Group B2 (Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans) based on tumors in mice following lung implants.

A.26 POLYCHLORINATED BIPHENYLS

Noncancer Toxicity

Epidemiologic studies of women in the United States associated oral polychlorinated biphenyl (PCB) exposure with low birth weight or retarded musculoskeletal or neurobehavioral development of their infants (ATSDR 1991a). Oral studies in animals established the liver as the target organ in all species, and the thyroid as an additional target organ in the rat. Effects observed in monkeys included gastritis, anemia, chloracne-like dermatitis, and immunosuppression. Oral treatment of animals induced developmental effects, including retarded neurobehavioral and learning development in monkeys. An oral RfD of 0.07 µg/kg/day was presented for Arochlor-1016. A chronic RfD of 0.02 µg/kg/day derived from a LOAEL of 0.005 mg/kg/day based on a 5-year study with monkeys was presented for Aroclor-1254 (EPA 1997a) and a subchronic oral RfD of 0.05 µg/kg/day with an uncertainty factor of 100 (EPA 1995). The target organ was the immune system.

Occupational exposure to PCBs was associated with upper respiratory tract and ocular irritation, loss of appetite, liver enlargement, increased serum concentrations of liver enzymes, skin irritation, rashes and chloracne, and, in heavily exposed female workers, decreased birth weight of their infants (ATSDR 1991a). Concurrent exposure to other chemicals confounded the interpretation of the occupational exposure studies. Laboratory animals exposed by inhalation to Aroclor-1254 vapors exhibited moderate liver degeneration, decreased body weight gain and slight renal tubular degeneration. Neither subchronic nor chronic inhalation RfC values were available.

Target organs for PCBs include the skin, liver, fetus, and neonate.

Carcinogenicity

The EPA (1995) classifies the PCBs as EPA cancer weight-of-evidence Group B2 substances (probable human carcinogens), based on inadequate data in humans and sufficient data in animals. The human data consist of several epidemiologic occupational and accidental oral exposure studies with serious limitations, including poorly quantified concentrations of PCBs and durations of exposure, and probable exposures to other potential carcinogens.

The animal data consist of several oral studies in rats and mice with various arochlors, kanechlors, or clophens (commercial PCB mixtures manufactured in the United States, Japan and Germany, respectively) that reported increased incidence of liver tumors in both species (EPA 1997a).

The EPA (1997a) presents a new oral slope factor of 2.0 per mg/kg/day for all PCBs based on new mechanistic studies that PCB congeners are have dioxin-like characteristics and may promote tumors by different routes of action. EPA is further investigating PCBs.

A.27 2,4,5-TP (SILVEX) [2,4,5-TRICHLOROPHENOXY PROPIONIC ACID]

Non-carcinogenic Toxicity

Chronic oral exposure of dogs to 2,4,5-TP induced liver effects (EPA 1997a). Health effects were observed in a two year study of 8 dogs. The EPA presented a verified RfD for chronic oral exposure of 0.008 mg/kg/day, based on a NOAEL of 0.75 mg/kg/day for liver effects in the diet study with an uncertainty factor of 100.

2,4,5-TP appears to be teratogenic and fetotoxic in mice and rats (EPA 1997a).

Carcinogenicity

EPA classifies 2,4,5-TP as a cancer weight-of-evidence Group D compound (not classifiable as to human carcinogenicity) based on inadequate gavage and diet studies in mice. A unit risk for inhalation was not available.

A.28 THALLIUM

Noncancer Toxicity

Thallium is highly toxic; acute ingestion by humans or laboratory animals induced gastroenteritis, neurological dysfunction, and renal and liver damage (Kazantzis, 1986). Chronic ingestion of more moderate doses characteristically caused alopecia. Thallium was used medicinally to induce alopecia in cases of ringworm of the scalp, sometimes with disastrous results. In industrial (inhalation, oral, dermal) exposure, neurologic signs preceded alopecia, suggesting that the nervous system is more sensitive than the hair follicle. The EPA (1994c) presented verified chronic oral RfD values for several thallium compounds (thallium acetate, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, thallium sulfate, and thallic oxide) based on increased incidence of alopecia and increased serum levels of liver enzymes indicative of hepatocellular damage in rats treated with thallium sulfate for 90 days. An oral RfD for thallium alone was not located. That for thallium sulfate is 8.00E-05 (EPA 1997b), based on a lack of effects from an oral subchronic study in which rats received 0.25 mg/kg/day. The uncertainty factor was 3000 and the confidence level was low.

Carcinogenicity

Several thallium compounds (thallic oxide, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, thallium sulfate) were classified as cancer weight-of-evidence Group D substances (not classifiable as to carcinogenicity to humans) (EPA 1994c). No weight-of-evidence classification was located for thallium alone.

A.29 TIN

Pharmacokinetics

Estimates of the gastrointestinal absorption efficiency of tin in humans and animals range from 0.6 percent to 5 percent (Magos 1986). The data suggest that tin in the +2 valence state is more readily absorbed than tin in the +4 valence state. Species differences in gastrointestinal absorption appear to be slight. Absorption efficiency appears to be somewhat greater when the administered dose is smaller. From these data, it appears that an estimate of 5 percent (0.05) is a reasonable estimate of gastrointestinal absorption efficiency. Data regarding dermal uptake of tin were not located.

Noncancer Toxicity

Industrial (inhalation) exposure to tin dust results in a benign pneumoconiosis called stannosis (Magos 1986). Acute oral exposure causes gastroenteritis (nausea and diarrhea) in humans. Other effects in animals include anemia, interference with calcium metabolism, and liver and kidney lesions. A chronic oral RfD of 0.6 mg/kg-day was based on a NOAEL for liver and kidney lesions of 2000 ppm stannous chloride in the diet in a two-year study in rats (EPA 1995). An uncertainty factor of 100 was applied. The chronic oral RfD was considered sufficiently protective for subchronic exposure as well.

Carcinogenicity

Data regarding the carcinogenicity of tin were not located in the available literature.

A.30 VANADIUM

Noncancer Toxicity

The oral toxicity of vanadium compounds to humans is very low (Lagerkvist et al. 1986), probably because little vanadium is absorbed from the GI tract. Effects in humans exposed by inhalation include upper and lower respiratory tract irritation. A provisional subchronic and chronic oral RfD of 0.007 mg/kg/day was derived from a NOEL of 5 ppm in rats in a lifetime drinking water study with an uncertainty factor of 100 (EPA 1995). A target organ could not be identified for oral exposure. The respiratory tract is the target organ for inhalation exposure.

Carcinogenicity

No information was located regarding the carcinogenicity of vanadium.

A.31 ZINC

Pharmacokinetics

Zinc is a nutritionally required trace element. Estimates of the efficiency of GI absorption of zinc in animals range from <10 to 90 percent (Elinder 1986b). Estimates in normal humans range from approximately 20 to 77 percent (Elinder 1986b; Goyer 1991). The net absorption of zinc appears to be homeostatically controlled, but it is unclear whether GI absorption, intestinal secretion, or both are regulated. Distribution of absorbed zinc is primarily to the liver (Goyer 1991), with subsequent redistribution to bone, muscle, and kidney (Elinder 1986b). Highest tissue concentrations are found in the prostate. Excretion appears to be principally through the feces, in part from biliary secretion, but the relative importance of fecal and urinary excretion is species-dependent. The half-life of zinc absorbed from the GI tracts of humans in normal zinc homeostasis is approximately 162 to 500 days.

Noncancer Toxicity

Humans exposed to high concentrations of aerosols of zinc compounds may experience severe pulmonary damage and death (Elinder 1986b). The usual occupational exposure is to freshly formed fumes of zinc, which can induce a reversible syndrome known as metal fume fever. Orally, zinc exhibits a low order of acute toxicity. Animals dosed with 100 times dietary requirement showed no evidence of toxicity (Goyer 1991). In humans, acute poisoning from foods or beverages prepared in galvanized containers is characterized by GI upset (Elinder 1986b). Chronic oral toxicity in animals is associated with poor growth, GI inflammation, arthritis, lameness, and a microcytic, hypochromic anemia (Elinder 1986b), possibly secondary to copper deficiency (Underwood 1977). The EPA (1995) presented a verified RfD of 0.3 mg/kg/day for chronic oral exposure to zinc, based on anemia in humans.

<u>Carcinogenicity</u>

The EPA (1997a) classifies zinc in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) based on inadequate evidence for carcinogenicity in humans and animals. The human data consist largely of occupational exposure studies not designed to detect a carcinogenic response, and of reports that prostatic zinc concentrations were lower in cancerous than in noncancerous tissue. The animal data consist of several dietary, drinking water, and zinc injection studies, none of which provided convincing data for a carcinogenic response.

APPENDIX A, PART 2
A DETAILED EXPLANATION OF INHALATION OF FUGITIVE DUST EXPOSURE MODELING

APPENDIX A, PART 2
A DETAILED EXPLANATION OF INHALATION OF FUGITIVE DUST EXPOSURE MODELING

INHALATION OF PARTICULATES FROM SOIL

To evaluate the estimated levels of site contaminants that would occur in ambient air due to wind erosion at NAS Key West, a three-step modeling process was performed. Respirable, particle-phase emission rates are calculated in the first step. In the second phase, contaminant emission rates on a unit-basis are calculated. The third phase calculates downwind ambient concentrations by using dispersion modeling. These methods are explained in the following text.

Step 1: Estimation of PM_{10} Emissions From Wind Erosion

Emission rates for respirable particle-phase contaminants by wind erosion have been developed by Cowherd and others (1985). Airborne respirable particulate matter (PM_{10}) are defined as having an aerodynamic diameter less than or equal to 10 µm. A conservative estimate of the PM_{10} emission factor (E_{10}) for contaminated surface soils with "unlimited" erosion potential was developed using an emission factor derived by Gillette (1981). The following equation is used:

$$E_{10} = \left(1\times10^{-5}\right)*\left(1-V\right)*\left(\frac{U}{Ut}\right)^3*F(x)$$

where:
- E_{10} = PM_{10} emission factor (g/m^2 - s)
- 1E-05 = empirical constant (g/m^2 - s)
- V = fraction of the contaminated surface area with continuous vegetative cover
- U = mean annual wind speed (m/s)
- Ut = threshold value of wind speed at 7 m (m/s)
- F(x) = function to estimate unlimited erosion (plotted in Cowherd, et. al 1985)
- x = dimensionless ratio = 0.886 x Ut/U

and:

$$Ut = Ut = U^{*}*\left(\frac{1}{0.4}\right)*LN\left(\frac{z}{z_o}\right)$$

where:
- Ut = wind speed at height z (m/s)
- z = height above surface (cm)
- z_0 = roughness height (cm)
- U* = friction velocity (m/s)

For values of x greater than 2:

$$F(x) = 0.18\left(8x^3 + 12x\right)exp\left(-x^2\right)$$

Step 2: Estimation of Contaminant Emission Rates

Contaminant-specific emission rates are calculated from the PM_{10} emission rates, the mass fraction of contaminant in PM_{10} emissions, and the contaminated surface area. These factors are used to calculate contaminant emission rates (Q_{10}) by using the following equation:

$$Q_{10} = f * E_{10} * A * 1$$

where:	Q10	=	contaminant emission rate as PM_{10} (µg/s)
	f	=	mass fraction of contaminant in PM_{10} emissions (mg contaminant/kg PM_{10})
	E_{10}	=	PM_{10} emission rate (g PM_{10}/m^2-s)
	A	=	contaminated surface area (m^2)
	1	=	conversion factor (1,000 µg contaminant/mg contaminant x kg PM_{10}/ 1,000 g PM_{10})

Step 3: Airborne Contaminant Concentration

The box model for air dispersion has been selected to predict contaminant air concentrations bases on PM_{10} emission rate. This is the most appropriate model to use when receptors are less than 100 meters from the edge of a source area. This is a conservative model which overpredicts concentrations by approximately four to six; therefore, it provides concentrations protective of human health. The model assumes mixing of emissions with the ambient air is complete. The box encloses the entire source area. The mixing height is determined by the following equation presented by Pasquill (1975) for neutral stability:

$$x = 6.25 * z_o * \left[\left(H/z_o\right) * ln\left(H/z_o\right) - 1.58 * \left(H/z_o\right) + 1.58\right]$$

where:	x	=	downwind distance from the leading edge of the source area to the receptor (m)
	H	=	downwind mixing height (m)
	z_0	=	roughness height (m)

The roughness height has been selected at 0.02 meters based on determination by Cowherd and others (1985). Downwind distance to receptors is measured to the closest exposure points to potentially exposed populations. For purposes of this evaluation, this distance has been conservatively assumed as

1 meter (the receptor is at the source). The ambient 24-hour contaminant concentration (C_{10}) is estimated by the bos model equation:

$$C_{10} = \frac{(Q_{10} * a)}{([u] * H * w}$$

where:	C_{10}	=	concentration of contaminant at distance X (μg/m^3)
	Q_{10}	=	particle-phase emission rate from wind erosion (μg/s)
	a	=	fraction of 24 hours during which emissions occur
	U	=	average wind speed (m/s)
	H	=	downwind mixing height (m)
	W	=	width of area perpendicular to wind (m)
	C_{10}/1,000	=	CA in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report

APPENDIX A, PART 3
A DETAILED EXPLANATION OF DERMAL EXPOSURE TO WATER AND SOIL

APPENDIX A, PART 3
A DETAILED EXPLANATION OF DERMAL EXPOSURE TO WATER AND SOIL

Water

Dermal exposure to water was evaluated using the following equations (EPA, 1992c):

Inorganics

For inorganics (steady state approach), the dose absorbed per unit area per event is:

$$DA_{event} = PC_{event} * C_w * CF_1 * CF_2$$

$$PC_{event} = K_{pw} * t_{event}$$

where: PC_{event} = Diffusion depth per event (cm/event)
K_{pw} = Permeability coefficient from water (cm/hr)
t_{event} = Duration of event (hr/event)
C_w = Concentration of contaminant in water (mg/L)
CF_1 = Conversion factor ($L/10^3\ cm^3$)
CF_2 = Conversion factor ($mg/10^3\ \mu g$)
DA_{event} = Dose absorbed per unit area per event (mg/cm^2-event)

Organics

For organics (the unsteady state approach), the dose absorbed per unit area per event is:

$$DA_{event} = PC_{event} * C_w * CF_3 * CF_4$$

$$PC_{event} = 2 * Kp * \sqrt{\frac{6 * \tau * t_{event}}{\pi}}$$

where: $t < t^*$

and $$DA_{event} = PC_{event} * CW * CF_5 * CF_6$$

$$PC_{event} = Kp * ((t_{event}/(1+B)) + 2\tau * ((1+3B)/(1+B))$$

where: $t > t^*$
where: Kp = Permeability coefficient from water (cm/hr)
CW = Concentration of contaminant in water (µg/L)

t	=	lsc2/6 Dsc (hr)
l_{sc}	=	Thickness of stratum corneum (10 µm)
D_{sc}	=	Stratum corneum diffusion diffusion coefficient (cm^2/hr)
t_{event}	=	Duration of a single event (hr/event)
p	=	Pi (dimensionless)
t*	=	Time to reach steady state (hr)
B	=	Octanol water partition coefficient divided by 104 (dimensionless)
CF_3	=	Units conversion factor (1 mg/10^3 µg)
CF_4	=	Units conversion factor (1 liter/10^3 cm^3)
CF_5	=	Units conversion factor (1 mg/10^3 µg)
CF_6	=	Units conversion factor (1 liter/10^3 cm^3)

Dermally Absorbed Dose (DAD)

After DA_{event} is calculated, the dermally absorbed dose (DAD) for use in risk calculations can be derived by using the following:

For adults:

$$DAD_{adult} = \frac{DA_{event} * EV * EF * ED * SA}{BW * AT}$$

For children:

To account for changing surface areas and body weight, the DAD is calculated as follows:

$$DAD_{child} = \frac{DA_{event} * EV * EF}{AT} * \sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

where:	EV	=	Event frequency (events/day)
	EF	=	Exposure frequency (days/year)
	AT	=	Averaging time (days). For non-carcinogenic effects, AT = ED, for carcinogenic effects, AT = 70 years or 25,550 days.
	SA_i	=	Surface area exposed at age i (cm^2)
	ED_i	=	Exposure duration at age i (years)
	BW_i	=	Bodyweight at age i (kg)

Values of:

$$\sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

The age adjusted, bodyweight-normalized surface areas exposed while wading of a resident child and a adolescent trespasser based on RME exposure are 766.7 cm^2-year/kg and 1136.3 cm^2-year/kg, respectively. The age adjusted, bodyweight-normalized surface areas exposed while wading of a resident child and a adolescent trespasser based on CTE exposure are 252.8 cm^2-year/kg and 212.3 cm^2-year/kg, respectively. For wading, it is assumed that the entire surface area of the feet, lower legs, and hands is exposed to the surface water during the entire exposure event. This assumption is for shallow water situations. Averaging surface areas over the 6 childhood years yields the following: hands represent 5.5 percent of total body surface area, lower leg represents 12.8 percent of total body surface area, and the feet represent 7 percent of total body surface area. Therefore, the feet, lower legs and hands represent approximately 25 percent of total body surface area for children ages 1 through 6 (Table C.3-15 of Appendix C of the Supplemental RFI/RI Report). This value is the same value which EPA identifies as the per cent of total body surface area which is available for soil contact (EPA 1992c). This value, 25 percent of total body surface area is used here to represent surface area available for waders of all ages. CTE exposure takes into account a child aged 3 through 5 years.

Soil

Dermal exposure to soil was evaluated using the following equations (EPA, 1992c):

The calculation of the estimated dermally absorbed dose per unit area per event is:

$$DA_{event} = CS * AF * ABS * CF$$

where: CS = Contaminant concentration in soil/sediment (mg/kg)
AF = Adherence factor of soil to skin (mg/cm^2-event)
ABS = Absorption fraction (dimensionless)
CF = Conversion factor (10^{-6} kg/mg)

Dermally Absorbed Dose - Adults

For adults, the dermally absorbed dose for use in quantitative risk assessments is as follows:

$$DA_{adult} = \frac{DA_{event} * EF * ED * SA}{BW * AT}$$

Dermally Absorbed Dose - Children

For children, to account for changing surface areas and bodyweights, the dermally absorbed dose is calculated as follows:

$$DA_{child} = \frac{DA_{event} * EF}{AT} * \sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

where: EF = Exposure frequency (events/year)

AT	=	Averaging time (days). For noncarcinogenic effects AT - ED, and for carcinogenic effects AT - 70 years or 25,550 days.
SA_i	=	Surface area exposed at age i (cm^2)
ED_i	=	Exposure duration at age i (years)
BW_i	=	Bodyweight at age i (kg)

For the typical case, EPA recommends SA for head and hands only. For the "reasonable worst case," the EPA recommends the SA of the head, hands, forearms, and lower legs. EPA simplifies these assumptions by saying that 25 percent of the total body surface area would be available for soil contact. For adults, using 50th and 95th percentile whole body SA values, the default SA values are 5000 cm^2 and 5800. For children, the default values for each age group would be equal to 25 percent of the 50th percentile and 95th percentile whole body SA values.

Values of:

$$\sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

The age adjusted, bodyweight-normalized surface areas exposed to soil of a resident child and a trespasser child based on RME exposure are 766.7 cm^2-year/kg and 1136.3 cm^2-year/kg, respectively. The age adjusted, bodyweight-normalized surface areas exposed to soil of a resident child and a trespasser child based on RME exposure are 252.8 cm^2-year/kg and 212.3 cm^2-year/kg, respectively.

APPENDIX A, PART 4
RISK ASSESSMENT EXAMPLE CALCULATIONS

APPENDIX A, PART 4
RISK ASSESSMENT EXAMPLE CALCULATIONS

Surface Soil Exposure

Three potential exposure routes are associated with theoretical surface soil direct contact at the NAS Key West sites. These exposure routes include ingestion, dermal contact, and inhalation of fugitive dust. Example calculations for each of these routes of exposure are presented in the following text.

Ingestion - RME

Incidental surface soil ingestion exposure for arsenic at SWMU 5 is estimated for an occupational worker from the following equation (EPA, 1989d):

$$IEX(mg/kg)/day = \frac{CS * IR_{soil} * FI * CF * EF * ED}{BW * AT}$$

where:	CS	= 13 mg/kg	=	Arsenic rep. conc. in surface soil at SWMU 5
	IR_{soil}	= 50 mg soil/day	=	Soil ingestion rate
	FI	= 1.0	=	Fraction ingested from contaminated source
	EF	= 250 days/yr	=	Exposure frequency
	ED	= 25 yrs	=	Exposure duration
	BW	= 70 kg	=	Body weight
	AT_{car}	= 25,550 days	=	Averaging time for carcinogens (365 days/yr x 70 yrs)
	AT_{noncar}	= 9125 days	=	Averaging time, non-carcinogens (365 days/yr x 25 yr)
	CF	= 1E-6 kg soil/mg soil	=	Conversion factor
	IEX_{car}	= 2.28E-6 mg/kg/day	=	Carcinogenic ingestion exposure
	IEX_{noncar}	= 6.36E-6 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental ingestion of arsenic in surface soil is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	= 2.28E-6 (mg/kg)/day	=	Ingestion exposure
	SF	= 1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	= 3.410E-6	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = {IEX_{noncar}}/{RfD}$$

where:	IEX_{noncar}	= 6.36E-6 mg/kg/day	=	Ingestion exposure
	RfD	= 3E-4 mg/kg	=	Reference dose
	NC	= 2.12E-2	=	Noncarcinogenic risk

Ingestion - CTE

Incidental surface soil ingestion exposure for arsenic at SWMU 5 is estimated for an occupational worker from the following equation (EPA, 1989d):

$$IEX(mg/kg)/day = \frac{CS * IR_{soil} * FI * CF * EF * ED}{BW * AT}$$

where:	CS	= 13 mg/kg	=	Arsenic rep. conc. in surface soil at SWMU 5
	IR_{soil}	= 50 mg soil/day	=	Soil ingestion rate
	FI	= 1.0	=	Fraction ingested from contaminated source
	EF	= 250 days/yr	=	Exposure frequency
	ED	= 9 yrs	=	Exposure duration
	BW	= 70 kg	=	Body weight
	AT_{car}	= 25,550 days	=	Averaging time for carcinogens (365 days/yr x 70 yrs)
	AT_{noncar}	= 3285 days	=	Averaging time, non-carcinogens (365 days/yr x 9 yr)
	CF	= 1E-6 kg soil/mg soil	=	Conversion factor
	IEX_{car}	= 8.19E-7 mg/kg/day	=	Carcinogenic ingestion exposure
	IEX_{noncar}	= 6.36E-6 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental ingestion of arsenic in surface soil is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	= 8.19E-7 (mg/kg)/day	=	Ingestion exposure
	SF	= 1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	= 1.23E-6	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = {IEX_{noncar}}/{RfD}$$

where:	IEX_{noncar}	= 6.36E-6 mg/kg/day	=	Ingestion exposure
	RfD	= 3E-4 mg/kg	=	Reference dose
	NC	= 2.12E-2	=	Noncarcinogenic risk

<u>Dermal Contact - RME</u>

Incidental surface soil dermal contact exposure for arsenic at SWMU 5 is estimated for an occupational worker from the following equation (EPA 1989d; EPA 1992c):

$$DEX(mg/kg)/day = \frac{CS * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

where:	CS	= 13 mg/kg	=	Arsenic rep. conc. in surface soil at SWMU 5
	SA	= 2,300 cm^2/day	=	Skin surface area available for contact
	AF	= 1.0 mg/cm^2	=	Soil-to-skin adherence factor
	ABS	= 0.032	=	Fraction from contaminated source for arsenic
	EF	= 250 days/yr	=	Exposure frequency
	ED	= 25 yrs	=	Exposure duration
	CF	= 1E-06 kg soil/mg soil	=	Conversion factor
	BW	= 70 kg	=	Body weight
	AT_{car}.	= 25,550 days	=	Averaging time, carcinogens (365 days/yr x 70 yrs)
	AT_{noncar}	= 9,125 days	=	Averaging time, non-carcinogens (365 days/yr x 25 yr)
	DEX_{car}	= 3.35E-6 mg/kg/day	=	Carcinogenic dermal exposure
	DEX_{noncar}	= 9.36E-6 mg/kg/day	=	Noncarcinogenic dermal exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental dermal contact with arsenic in surface soil is estimated as follows:

$$CA = DEX_{car} * {}^{SF}\!/_{GI}$$

where:	DEX_{car}	= 3.35E-6 mg/kg/day	=	Dermal exposure
	SF	= 1.5E+0 $(mg/kg/day)^{-1}$	=	Slope factor
	GI	= 0.2	=	Gastrointestinal absorption factor
	CA	= 2.51E-5	=	Carcinogenic Risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Sections 3.2.4 and 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = {}^{DEX_{noncar}}\!/_{RfD * GI}$$

where:	DEX_{noncar}	= 9.36E-6 mg/kg/day	=	Dermal exposure
	RfD	= 3E-4 mg/kg	=	Reference dose
	GI	= 0.2	=	Gastrointestinal absorption factor
	NC	= 1.56E-1	=	Noncarcinogenic risk

Dermal Contact - CTE

Incidental surface soil dermal contact exposure for arsenic at SWMU 5 is estimated for an occupational worker from the following equation (EPA 1989d; EPA 1992c):

$$DEX(mg / kg) / day = \frac{CS * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

where:	CS	= 13 mg/kg	=	Arsenic rep. conc. in surface soil at SWMU 5
	SA	= 2,300 cm^2/day	=	Skin surface area available for contact
	AF	= 0.2 mg/cm^2	=	Soil-to-skin adherence factor
	ABS	= 0.032	=	Fraction from contaminated source for arsenic
	EF	= 250 days/yr	=	Exposure frequency
	ED	= 9 yrs	=	Exposure duration
	CF	= 1E-06 kg soil/mg soil	=	Conversion factor
	BW	= 70 kg	=	Body weight
	AT_{car}	= 25,550 days	=	Averaging time, carcinogens (365 days/yr x 70 yrs)
	AT_{noncar}	= 3285 days	=	Averaging time, non-carcinogens (365 days/yr x 25 yr)
	DEX_{car}	= 2.41E-7 mg/kg/day	=	Carcinogenic dermal exposure
	DEX_{noncar}	= 1.87E-6 mg/kg/day	=	Noncarcinogenic dermal exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental dermal contact with arsenic in surface soil is estimated as follows:

$$CA = DEX_{car} * {SF}/{GI}$$

where:	DEX_{car}	= 2.41E-7 mg/kg/day	=	Dermal exposure
	SF	= 1.5E+0 $(mg/kg/day)^{-1}$	=	Slope factor
	GI	= 0.2	=	Gastrointestinal absorption factor
	CA	= 1.81E-6	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$CA = {DEX_{noncar}}/{RfD * GI}$$

where:	DEX_{noncar}	= 1.87E-6 mg/kg/day	=	Dermal exposure
	RfD	= 3E-4 mg/kg	=	Reference dose
	GI	= 0.2	=	Gastrointestinal absorption factor
	NC	= 3.12E-2	=	Noncarcinogenic risk

Inhalation - RME

Incidental surface soil inhalation of fugitive dust emission exposure for arsenic and cadmium at SWMU 5 is estimated for an occupational worker from the following equations (EPA 1989d; Cowherd, et al. 1985):

$$INHX(mg / kg) / day = I_{inh} = \frac{CA * CS * IR_{air} * ET * EF * ED * FR - I}{BW * AT}$$

$$INHX(mg / kg) / day = I_{oral} = \frac{CA * CS * IR_{air} * ET * EF * ED * FR - O}{BW * AT}$$

$$E_{10} = (1x10^{-5}) * (1 - V) * (\frac{[u]}{Ut})^3 * F(x)$$

$$Ut = U^* * (\frac{1}{0.4}) * LN(\frac{z}{z_O})$$

$$Q_{10} = f * E_{10} * A$$

$$C_{10} = \frac{(Q_{10} * a)}{([u] * H * w)}$$

Exposure to fugitive dust emissions can be estimated by first estimating the rate of distribution and arsenic and cadmium emissions from SWMU 5 and then relating this to the exposure rate for the receptors.

Estimation of PM_{10} Emissions are as follows:

where:	V	= 0.6	= Fraction of vegetative cover
	[u]	= 3.9 m/s	= Mean annual wind speed (Tampa, Fla.) (Table 4-1, Cowherd, et al. 1985)
	Ut	= 5.6 m/s	= Threshold value of wind speed at 7 m
	z	= 7 m	= Height above surface (Cowherd et. al 1985)
	z_0	= 0.2 m	= Roughness height for the area, medium buildings (Figure 3-6, Cowherd, et al. 1985)
	U*	= 0.63 m/s	= Friction velocity for assumed particle size 1 mm(Figure 3-4, Cowherd, et al. 1985)
	F(x)	= 1.3	= Function (calculated or from Figure 4-3, Cowherd et al. 1985)
	E10	= 1.76E-6 g/(m^2s)	= Particulates less than 10 microns (PM_{10}) average annual emission rate

Estimation of Contaminant Emission Rates are as follows:

where:	f	= 1	= Fraction of PM_{10} with contaminant (mg contaminant/kg soil)
	E10	= 1.76E-6 g/(m^2s)	= Particulates less than 10 microns (PM_{10}) average annual emission rate
	A	= 33,600 m^2	= Source area
	Q_{10}	= 5.90E-2 µg/sec	= Contaminant emission rate

To estimate the annual average air concentration to receptors near the site, a screening air dispersion model was used as described in Cowherd, et al.

Airborne Contaminant Concentrations were estimated as follows:

where:	Q_{10}	= 5.90E-2 µg/sec	= Contaminant emission rate
	a	= 1	= Fraction of 24 hours during which activity occurs
	[u]	= 3.9 m/s	= Wind speed
	H	= 0.276 m	= Downwind mixing height, based on described value of X

		=	Downwind distance from leading edge of area source to receptor; derived value of X from equation: X
		=	6.25 * (z0) * [(H/z_0) * ln(H/z_0) - 1.58 * (H/z_0) + 1.58]
z_0	= 0.2 m	=	Roughness height
w	= 140 m/s	=	Width of area perpendicular to wind
C_{10}	= 3.92E-4 (μg/m^3)	=	Airborne contaminant concentration

The EPA (1989a) inhalation equation was estimated as follows:

where:

CA	= 3.92E-7 mg/m^3	=	C_{10}/1,000, airborne Contaminant concentration
CS	= 13 mg/kg	=	arsenic rep. conc. in surface soil at SWMU 5
IR_{air}	= 0.833 m^3/hour	=	Soil inhalation rate
FI	= 1.0	=	Fraction ingested from contaminated source
ET	= 8 hours/day	=	Exposure Time
EF	= 250 days/yr	=	Exposure frequency
ED	= 25 yrs	=	Exposure duration
BW	= 70 kg	=	Body weight
CF	= 1E-06 kg soil/mg soil	=	Conversion Factor
FR-I	= 0.125	=	Fraction inhaled and retained in lungs
FR-O	= 0.625	=	Fraction inhaled and eventually swallowed
AT_{car}	= 25,550 days	=	Averaging time, carcinogens (365 days/yr x 70 yrs)
AT_{noncar}	= 9,125 days	=	Averaging time, noncarcinogens (365 days/yr x 25 yr)
$I_{inh-car}$	= 1.48E-14 mg/kg/day	=	Carcinogenic inhalation exposure (retained in lungs)
$I_{oral-car}$	= 7.42E-14 mg/kg/day	=	Carcinogenic inhalation exposure (eventually swallowed)

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental inhalation of arsenic in fugitive dust is estimated as follows:

$$CA = \left(I_{inh-car} * SF_{inh}\right) + \left(I_{oral-car} * SF_{oral}\right)$$

where:

$I_{inh-car}$	= 1.48E-14 mg/kg/day	=	Inhalation exposure (inhaled portion)
$I_{oral-car}$	= 7.42E-14 mg/kg/day	=	Inhalation exposure (swallowed portion)
SF_{inh}	= 15.1 $(mg/kg/day)^{-1}$	=	Slope factor (inhalation)
Sf_{oral}	= 1.5$(mg/kg/day)^{-1}$	=	Slope factor (oral)
CA	= 3.35E-13	=	Carcinogenic Risk

Arsenic does not have an inhalation reference dose, therefore, no noncarcinogenic risks were estimated for arsenic. Cadmium in surface soil at SWMU 5 was used to estimated noncarcinogenic risks for this pathway. Noncarcinogenic risks are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

where:	CS	=	12.6 mg/kg	=	cadmium rep. conc. in surface soil at SWMU 5
	$I_{inh\text{-}noncar}$	=	4.03E-14 mg/kg/day	=	Noncarcinogenic inhalation exposure (retained in lungs)
	$I_{oral\text{-}noncar}$	=	2.01E-13 mg/kg/day	=	Noncarcinogenic inhalation exposure (eventually swallowed)

$$NC = \left(I_{inh-noncar} / RfD_{inh} \right) + \left(I_{oral-noncar} / RfD_{oral} \right)$$

where:	$I_{inh\text{-}noncar}$	=	4.03E-14 mg/kg/day	=	Inhalation exposure (inhaled portion)
	$I_{oral\text{-}noncar}$	=	2.01E-13 mg/kg/day	=	Inhalation exposure (swallowed portion)
	RfD_{inh}	=	5.71E-5 mg/kg/day	=	Reference dose (inhalation)
	RfD_{oral}	=	1E-3 mg/kg/day	=	Reference dose (oral)
	NC	=	9.06E-10	=	Noncarcinogenic risk

<u>Inhalation - CTE</u>

Incidental surface soil inhalation of fugitive dust emission exposure for arsenic and cadmium at SWMU 5 is estimated for an occupational worker from the following equations (EPA 1989d; Cowherd, et al. 1985):

$$INHX(mg / kg) / day = I_{inh} = \frac{CA * CS * IR_{air} * ET * EF * ED * FR - I}{BW * AT}$$

$$INHX(mg / kg) / day = I_{oral} = \frac{CA * CS * IR_{air} * ET * EF * ED * FR - O}{BW * AT}$$

$$E_{10} = (1x10^{-5}) * (1 - V) * (\frac{[u]}{Ut})^3 * F(x)$$

$$Ut = U^* * (\frac{1}{0.4}) * LN(\frac{z}{z_O})$$

$$Q_{10} = f * E_{10} * A$$

$$C_{10} = \frac{(Q_{10} * a)}{([u] * H * w)}$$

Exposure to fugitive dust emissions can be estimated by first estimating the rate of distribution and arsenic and cadmium emissions from SWMU 5 and then relating this to the exposure rate for the receptors.

Estimation of PM_{10} Emissions are as follows:

where:	V	= 0.6	= Fraction of vegetative cover
	[u]	= 3.9 m/s	= Mean annual wind speed (Tampa, Fla.) (Table 4-1, Cowherd, et al. 1985)
	Ut	= 5.6 m/s	= Threshold value of wind speed at 7 m
	z	= 7 m	= Height above surface (Cowherd et. al 1985)
	z_0	= 0.2 m	= Roughness height for the area, medium buildings (Figure 3-6, Cowherd, et al. 1985)
	U*	= 0.63 m/s	= Friction velocity for assumed particle size 1 mm(Figure 3-4, Cowherd, et al. 1985)
	F(x)	= 1.3	= Function (calculated or from Figure 4-3, Cowherd et al. 1985)
	E10	= 1.76E-6 g/(m^2s)	= Particulates less than 10 microns (PM_{10}) average annual emission rate

Estimation of Contaminant Emission Rates are as follows:

where:	f	= 1	= Fraction of PM_{10} with contaminant (mg contaminant/kg soil)
	E10	= 1.76E-6 g/(m^2s)	= Particulates less than 10 microns (PM_{10}) average annual emission rate
	A	= 33,600 m^2	= Source area
	Q_{10}	= 5.90E-2 µg/sec	= Contaminant emission rate

To estimate the annual average air concentration to receptors near the site, a screening air dispersion model was used as described in Cowherd, et al.

Airborne Contaminant Concentrations were estimated as follows:

where:	Q_{10}	= 5.90E-2 µg/sec	= Contaminant emission rate
	a	= 1	= Fraction of 24 hours during which activity occurs
	[µ]	= 3.9 m/s	= Wind speed
	H	= 0.276 m	= Downwind mixing height, based on described value of X
			= Downwind distance from leading edge of area source to receptor; derived value of X from equation: $X = 6.25 * (z0) * [(H/z_0) * \ln(H/z_0) - 1.58 * (H/z_0) + 1.58]$
	z_0	= 0.2 m	= Roughness height
	w	= 140 m/s	= Width of area perpendicular to wind
	C_{10}	= 3.92E-4 (µg/m^3)	= Airborne contaminant concentration

The EPA (1989d) inhalation equation was estimated as follows:

where:	CA	= 3.92E-7 mg/m^3	= C_{10}/1,000, airborne Contaminant concentration
	CS	= 13 mg/kg	= arsenic rep. conc. in surface soil at SWMU 5

IR_{air}	=	0.833 m^3/hour	=	Soil inhalation rate
FI	=	1.0	=	Fraction ingested from contaminated source
ET	=	8 hours/day	=	Exposure Time
EF	=	250 days/yr	=	Exposure frequency
ED	=	9 yrs	=	Exposure duration
BW	=	70 kg	=	Body weight
CF	=	1E-06 kg soil/mg soil	=	Conversion Factor
FR-I	=	0.125	=	Fraction inhaled and retained in lungs
FR-O	=	0.625	=	Fraction inhaled and eventually swallowed
AT_{car}	=	25,550 days	=	Averaging time, carcinogens (365 days/yr x 70 yrs)
AT_{noncar}	=	3285 days	=	Averaging time, non-carcinogens (365 days/yr x 9 yr)
$I_{inh-car}$	=	5.34E-15 mg/kg/day	=	Carcinogenic inhalation exposure (retained in lungs)
$I_{oral-car}$	=	2.67E-14 mg/kg/day	=	Carcinogenic inhalation exposure (eventually swallowed)

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, adolescent trespassers, maintenance workers, and occupational workers.

The cancer risk for an occupational worker from incidental inhalation of arsenic in fugitive dust is estimated as follows:

$$CA = \left(I_{inh-car} * SF_{inh}\right) + \left(I_{oral-car} * SF_{oral}\right)$$

where:	$I_{inh-car}$	=	5.34E-15 mg/kg/day	=	Inhalation exposure (inhaled portion)
	$I_{oral-car}$	=	2.67E-14 mg/kg/day	=	Inhalation exposure (swallowed portion)
	SF_{inh}	=	15.1 $(mg/kg/day)^{-1}$	=	Slope factor (inhalation)
	Sf_{oral}	=	1.5$(mg/kg/day)^{-1}$	=	Slope factor (oral)
	CA	=	1.21E-13	=	Carcinogenic risk

Arsenic does not have an inhalation reference dose, therefore, no noncarcinogenic risks were estimated for arsenic. Cadmium in surface soil at SWMU 5 was used to estimated noncarcinogenic risks for this pathway. Noncarcinogenic risks are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

where:	CS	=	12.6 mg/kg	=	cadmium rep. conc. in surface soil at SWMU 5
	$I_{inh-noncar}$	=	4.03E-14 mg/kg/day	=	Noncarcinogenic inhalation exposure (retained in lungs)
	$I_{oral-noncar}$	=	2.01E-13 mg/kg/day	=	Noncarcinogenic inhalation exposure (eventually swallowed)

$$NC = \left(I_{inh-noncar} / RfD_{inh}\right) + \left(I_{oral-noncar} / RfD_{oral}\right)$$

where: $I_{inh\text{-}noncar}$ = 4.03E-14 mg/kg/day = Inhalation exposure (inhaled portion)
$I_{oral\text{-}noncar}$ = 2.01E-13 mg/kg/day = Inhalation exposure (swallowed portion)
RfD_{inh} = 5.71E-5 mg/kg/day = Reference dose (inhalation)
RfD_{oral} = 1E-3 mg/kg/day = Reference dose (oral)
NC = 9.06E-10 = Noncarcinogenic risk

Subsurface Soil Exposure

The assumptions for incidental ingestion of, dermal contact with, and inhalation of fugitive dust emissions for COPCs in subsurface soil are the same as the assumptions and equations for surface soil presented in the previous section, except the potential receptor is an excavation worker (assumptions for this exposure scenario are presented in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report).

Sediment Exposure

Two potential exposure routes are associated with theoretical sediment direct contact at the NAS Key West sites. These exposure routes include ingestion and dermal contact. Example calculations for each of these routes of exposure are presented in the following text.

Ingestion - RME

Incidental sediment ingestion exposure for arsenic at SWMU 5 is estimated for an adult trespasser from the following equation (EPA, 1989d):

$$IEX(mg/kg)/day = \frac{CS * IR_{sediment} * FI * CF * EF * ED}{BW * AT}$$

where: CS = 8.02 mg/kg = Arsenic rep. conc. in sediment at SWMU 5
IR_{sed} = 100 mg soil/day = Sediment ingestion rate
FI = 1.0 = Fraction ingested from contaminated source
CF = 1E-6 kg soil/mg soil = Conversion factor
EF = 24 days/yr = Exposure frequency
ED = 19 yrs = Exposure duration
BW = 70 kg = Body weight
AT_{car} = 25,550 days = Averaging time for carcinogens (365 days/yr x 70yrs)
AT_{noncar} = 6,935 days = Averaging time, noncarcinogens (365 days/yr x 19 yr)
IEX_{car} = 2.05E-7 mg/kg/day = Carcinogenic ingestion exposure
IEX_{noncar} = 7.53E-7 mg/kg/day = Noncarcinogenic ingestion exposure

As discussed in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The cancer risk for an adult trespasser from incidental ingestion of arsenic in SWMU 5 sediment is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	= 2.05E-7 mg/kg/day	=	Ingestion exposure
	SF	= 1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	= 3.07E-7	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$CA = {IEX_{noncar}}/{RfD}$$

where:	IEX_{noncar}	= 7.53E-7 mg/kg/day	=	Ingestion exposure
	RfD	= 3E-4 mg/kg	=	Reference dose
	NC	= 2.51E-3	=	Noncarcinogenic risk

Ingestion - CTE

Incidental sediment ingestion exposure for arsenic at SWMU 5 is estimated for an adult trespasser from the following equation (EPA, 1989d):

$$IEX(mg / kg) / day = \frac{CS * IR_{se\dim ent} * FI * CF * EF * ED}{BW * AT}$$

where:	CS	= 8.02 mg/kg	=	Arsenic rep. conc. in sediment at SWMU 5
	IR_{sed}	= 50 mg soil/day	=	Sediment ingestion rate
	FI	= 1.0	=	Fraction ingested from contaminated source
	CF	= 1E-6 kg soil/mg soil	=	Conversion factor
	EF	= 12 days/yr	=	Exposure frequency
	ED	= 7 yrs	=	Exposure duration
	BW	= 70 kg	=	Body weight
	AT_{car}	= 25,550 days	=	Averaging time for carcinogens (365 days/yr x 70 yrs)
	AT_{noncar}	= 2555 days	=	Averaging time, noncarcinogens (365 days/yr x 7 yr)
	IEX_{car}	= 1.88E-8 mg/kg/day	=	Carcinogenic ingestion exposure
	IEX_{noncar}	= 1.89E-7 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The cancer risk for an adult trespasser from incidental ingestion of arsenic in SWMU 5 sediment is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	= 1.88E-8 mg/kg/day	=	Ingestion exposure
	SF	= 1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	= 2.83E-8	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$CA = {IEX_{noncar}}/{RfD}$$

where:	IEX_{noncar}	= 1.89E-7 mg/kg/day	=	Ingestion exposure
	RfD	= 3E-4 mg/kg	=	Reference dose
	NC	= 6.28E-4	=	Noncarcinogenic risk

Dermal Contact - RME

Dermal exposure to arsenic from SWMU 5 sediment is estimated for an adult trespasser from the following equation (EPA, 1989d; EPA, 1992c):

$$DEX(mg / kg) / day = \frac{CS * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

where:	CS	= 8.02 mg/kg	=	Arsenic rep. conc. in sediment at SWMU 5
	AF	= 1.0 mg/cm2	=	Soil-to-skin adherence factor
	ABS	= 0.032	=	Absorption fraction from contaminated source for arsenic
	CF	= 1E-06 kg soil/mg soil	=	Conversion factor
	SA	= 5750 cm2/day	=	Skin surface area available for contact
	EF	= 24 days/yr	=	Exposure frequency
	ED	= 19 yrs	=	Exposure duration
	BW	= 70 kg	=	Body weight
	AT_{car}	= 25,550 days	=	Averaging time, carcinogen (365 days/yr x 70 yrs)
	AT_{noncar}	= 6,935 days	=	Averaging time, noncarcinogens (365 days/yr x 19 yr)
	DEX_{car}	= 3.77E-7 mg/kg/day	=	Carcinogenic dermal exposure
	DEX_{noncar}	= 1.39E-6 mg/kg/day	=	Noncarcinogenic dermal exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The lifetime cancer risk for an adult trespasser from dermal contact with arsenic in sediment at SWMU 5 is calculated as follows:

$$CA = DEX_{car} * {}^{SF}\!/_{GI}$$

where:	DEX_{car}	= 3.77E-7 mg/kg/day	=	Dermal exposure
	SF	= 1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	GI	= 0.2	=	Gastrointestinal absorption factor
	CA	= 2.83E-6	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$CA = {}^{DEX_{noncar}}\!/_{RfD * GI}$$

where:	DEX_{noncar}	= 1.39E-6 mg/kg/day	=	Dermal exposure
	RfD	= 3E-4 mg/kg	=	Reference dose
	GI	= 0.2	=	Gastrointestinal absorption factor
	NC	= 2.31E-2	=	Noncarcinogenic risk

Dermal Contact - CTE

Dermal exposure to arsenic from SWMU 5 sediment is estimated for an adult trespasser from the following equation (EPA, 1989d; EPA, 1992c):

$$DEX(mg/kg)/day = \frac{CS * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

where:	CS	= 8.02 mg/kg	=	Arsenic rep. conc. in sediment at SWMU 5
	AF	= 0.2 mg/cm2	=	Soil-to-skin adherence factor
	ABS	= 0.032	=	Absorption fraction from contaminated source for arsenic
	CF	= 1E-06 kg soil/mg soil	=	Conversion factor
	SA	= 5750 cm2/day	=	Skin surface area available for contact
	EF	= 12 days/yr	=	Exposure frequency
	ED	= 7 yrs	=	Exposure duration
	BW	= 70 kg	=	Body weight
	AT_{car}	= 25,550 days	=	Averaging time, carcinogen (365 days/yr x 70 yrs)
	AT_{noncar}	= 2555 days	=	Averaging time, noncarcinogens (365 days/yr x 7 yr)
	DEX_{car}	= 1.39E-8 mg/kg/day	=	Carcinogenic dermal exposure
	DEX_{noncar}	= 1.39E-7 mg/kg/day	=	Noncarcinogenic dermal exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The lifetime cancer risk for an adult trespasser from dermal contact with arsenic in sediment at SWMU 5is calculated as follows:

$$CA = DEX_{car} * {}^{SF}\!/_{GI}$$

where:	DEX_{car}	=	1.39E-8 mg/kg/day	=	Dermal exposure
	SF	=	1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	GI	=	0.2	=	Gastrointestinal absorption factor
	CA	=	1.04E-7	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$CA = {}^{DEX_{noncar}}\!/_{RfD * GI}$$

where:	DEX_{noncar}	=	1.39E-7 mg/kg/day	=	Dermal exposure
	RfD	=	3E-4 mg/kg	=	Reference dose
	GI	=	0.2	=	Gastrointestinal absorption factor
	NC	=	2.31E-3	=	Noncarcinogenic risk

Surface Water Exposure

Two potential exposure routes are associated with theoretical surface water direct contact at the NAS Key West sites. These exposure routes include ingestion and dermal contact. Example calculations for each of these routes of exposure are presented in the following text.

Ingestion - RME

Incidental surface water ingestion exposure for arsenic at AOC B is estimated for an adult trespasser from the following equation (EPA 1989d):

$$IEX = \frac{CW * IR_{sw} * CF * EF * ED}{BW * AT}$$

where:	CW	=	11.9 µg/L	=	Arsenic rep. conc. in surface water at AOC B
	IR_{sw}	=	0.13 L/day	=	Ingestion rate
	CF	=	1E-3 mg/µg	=	Conversion factor

EF	=	24 days/yr	=	Exposure frequency
ED	=	19 yrs	=	Exposure duration
BW	=	70 kg	=	Body weight
AT_{car}	=	25,550 days	=	Averaging time for carcinogens (365 days/yr x 70 yrs)
AT_{noncar}	=	6,935 days	=	Averaging time, non-carcinogens (365 days/yr x 19 yr)
IEX_{car}	=	3.94E-7 mg/kg/day	=	Carcinogenic ingestion exposure
IEX_{noncar}	=	1.45E-6 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The lifetime cancer risk for an adult trespasser from ingestion of arsenic in surface water at AOC B is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	=	3.94E-7 mg/kg/day	=	Ingestion exposure
	SF	=	1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	=	5.92E-7	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = IEX_{noncar} / RfD$$

where:	IEX_{noncar}	=	1.45E-6 mg/kg/day	=	Ingestion exposure
	RfD	=	3E-4 mg/kg	=	Reference dose
	NC	=	4.84E-3	=	Noncarcinogenic risk

Ingestion - CTE

Incidental surface water ingestion exposure for arsenic at AOC B is estimated for an adult trespasser from the following equation (EPA 1989d):

$$IEX = \frac{CW * IR_{sw} * CF * EF * ED}{BW * AT}$$

where:	CW	=	11.9 µg/L	=	Arsenic rep. conc. in surface water at AOC B
	IR_{sw}	=	0.13 L/day	=	Ingestion rate
	CF	=	1E-3 mg/µg	=	Conversion factor
	EF	=	12 days/yr	=	Exposure frequency

ED	=	7 yrs	=	Exposure duration
BW	=	70 kg	=	Body weight
AT_{car}	=	25,550 days	=	Averaging time for carcinogens (365 days/yr x 70 yrs)
AT_{noncar}	=	2555 days	=	Averaging time, non-carcinogens (365 days/yr x 7 yr)
IEX_{car}	=	7.27E-8 mg/kg/day	=	Carcinogenic ingestion exposure
IEX_{noncar}	=	7.27E-7 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The lifetime cancer risk for an adult trespasser from ingestion of arsenic in surface water at AOC B is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	=	7.27E-8 mg/kg/day	=	Ingestion exposure
	SF	=	1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	=	1.09E-7	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = {IEX_{noncar}}/{RfD}$$

where:	IEX_{noncar}	=	7.27E-7 mg/kg/day	=	Ingestion exposure
	RfD	=	3E-4 mg/kg	=	Reference dose
	NC	=	2.42E-3	=	Noncarcinogenic risk

<u>Dermal Contact - RME</u>

Dermal exposure to arsenic in AOC B surface water during wading was evaluated using the following equations (EPA, 1992c):

$$DEX = \frac{Kp * ET * CW * CF_1 * CF_2 * EV * EF * ED * SA}{BW * AT}$$

where:	Kp	=	1E-3 cm/hr	=	Permeability coefficient from water
	CW	=	11.9 µg/L	=	Arsenic rep. conc. in surface water at AOC B
	CF_1	=	(1 liter/10^3 cm^3)	=	Conversion Factor
	CF_2	=	(1 mg/10^3 µg)	=	Conversion Factor
	EV	=	1 event/day	=	Event frequency

EF	=	24 days/yr	=	Exposure frequency
ED	=	19 yrs	=	Exposure duration
SA	=	5750 cm^2	=	Skin surface area exposed
ET	=	2.6 hours/event	=	Exposure time
BW	=	70 kg	=	Body weight
AT_{car}	=	25,550 days	=	Averaging time, carcinogen (365 days/yr x 70 yrs)
AT_{noncar}	=	6,935 days	=	Averaging time, non-carcinogen (365 days/yr x 19 yr)
DEX_{car}	=	4.54E-8 mg/kg/day	=	Carcinogenic dermal exposure
DEX_{noncar}	=	1.67E-7 mg/kg/day	=	Noncarcinogenic dermal exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The cancer risk for an adult trespasser from dermal contact with arsenic in surface water at AOC B is estimated as follows:

$$CA = DEX_{car} * {}^{SF}\!/_{GI}$$

where:	DEX_{car}	=	4.54E-8 mg/kg/day	=	Dermal exposure
	SF	=	2.15E+1 $(mg/kg/day)^{-1}$	=	Slope factor
	GI	=	0.2	=	Gastrointestinal absorption factor
	CA	=	3.40E-7	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = {}^{DEX_{noncar}}\!/_{RfD * GI}$$

where:	DEX_{noncar}	=	1.67E-7 mg/kg/day	=	Dermal exposure
	RfD	=	3E-4 mg/kg	=	Reference dose
	GI	=	0.2	=	Gastrointestinal absorption factor
	NC	=	2.79E-3	=	Noncarcinogenic risk

<u>Dermal Contact - CTE</u>

Dermal exposure to arsenic in AOC B surface water during wading was evaluated using the following equations (EPA, 1992c):

$$DEX = \frac{Kp * ET * CW * CF_1 * CF_2 * EV * EF * ED * SA}{BW * AT}$$

where:	Kp	= 1E-3 cm/hr	=	Permeability coefficient from water
	CW	= 11.9 µg/L	=	Arsenic rep. conc. in surface water
	CF_1	= (1 liter/10^3 cm^3)	=	Conversion Factor
	CF_2	= (1 mg/10^3 µg)	=	Conversion Factor
	EV	= 1 event/day	=	Event frequency
	EF	= 12 days/yr	=	Exposure frequency
	ED	= 7 yrs	=	Exposure duration
	SA	= 5750 cm^2	=	Skin surface area exposed
	ET	= 2.6 hours/event	=	Exposure time
	BW	= 70 kg	=	Body weight
	AT_{car}	= 25,550 days	=	Averaging time, carcinogen (365 days/yr x 70 yrs)
	AT_{noncar}	= 2555 days	=	Averaging time, non-carcinogen (365 days/yr x 7 yr)
	DEX_{car}	= 8.36E-9 mg/kg/day	=	Carcinogenic dermal exposure
	DEX_{noncar}	= 8.36E-8 mg/kg/day	=	Noncarcinogenic dermal exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptors for this scenario include residents, adult trespassers, and adolescent trespassers.

The cancer risk for an adult trespasser from dermal contact with arsenic in surface water at AOC B is estimated as follows:

$$CA = DEX_{car} * {}^{SF}\!/_{GI}$$

where:	DEX	= 8.36E-9 mg/kg/day	=	Dermal exposure
	SF	= 1.5 $(mg/kg/day)^{-1}$	=	Slope factor
	GI	= 0.2	=	Gastrointestinal absorption factor
	CA	= 6.27E-8	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = {}^{DEX_{noncar}}\!/_{RfD * GI}$$

where:	DEX_{noncar}	= 8.36E-8 mg/kg/day	=	Dermal exposure
	RfD	= 3E-4 mg/kg	=	Reference dose
	GI	= 0.2	=	Gastrointestinal absorption factor
	NC	= 1.39E-3	=	Noncarcinogenic risk

Shellfish Exposure

One potential exposure route is associated with theoretical shellfish direct contact at the NAS Key West sites. This exposure route is ingestion. Example calculations for this route of exposure is presented in the following text.

Ingestion - RME

Shellfish ingestion exposure for heptachlor epoxide at IR 7 is estimated for an adult resident from the following equation (EPA 1989d):

$$IEX = \frac{CF * IR_{fish} * CF * EF * ED}{BW * AT}$$

where:	CF	=	0.00081 mg/kg	=	Heptachlor epoxide avg. conc. in shellfish at IR 7
	IR_{sw}	=	54 g/day	=	Ingestion rate
	CF	=	1E-3 kg/g	=	Conversion factor
	EF	=	365 days/yr	=	Exposure frequency
	ED	=	30 yrs	=	Exposure duration
	BW	=	70 kg	=	Body weight
	AT_{car}	=	25,550 days	=	Averaging time for carcinogens (365 days/yr x70 yrs)
	AT_{noncar}	=	10950 days	=	Averaging time, non-carcinogens (365 days/yr x 30 yr)
	IEX_{car}	=	2.68E-7 mg/kg/day	=	Carcinogenic ingestion exposure
	IEX_{noncar}	=	6.25E-7 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptor for this scenario is the adult resident.

The lifetime cancer risk for an adult resident from ingestion of heptachlor epoxide in surface water at IR 7 is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	=	2.68E-7 mg/kg/day	=	Ingestion exposure
	SF	=	9.1 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	=	2.44E-6	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = IEX_{noncar} / RfD$$

where:	IEX_{noncar}	=	6.25E-7 mg/kg/day	=	Ingestion exposure
	RfD	=	1.3E-5 mg/kg	=	Reference dose
	NC	=	4.81E-2	=	Noncarcinogenic risk

Ingestion - CTE

Shellfish ingestion exposure for heptachlor epoxide at IR 7 is estimated for an adult resident from the following equation (EPA 1989d):

$$IEX = \frac{CF * IR_{fish} * CF * EF * ED}{BW * AT}$$

where:	CF	=	0.00081 mg/kg	=	Heptachlor epoxide avg. conc. in shellfish at IR 7
	IR_{sw}	=	6.5 g/day	=	Ingestion rate
	CF	=	1E-3 kg/g	=	Conversion factor
	EF	=	365 days/yr	=	Exposure frequency
	ED	=	9 yrs	=	Exposure duration
	BW	=	70 kg	=	Body weight
	AT_{car}	=	25,550 days	=	Averaging time for carcinogens (365 days/yr x70 yrs)
	AT_{noncar}	=	3285 days	=	Averaging time, non-carcinogens (365 days/yr x 9 yr)
	IEX_{car}	=	9.67E-9 mg/kg/day	=	Carcinogenic ingestion exposure
	IEX_{noncar}	=	7.52E-8 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptor for this scenario is the adult resident.

The lifetime cancer risk for an adult resident from ingestion of heptachlor epoxide in surface water at IR 7 is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	=	9.67E-9 mg/kg/day	=	Ingestion exposure
	SF	=	9.1 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	=	8.80E-8	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = IEX_{noncar} / RfD$$

where:	IEX_{noncar}	=	7.52E-8 mg/kg/day	=	Ingestion exposure
	RfD	=	1.3E-5 mg/kg	=	Reference dose
	NC	=	5.79E-3	=	Noncarcinogenic risk

Shellfish Exposure

One potential exposure route is associated with theoretical shellfish direct contact at the NAS Key West sites. This exposure route is ingestion. Example calculations for this route of exposure is presented in the following text.

Ingestion - RME

Shellfish ingestion exposure for heptachlor epoxide at IR 7 is estimated for an adult resident from the following equation (EPA 1989d):

$$IEX = \frac{CF * IR_{fish} * CF * EF * ED}{BW * AT}$$

where:			
CF	= 0.00081 mg/kg	=	Heptachlor epoxide avg. conc. in shellfish at IR 7
IR_{sw}	= 54 g/day	=	Ingestion rate
CF	= 1E-3 kg/g	=	Conversion factor
EF	= 365 days/yr	=	Exposure frequency
ED	= 30 yrs	=	Exposure duration
BW	= 70 kg	=	Body weight
AT_{car}	= 25,550 days	=	Averaging time for carcinogens (365 days/yr x70 yrs)
AT_{noncar}	= 10950 days	=	Averaging time, non-carcinogens (365 days/yr x 30 yr)
IEX_{car}	= 2.68E-7 mg/kg/day	=	Carcinogenic ingestion exposure
IEX_{noncar}	= 6.25E-7 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptor for this scenario is the adult resident.

The lifetime cancer risk for an adult resident from ingestion of heptachlor epoxide in surface water at IR 7 is estimated as follows:

$$CA = IEX_{car} * SF$$

where:			
IEX_{car}	= 2.68E-7 mg/kg/day	=	Ingestion exposure
SF	= 9.1 $(mg/kg/day)^{-1}$	=	Slope factor
CA	= 2.44E-6	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = {IEX_{noncar}} / {RfD}$$

where:	IEX_{noncar}	=	6.25E-7 mg/kg/day	=	Ingestion exposure
	RfD	=	1.3E-5 mg/kg	=	Reference dose
	NC	=	4.81E-2	=	Noncarcinogenic risk

Ingestion - CTE

Shellfish ingestion exposure for heptachlor epoxide at IR 7 is estimated for an adult resident from the following equation (EPA 1989d):

$$IEX = \frac{CF * IR_{fish} * CF * EF * ED}{BW * AT}$$

where:	CF	=	0.00081 mg/kg	=	Heptachlor epoxide avg. conc. in shellfish at IR 7
	IR_{sw}	=	6.5 g/day	=	Ingestion rate
	CF	=	1E-3 kg/g	=	Conversion factor
	EF	=	365 days/yr	=	Exposure frequency
	ED	=	9 yrs	=	Exposure duration
	BW	=	70 kg	=	Body weight
	AT_{car}	=	25,550 days	=	Averaging time for carcinogens (365 days/yr x70 yrs)
	AT_{noncar}	=	3285 days	=	Averaging time, non-carcinogens (365 days/yr x 9 yr)
	IEX_{car}	=	9.67E-9 mg/kg/day	=	Carcinogenic ingestion exposure
	IEX_{noncar}	=	7.52E-8 mg/kg/day	=	Noncarcinogenic ingestion exposure

As discussed in Section 3.2.4 of Appendix C of the Supplemental RFI/RI Report, the potential receptor for this scenario is the adult resident.

The lifetime cancer risk for an adult resident from ingestion of heptachlor epoxide in surface water at IR 7 is estimated as follows:

$$CA = IEX_{car} * SF$$

where:	IEX_{car}	=	9.67E-9 mg/kg/day	=	Ingestion exposure
	SF	=	9.1 $(mg/kg/day)^{-1}$	=	Slope factor
	CA	=	8.80E-8	=	Carcinogenic risk

Noncarcinogenic risks for this pathway are estimated based on procedures outlined in Section 3.2.5 of Appendix C of the Supplemental RFI/RI Report.

$$NC = {IEX_{noncar}}\Big/{RfD}$$

where:	IEX_{noncar}	=	7.52E-8 mg/kg/day	=	Ingestion exposure
	RfD	=	1.3E-5 mg/kg	=	Reference dose
	NC	=	5.79E-3	=	Noncarcinogenic risk

References

Aaseth, J. and T. Norseth, 1986, "Copper," Handbook on the Toxicology of Metals, Volume II, L. Friberg, G. F. Nordberg, and V. B. Vouk (eds.), Elsevier Science Publishers B. V., New York, pp. 233 - 254.

ACGIH (American Conference of Governmental Industrial Hygienists), 1986, *Documentation of Threshold Limit Values and Biological Exposure Indices*, fifth edition, Cincinnati, Ohio.

ACGIH, 1991, *Documentation of the Threshold Limit Values and Biological Exposure Indices*, sixth edition, Cincinnati, Ohio.

ATSDR (Agency for Toxic Substances and Disease Registry), 1987, *Draft Toxicological Profile for Benzo(a)pyrene*, U.S. Public Health Service, Atlanta, Georgia.

ATSDR (Agency for Toxic Substances and Disease Registry), 1989, *Toxicological Profile for p,p'-DDT, p,p'-DDE, p,p' DDD*, U.S. Public Health Service, Atlanta, Georgia.

ATSDR (Agency for Toxic Substances and Disease Registry), 1990, *Draft Toxicological Profile for Polycyclic Aromatic Hydrocarbons*, U.S. Public Health Service, Atlanta, Georgia.

ATSDR (Agency for Toxic Substances and Disease Registry), 1991a, *Toxicological Profile for Selected PCBs (Arochlor-1260, -1254, -1248, -1242, -1232, -1221, and -1016)*, U.S. Public Health Service, Atlanta, Georgia.

ATSDR (Agency for Toxic Substances and Disease Registry), 1991b, *Draft Toxicological Profile for Nickel*, U.S. Public Health Service, Atlanta, Georgia.

Berlin, M., 1986, "Mercury," *Handbook on the Toxicology of Metals*, Friberg, L., G. F. Nordberg, and V. B. Vouk (eds.), Volume II, second edition, Elsevier Science Publishers B. V., New York.

Cebrian, M. E., A. Albores, M. Aguilar, and E. Blakely, 1983, "Chronic Arsenic Poisoning in the North of Mexico," *Human Toxicology*, Volume 2, pp. 121-133.

Clayton, G. D. and F. E. Clayton, 1981, "Patty's Industrial Hygiene and Toxicology," Volumes I-III, third edition, New York, John Wiley and Sons.

Clement International, 1990, *Development of Relative Potency Estimates for PAHs and Hydrocarbon Combustion Product Fractions Compared to Benzo(a)pyrene and Their Use in Carcinogen Risk Assessments*, prepared for the U.S. EPA, Washington, D.C.

Cook, J. W., 1932, "The Production of Cancer by Pure Hydrocarbons, Part II," Proceedings of the Royal Society of London, S.B., Vol. 11, pp. 485-496, (Cited in EPA, 1992a).

Cowherd, C., G. E. Muleski, P. J. Englehart, and D. A. Gillette, 1985, "Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites, EPA/600/8-85/002," prepared for U.S. EPA Office of Health and Environmental Assessment, Washington, D.C.

Druckery, H., H. Hamperl, and D. Schmahl, 1957, "Carcinogenic Action of Metallic Mercury After Intraperitoneal Administration in Rats," in *Zeitschrift Fur Krebsforschung and Klinische Onkologie*, Volume 61, pp. 511-519.

Earl, F. L., E. Miller, and E. J. Van Loon, 1973, "Reproductive, teratogenic, and neonatal effects of some pesticides and related compounds in beagle dogs and miniature swine," and "Pesticides and the Environment: Continuing Controversy," papers of the 8th Inter-America Conference on Toxicology and Occupational Medicine, Volume 2, Stratton, New York, pp. 253-266.

Ecobichon, D. J., 1996, "Toxic Effects of Pesticides," *Casarett and Doull's Toxicology, the Basic Science of Poisons*, C. D. Klaassen (ed.), fifth edition, McGraw-Hill, New York, pp. 643-689.

Elinder, C. G., and L. Friberg, 1986a, "Antimony," *Handbook on the Toxicology of Metals*, L. Friberg, G. F. Nordberg, and V.B. Vouk (eds.), Volume II, second edition, Elsevier Science Publishers B.V., New York, New York, pp. 26-42.

Elinder, C. G. and L. Friberg, 1986b, "Zinc," *Handbook on the Toxicology of Metals*, L. Friberg, G. F. Nordberg, and V.B. Vouk (eds.) Volume II, second edition, Elsevier Science Publishers B.V., New York, New York, pp. 664-679.

EPA (U.S. Environmental Protection Agency), 1979a, "Multimedia Health Assessment Document for Polycyclic Organic Matter," prepared under contract by J. Santodonato, et al., Syracuse Research Corporation.

EPA (U.S. Environmental Protection Agency), 1979b, *Polynuclear Aromatic Hydrocarbons: Ambient Water Quality Criteria* (Draft).

EPA (U.S. Environmental Protection Agency), 1979c, *Naphthalene: Ambient Water Quality Criteria*, (Draft).

EPA (U.S. Environmental Protection Agency), 1980a, "Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons," EPA 440/5-80-069, NTIS PB81-117806, Office of Water Regulations and Standards, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980b, *Ambient Water Quality Criteria for Hexachlorocyclohexane*, EPA/440/580-054, Office of Water Regulations and Standards, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1987, "Health Effects Assessment for Antimony and Compounds," EPA/600/8-88/018, NTIS PB 88-179445, prepared by Office of Health and Environment Assessment, Cincinnati, Ohio, for the Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, (U.S. Environmental Protection Agency), 1988, "13-Week mouse oral subchronic toxicity study," prepared by Toxicity Research Laboratories, Ltd., Muskegon, Michigan for the Office of Solid Waste, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1989a, "Mouse oral subchronic study with acenaphthene," study conducted by Hazelton Laboratories, Inc., for the Office of Solid Waste, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1989b, "Mouse oral subchronic toxicity study," prepared by Toxicity Research Laboratories, Ltd., Muskegon, Michigan for the Office of Solid Waste, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1989c, "Mouse oral subchronic toxicity of pyrene," study conducted by Toxicity Research Laboratories, Muskegon, Michigan for the Office of Solid Waste, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1989d, "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)," EPA 540/1-89/002, Office of Emergency and Remedial Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1990, *Technical Support Document for Lead*, prepared by the Chemical Hazard Assessment Division, Syracuse Research Corporation, under contract to the Environmental Criteria and Assessment Office, Cincinnati, Ohio.

EPA (U.S. Environmental Protection Agency), 1992a, *Health Effects Assessment Summary Tables (HEAST) - Annual Update FY 1992*, Environmental Criteria and Assessment Office, Cincinnati, Ohio, March.

EPA (U.S. Environmental Protection Agency), 1992b, D. L. Forman, U.S. EPA Region III, Philadelphia, Pennsylvania, memorandum, "Cobalt Toxicity," March 12.

EPA (U.S. Environmental Protection Agency), 1992c, *Dermal Exposure Assessment: Principals and Applications*, Interim Report, EPA 600/8-91/011/B, Office of Health and Environmental Assessment, Washington, D.C., January.

EPA (U.S. Environmental Protection Agency), 1993, "Integrated Risk Information System (IRIS)," Computer Database, EPA, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1994a, "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities," Office of Solid Waste Emergency Response Directive No. 355.4-12.

EPA (U.S. Environmental Protection Agency), 1994b, "Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children," EPA/540/R-93/081 PB 93-963510, February.

EPA (U.S. Environmental Protection Agency), 1994c, *Health Effects Assessment Summary Tables (HEAST) - Annual Update FY 1994*, Environmental Criteria and Assessment Office, Cincinnati, Ohio, March.

EPA (U.S. Environmental Protection Agency), 1995, *Health Effects Assessment Summary Tables (HEAST), Annual Update FY 1995*, EPA 540-R-95-036, prepared by the Office of Health and Environmental Assessment for the Office of Solid Waste and Emergency Response and the Office of Water, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1997a, "Integrated Risk Information System (IRIS)," Computer Database, EPA, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1997b, Roy L. Smith, memorandum, "Risk-Based Concentration Table, March 1997.

Fitzhugh, O. G., A. A. Nelson, E. P. Laug, et al., 1950, "Chronic Oral Toxicities for Mercuri-phenyl and Mercuric Salts", *Archives of Industrial Hygiene and Occupational Medicine*, Volume 2, pp. 433-442.

Friberg, L., G. F. Nordberg, and V. B. Vouk (eds.), Handbook on the Toxicology of Metals, Volume II, Second Edition, Elsevier Science Publishers B.V., New York, New York.

Gartrell, M., J. Craver, D. Podrebarac, et al., 1985, "Pesticides, Selected Elements and Other Chemicals in Adult Diet Samples," October 1979-September 1980, *J. Assoc. of Anal. Chem.*, Volume 68, pp. 1184-1197.

Genium Publishing Corporation, 1990, Aluminum Metal/Powder Material Safety Data Sheet, Sheet No. 100, Revision B, issued December 1981, Schenectady, New York.

Gillette, D. A., 1981, "Production of Dust that may be Carried Great Distances," *Desert Dust: Origin, Characteristics, and Effect on Man*, T. Pewe (ed.), Geological Society of America Special Paper 186.

Goyer, R. A., 1991, "Toxic Effects of Metals," *Casarett and Doull's Toxicology, the Basic Science of Poisons*, M. O. Amdur, J. Doull, and C. D. Klassen (eds.), fourth edition, Pergamon Press, New York, pp. 623 - 680.

Hayes, W., 1982, "Chlorinated Hydrocarbon Insecticides," *Pesticides Studied in Man*, Baltimore: Williams and Wilkins, pp. 186-195.

IARC (International Agency for Research on Cancer, 1980, *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 23, World Health Organization, Lyon, France.

Iffland, R., 1988, "Antimony," *Handbook on Toxicity of Inorganic Compounds*, Seiler, H. G., H. Sigel and A. Sigel (eds.), Marcel Dekker, Inc., New York, New York.

Ishinishi, N., K. Tsuchiya, M. Vahter, and B. A. Fowler, 1986. "Arsenic," *Handbook on the Toxicology of Metals*, L. Friberg, G. F. Nordberg, and V. B. Vouk (eds.), Volume II, second edition, Elsevier Science Publishers B.V., New York, pp. 43-83.

Johnson, A., D. Norton, and B. Yake, 1988, "Persistence of DDT in the Yakima River Drainage, Washington," *Arch. Environmental Contamination Toxicology*, Volume 17, pp. 289-297.

Kanisawa, M., and H. A. Schroeder, 1969, "Life Term Studies on the Effect of Trace Elements on Spontaneous Tumors in Mice and Rats," *Cancer Research*, Volume 29, pp. 892-895.

Kazantzis, G., 1986, "Thallium," *Handbook on the Toxicology of Metals*, L. Friberg, G. F. Nordberg, and V. B. Vouk (eds.), Volume II, second edition, Elsevier Science Publishers, New York, New York.

Knobloch, K. S., S. Szendzikowski, and A. Slusarczyk-Zablobona, 1969, "Acute and Subacute Toxicity of Acenaphthene and Acenaphthylene," *Med. Pracy* (Polish), Volume 20, pp. 210-222.

Kotin, P., et al., 1969, "Distribution, Retention, and Elimination of C^{14}-3,4-Benzopyrene After Administration to Mice and Rats, *Journal of the National Cancer Institute*, Volume 23, pp. 541.

Krewski, D., T. Thorslund, and J. Withey, 1989, "Carcinogenic Risk Assessment of Complex Mixtures," *Toxicology and Industrial Health*, Volume 5, pp. 851-867.

La Voie, E. J., S. Amin, S. S. Heaht, K. Furuya, and D. Hoffman, 1982, "Tumor Initiating Activity of Dihydrodiols of Benzo(b)fluoranthene, Carcinogenesis," Volume 3(1), pp. 49 - 52.

Lagerkvist, B., G. F. Nordberg, and V. B. Vouk, 1986, "Vanadium," *Handbook on the Toxicology of Metals*, Volume II, second edition, Elsevier Science Publishers B.V., New York, pp. 638-663.

Langard, S., and T. Norseth, 1986, "Chromium," *Handbook on the Toxicology of Metals*, L. Friberg, G. F. Nordberg, and V. B. Vouk (eds.), Volume II, Elsevier Science Publishers B.V., New York, pp. 185-210.

Laug, E. P., A. A. Nelson, O. G. Fitzhugh, and F. M. Kunze, 1950, "Liver Cell Alteration and DDT Storage in the Fat of the Rat Induced by Dietary Levels of 1-50 ppm DDT," *Journal of Pharmacology and Experimental Therapy*, Volume 98, pp. 268-273.

Lewtas, J., 1988, "Genotoxicity of Complex Mixtures: Strategies for the Identification and Comparative Assessment of Airborne Mutagens and Carcinogens from Combustion Sources," *Fundamentals of Applied Toxicology*, Volume 10, pp. 571-589.

Magos, L., 1986, "Tin" in *Handbook on the Toxicology of Metals, Second Edition, Volume II: Specific Metals*, L. Friberg, G. F. Norberg, and V. B. Vouk (eds.), Elsevier Science Publishers, New York, pp. 568-593.

Mitsumori, K., K. Maita, T. Saito, S. Tsuda, and Y. Shikasu, 1981, "Carcinogenicity of Methylmercury Chloride in ICR Mice: Preliminary Note on Renal Carcinogens," *Cancer Letter*, Volume 12, pp. 305-310.

NCI (National Cancer Institute), 1978, "Bioassays of DDT, TDE, and p,p'-DDE for Possible Carcinogenicity," *NCI Report No. 131*, DHEW Publ. No. (NIH) 78-1386.

NTP (National Toxicology Program), 1980, unpublished subchronic toxicity study, *Naphthalene (c52904), Fisher-344 Rats*, prepared by Battelle's Columbus Laboratories under subcontract No. 76-34-106002.

Pasquill, F., 1975, "The Dispersion of Materials in the Atmospheric Boundary Layer - The Basis for Generalization," *Lectures on Air Pollution and Environmental Impact Analysis*, American Meteorological Society, Boston, Massachusetts.

Rees, E. O., et al., 1971, "A Study of the Mechanism of Intestinal Absorption of Benzo(a)pyrene," *Biochemical and Biophysical Act*, Volume 255, p. 96.

Reeves, A. L., 1986a, "Barium," *Handbook on the Toxicology of Metals*, L. Friberg, G. F. Nordberg, and V. B. Vouk (eds.), Volume II, Elsevier Science Publishers B.V., New York, pp. 84-94.

Reeves, A. L., 1986b, "Beryllium," *Handbook on the Toxicology of Metals*, L. Friberg, G. F. Nordberg, and V. B. Vouk (eds.), Volume II, Elsevier Science Publishers B.V., New York, pp. 95-116.

Rossi, L., M. Ravera, G. Repetti, et al., 1977, "Long-term Administration of DDT or Phenobarbital in Wistar Rats," *International Journal of Cancer*, Volume 19, pp. 179-185.

Rossi, L., O. Barbieri, M. Sanquineti, J. R. P. Cabral, P. Bruzzi, and L. Santi, 1983, "Carcinogenicity Study with Technical-grade DDT and DDE in Hamsters," *Cancer Research*, 43:776-781.

RTC (Reproduction Toxicology Center), 1990, "Reproductive Toxicity Database (REPROTOX)," Reproduction Toxicology Center, Washington, D.C.

Sax, N. I. and R. J. Lewis, Sr., 1989, *Dangerous Properties of Industrial Materials*, Volume III, seventh edition, Van Nostrand Reinhold Co., New York, New York.

Schlede, E., et al., 1970a, "Effect of Enzyme Induction on the Metabolism and Tissue Distribution of Benzo(a)pyrene," *Cancer Research*, Volume 30, p. 2893.

Schlede, E., et al., 1970b, "Stimulatory Effect of Benzo(a)pyrene and Phenobarbitol Pretreatment on the Biliary Excretion of Benzo(a)pyrene Metabolites in the Rat," *Cancer Research*, Volume 30, p.2898.

Schmahl, D., 1995, "Examination of the Carcinogenic Action of Naphthalene and Anthracene in Rats," Z. Krebsfursch, Volume 60, pp. 697-710.

Schroeder, H. A., M. Mitchner, and A. P. Nasor, 1970, "Zirconium, Niobium, Antimony, Vanadium and Lead in Rats: Life Term Studies," *Journal of Nutrition*, Volume 100, pp. 59-66.

Southwick, J. W., A. E. Western, M. M. Beck, et al., 1983, "An Epidemiological Study of Arsenic in Drinking Water in Millard County, Utah," W. H. Lederer and R. J. Fensterheim (eds.), *Arsenic: Industrial, Biomedical, Environmental Perspectives*, Van Nostrand Reinhold Co., New York, pp. 210-255.

Thorslund, T. and G. Charnley, 1988, "Comparative Potency Approach for Estimating the Cancer Risk Associated with Exposure to Mixtures of Polycyclic Aromatic Hydrocarbons," ICF-Clement Associates, Washington, D.C.

Thun, M. J., T. M. Schnorr, A. B. Smith, and W. E. Halperin, 1985, "Mortality Among a Cohort of U.S. Cadmium Production Workers: An Update," *Journal of the National Cancer Institute*, Volume 74, pp. 325-333.

Tomatis, L. V. Turusov, R. T. Charles, and M. Boicchi, 1974, "Effect of long-term exposure to 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene, to 1,1-dichloro-2,2-bis(p-chlorophenyl)ethane, and the two chemicals combined on CF-1 mice," *Journal of National Cancer Institute*, 52:883-891.

Tseng, W. P., 1977, "Effects and Dose-response Relationships of Skin Cancer and Blackfoot Disease with Arsenic," *Environmental Health Perspectives*, Volume 19, pp. 109-119.

Tseng, W.P., H. M. Chu, S. W. How, J. M. Fong, C. S. Lin, and S. Yeh, 1968, "Prevalence of Skin Cancer in an Endemic Area of Arsenicism in Taiwan," *Journal of the National Cancer Institute*, Volume 40, pp. 453-463.

Tsuchiya, K., 1986, "Lead," *Handbook on the Toxicology of Metals*, L. Friberg, G. F. Nordberg, and V. B. Vouk (eds.), Volume II, second edition, Elsevier Science Publishers B.V., New York, pp. 298-353.

Underwood, E. J., 1977, *Trace Elements in Human and Animal Nutrition*, fourth edition, Academic Press, New York.

Vainich, et al., 1976, "The Fate of Intratracheally Instilled Benzo(a)pyrene in the Isolated Perfused Rat Lung of Both Control and 20-Methylcholanthrene Pretreated," *Research Communications in Chemical Pathology and Pharmacology*, Volume 13, pp. 259.

West, I., 1967, "Lindane and Hematologic Reactions." *Arch. Environ. Health*, 15:97-101.

APPENDIX A, PART 5
IEUBK MODEL RESULTS

NARRATIVE FOR

IEUBK MODEL RESULTS

The following sections of Appendix A Part 5 contain site-specific histograms that present the estimated percentage of children (age 0 to 6 years) with a blood-lead level above 10 µg/dL based on conditions present at each applicable site and background (for comparison purposes). The histograms are output from the IEUBK Model (v. 0.99). Also included are site-specific input parameters selected for each run of the IEUBK Model. IR 1, IR 3, and background are included.

HISTOGRAMS FOR

IR 1 - SURFACE SOIL DATA

IEUBK MODEL RESULTS

BASED ON RME EXPOSURE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT

Indoor AIR Pb Conc: 30.0 percent of outdoor.

ier AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT

WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.

Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	680.0	680.0
1-2	680.0	680.0
2-3	680.0	680.0
3-4	680.0	680.0
4-5	680.0	680.0
5-6	680.0	680.0
6-7	680.0	680.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model

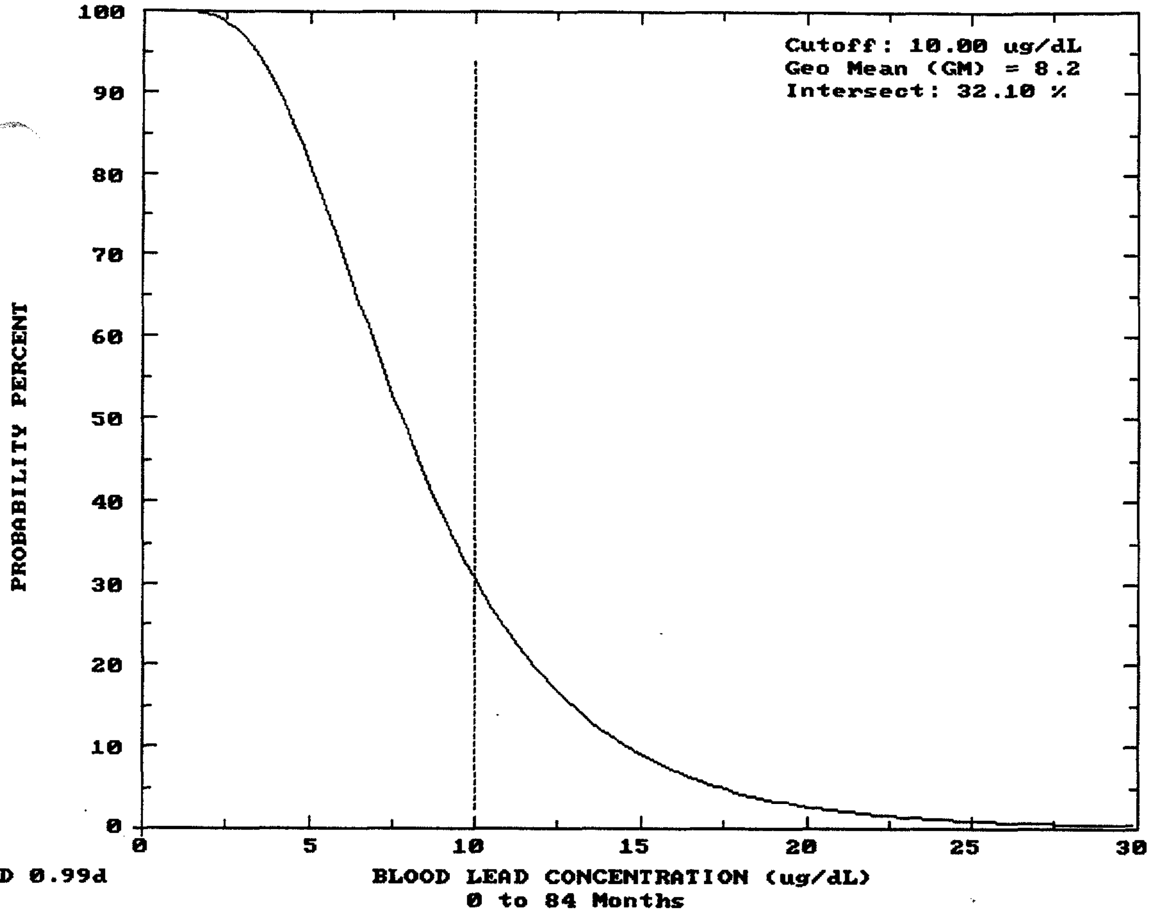
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	8.9	16.87	14.25
1-2:	10.2	25.10	21.96
2-3:	9.6	26.13	22.56
3-4:	9.2	26.73	23.15
4-5:	7.7	21.78	18.08
5-6:	6.5	20.61	16.60
7:	5.8	20.21	15.84

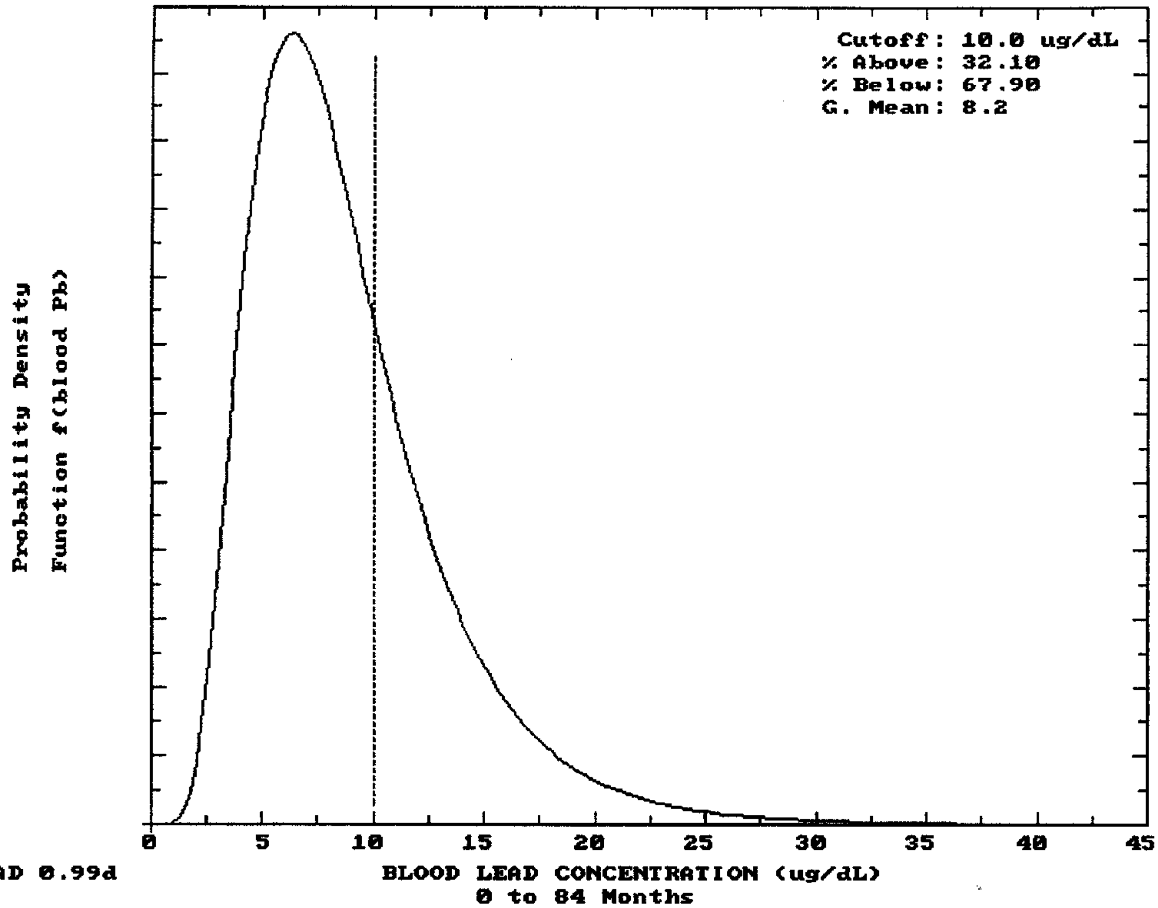
YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.27	0.33	0.00	0.02
1-2:	2.30	0.80	0.00	0.03
2-3:	2.66	0.85	0.00	0.06
3-4:	2.62	0.89	0.00	0.07
4-5:	2.66	0.97	0.00	0.07
5-6:	2.87	1.05	0.00	0.09
6-7:	3.20	1.08	0.00	0.09



Cutoff: 10.00 ug/dL
Geo Mean (GM) = 8.2
Intersect: 32.10 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD 0.99d


Cutoff: 10.0 ug/dL
% Above: 32.10
% Below: 67.90
G. Mean: 8.2
Probability Density
Function f(blood Pb)
0
5
10
15
20
25
30
35
40
45
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD 0.99d

HISTOGRAMS FOR

IR 1 - SURFACE SOIL DATA

IEUBK MODEL RESULTS

BASED ON CTE EXPOSURE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT

Indoor AIR Pb Conc: 30.0 percent of outdoor.

.er AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT

WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.

Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	174.6	174.6
1-2	174.6	174.6
2-3	174.6	174.6
3-4	174.6	174.6
4-5	174.6	174.6
5-6	174.6	174.6
6-7	174.6	174.6

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model

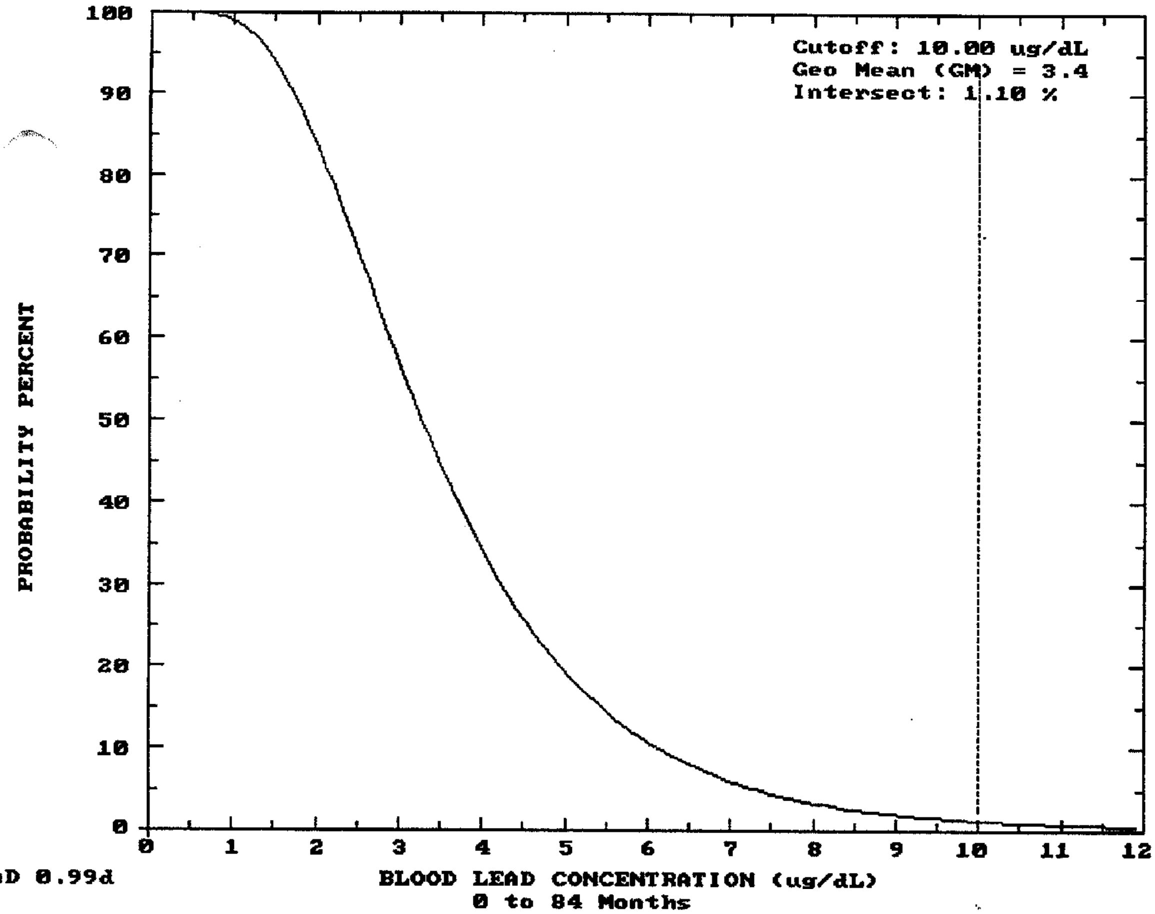
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	3.8	7.05	4.11
1-2:	4.2	10.07	6.47
2-3:	3.9	10.56	6.54
3-4:	3.7	10.59	6.61
4-5:	3.2	8.96	4.99
5-6:	2.8	8.76	4.52
':	2.5	8.88	4.28

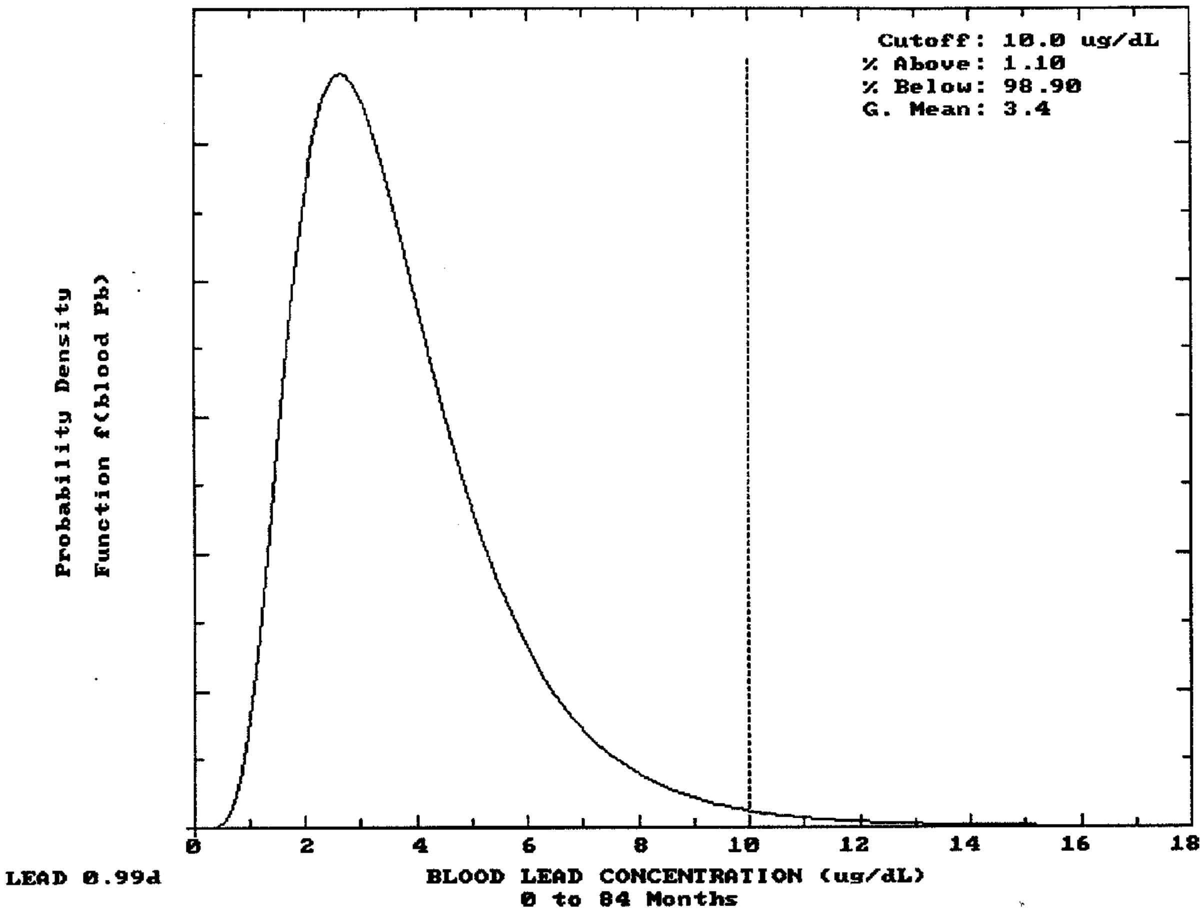
YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

------	-----------	------------	------------	--------
0.5-1:	2.55	0.37	0.00	0.02
1-2:	2.65	0.92	0.00	0.03
2-3:	3.00	0.96	0.00	0.06
3-4:	2.92	0.99	0.00	0.07
4-5:	2.86	1.05	0.00	0.07
5-6:	3.04	1.11	0.00	0.09
6-7:	3.37	1.13	0.00	0.09



Cutoff: 10.00 ug/dL
Geo Mean (GM) = 3.4
Intersect: 1.10 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD 0.99d


Cutoff: 10.0 ug/dL
% Above: 1.10
% Below: 98.90
G. Mean: 3.4
Probability Density
Function f(blood Pb)
0
2
4
6
8
10
12
14
16
18
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

HISTOGRAMS FOR

IR 3 - SURFACE SOIL DATA

IEUBK MODEL RESULTS

BASED ON RME EXPOSURE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT

Indoor AIR Pb Conc: 30.0 percent of outdoor.

er AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT

WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.

Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	566.0	566.0
1-2	566.0	566.0
2-3	566.0	566.0
3-4	566.0	566.0
4-5	566.0	566.0
5-6	566.0	566.0
6-7	566.0	566.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model

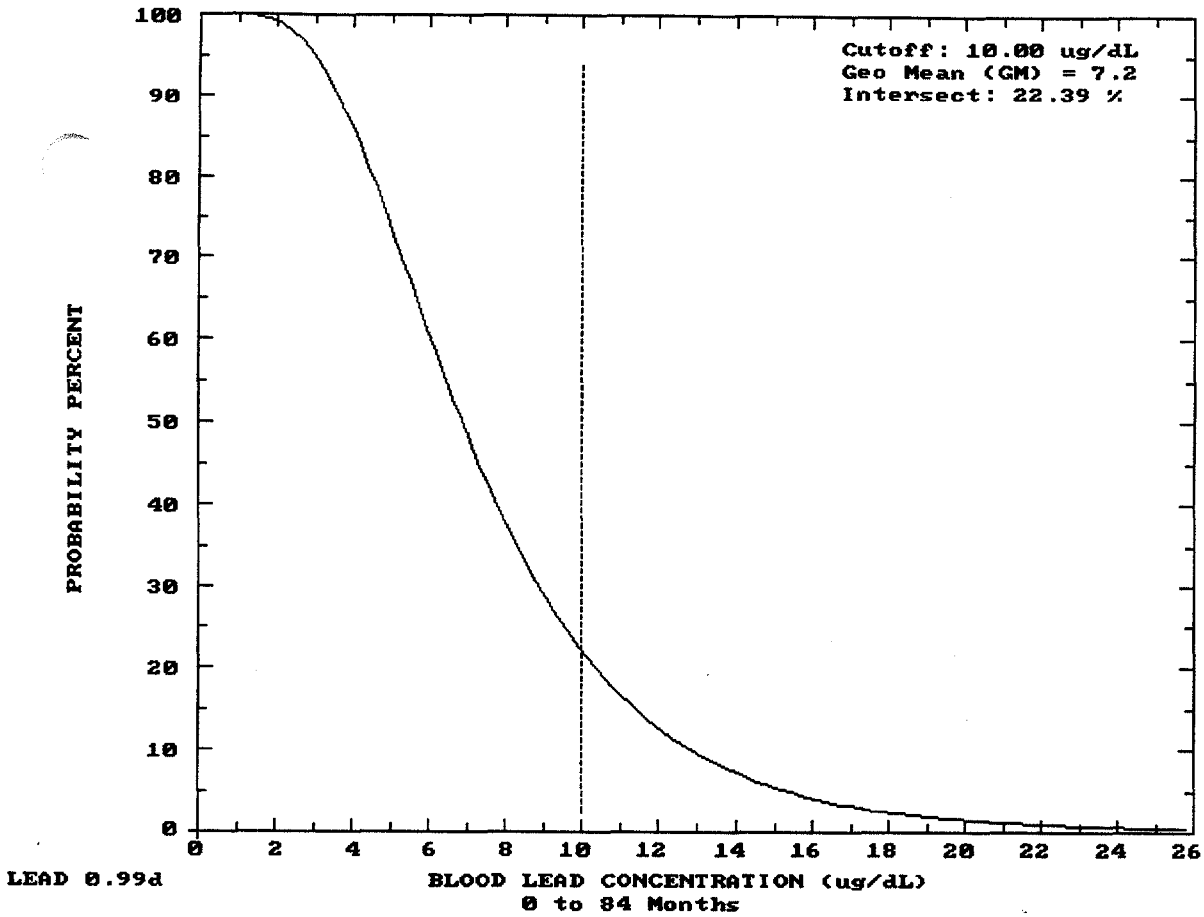
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

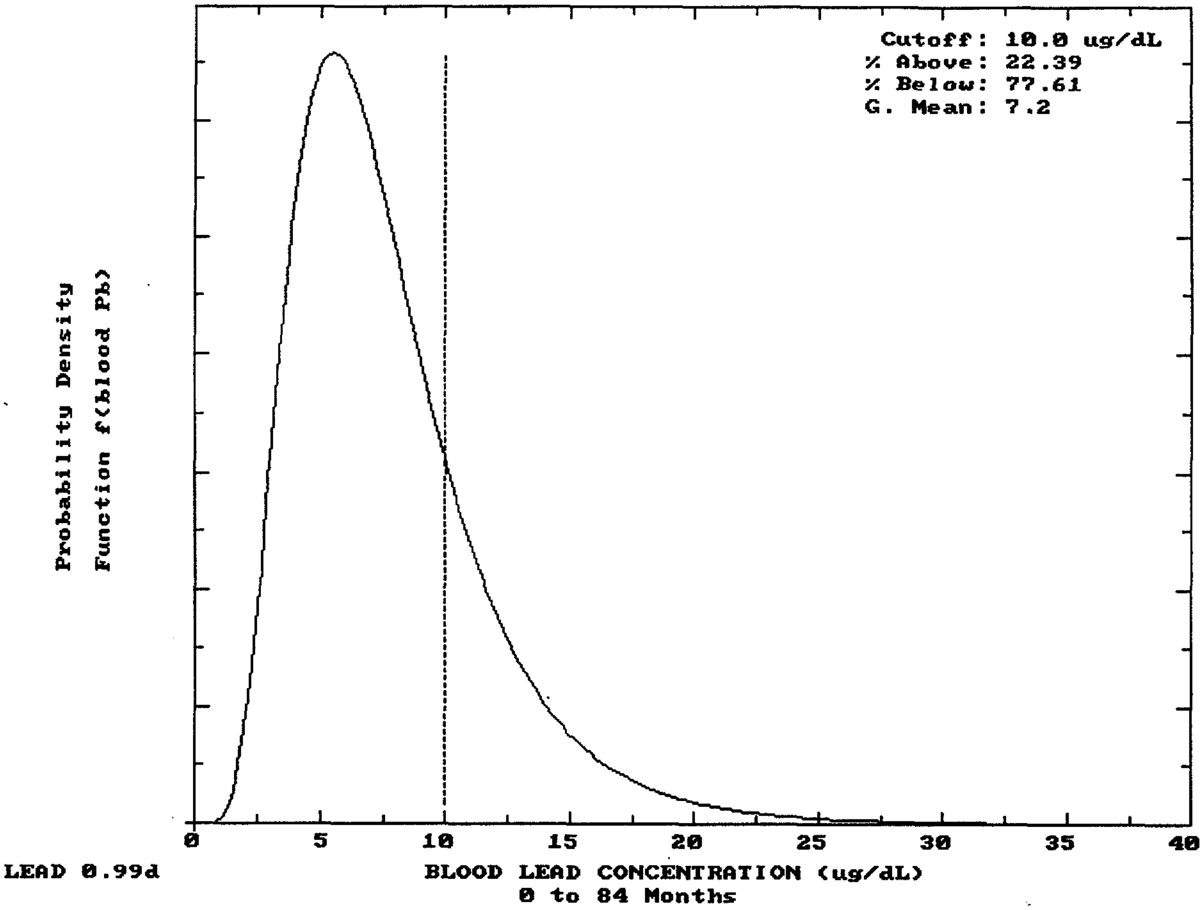
YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	7.9	14.83	12.15
1-2:	9.0	22.03	18.81
2-3:	8.4	22.92	19.26
3-4:	8.1	23.37	19.71
4-5:	6.7	19.04	15.28
5-6:	5.7	18.05	13.99
[illegible]:	5.1	17.75	13.33

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.33	0.34	0.00	0.02
1-2:	2.37	0.82	0.00	0.03
2-3:	2.73	0.87	0.00	0.06
3-4:	2.68	0.91	0.00	0.07
4-5:	2.70	0.99	0.00	0.07
5-6:	2.90	1.06	0.00	0.09
6-7:	3.23	1.09	0.00	0.09



Cutoff: 10.00 ug/dL
Geo Mean (GM) = 7.2
Intersect: 22.39 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months


Cutoff: 10.0 ug/dL
% Above: 22.39
% Below: 77.61
G. Mean: 7.2
Probability Density
Function f(blood Pb)
0
5
10
15
20
25
30
35
40
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

HISTOGRAMS FOR

IR 3 - SURFACE SOIL DATA

IEUBK MODEL RESULTS

BASED ON CTE EXPOSURE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
er AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	157.7	157.7
1-2	157.7	157.7
2-3	157.7	157.7
3-4	157.7	157.7
4-5	157.7	157.7
5-6	157.7	157.7
6-7	157.7	157.7

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

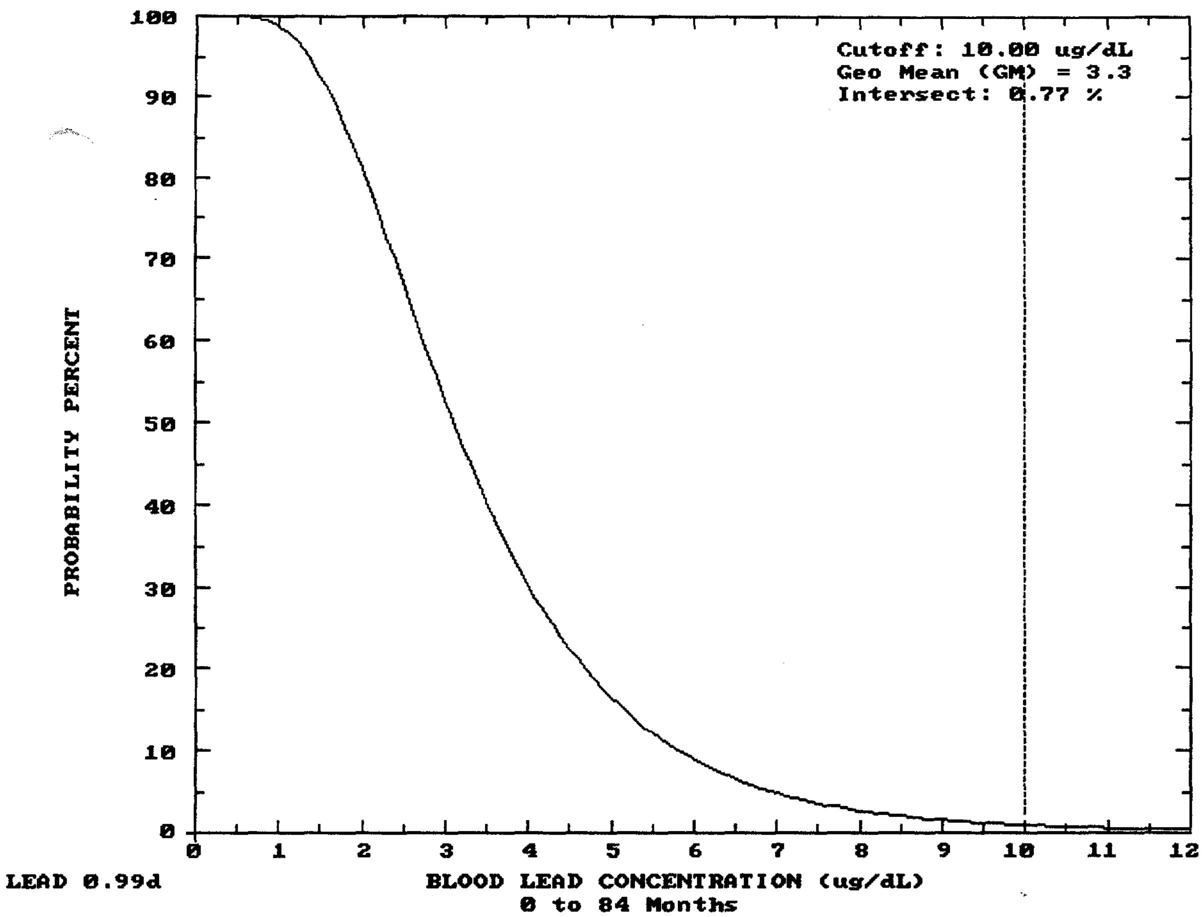
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

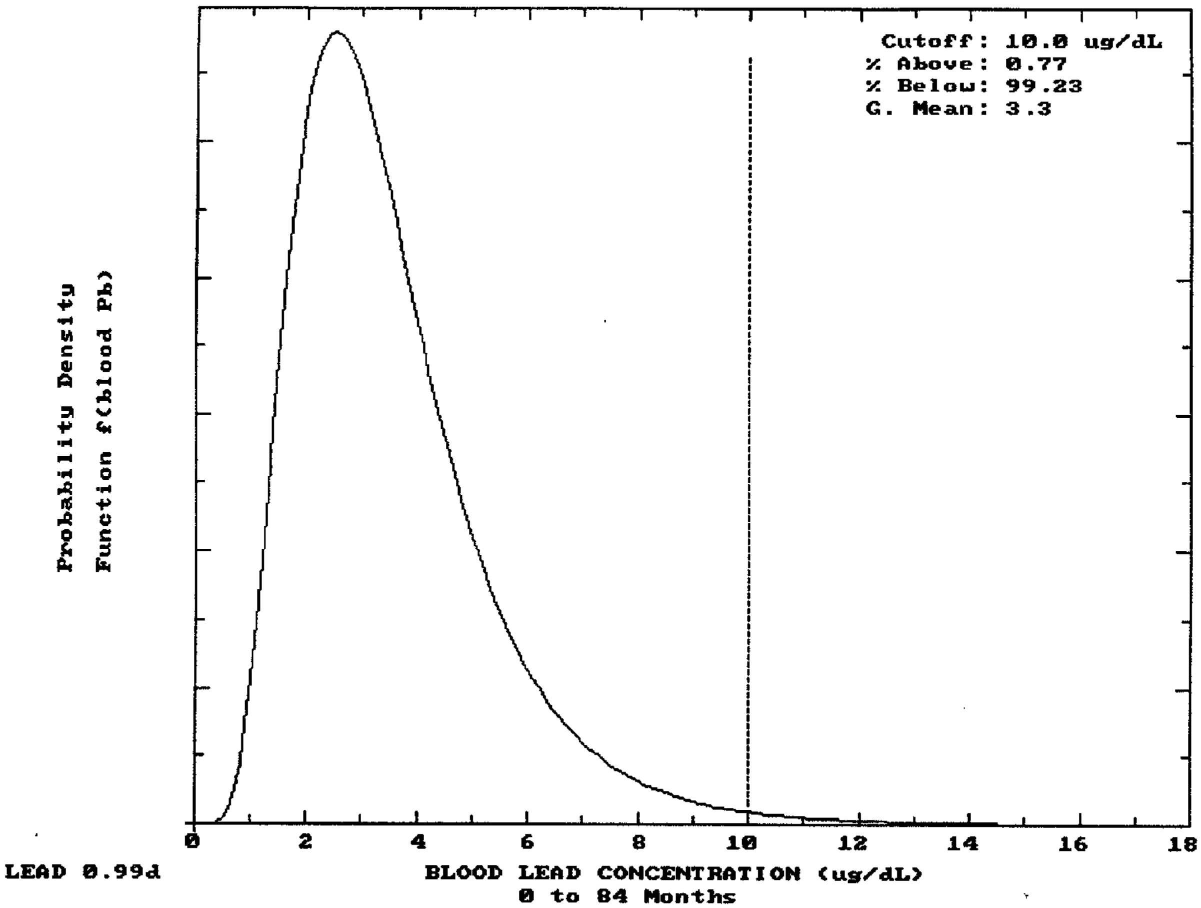
YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	3.6	6.68	3.73
1-2:	4.0	9.49	5.88
2-3:	3.7	9.97	5.93
3-4:	3.5	9.99	6.00
4-5:	3.0	8.50	4.52
5-6:	2.6	8.34	4.09
6[illegible]	2.4	8.48	3.87

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.56	0.37	0.00	0.02
1-2:	2.66	0.92	0.00	0.03
2-3:	3.01	0.97	0.00	0.06
3-4:	2.93	1.00	0.00	0.07
4-5:	2.87	1.05	0.00	0.07
5-6:	3.05	1.11	0.00	0.09
6-7:	3.37	1.14	0.00	0.09



Cutoff: 10.00 ug/dL
Geo Mean (GM) = 3.3
Intersect: 0.77 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months



Cutoff: 10.0 ug/dL
% Above: 0.77
% Below: 99.23
G. Mean: 3.3
Probability Density
Function f(blood Pb)
0
2
4
6
8
10
12
14
16
18
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

HISTOGRAMS FOR
BACKGROUND - SURFACE SOIL DATA
BASED ON RME EXPOSURE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT

Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT

WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.

Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	48.3	48.3
1-2	48.3	48.3
2-3	48.3	48.3
3-4	48.3	48.3
4-5	48.3	48.3
5-6	48.3	48.3
6-7	48.3	48.3

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model

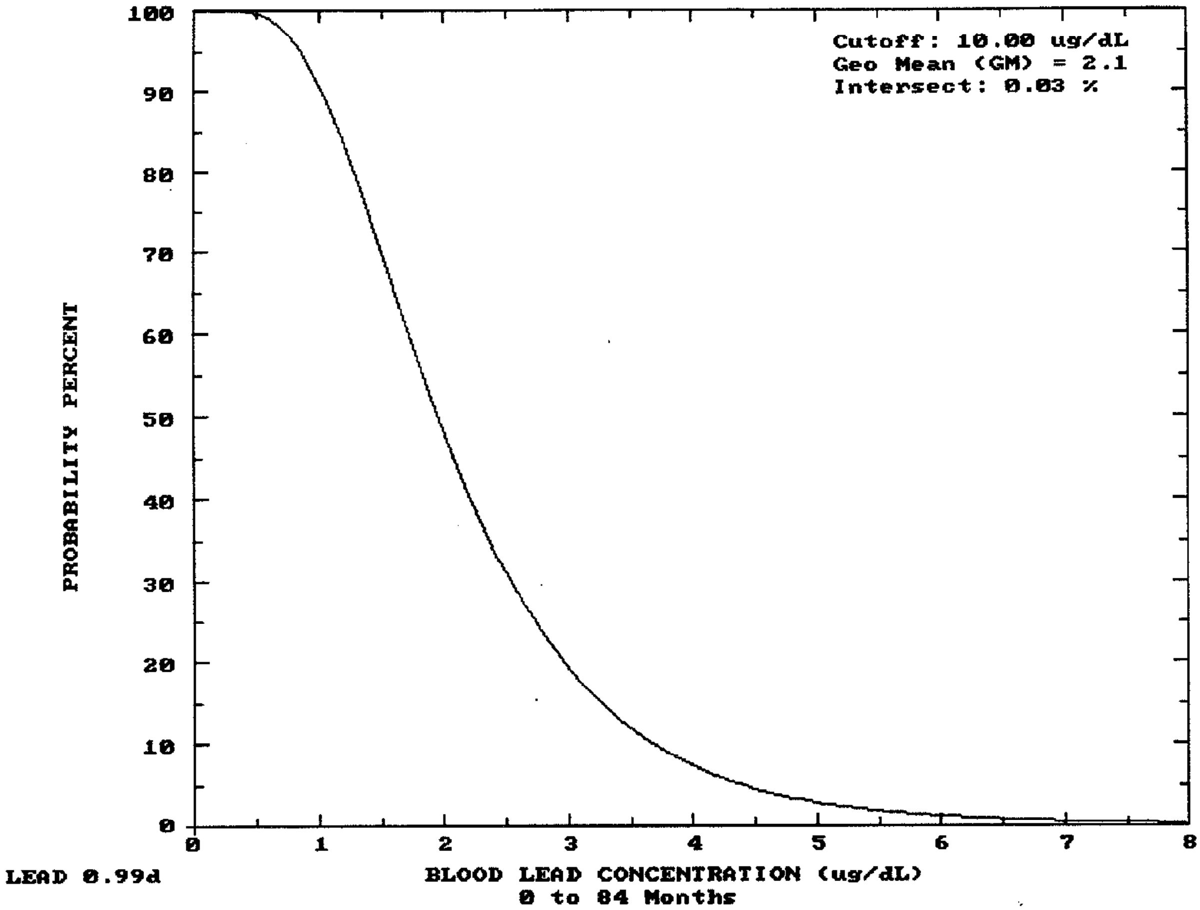
Maternal Blood Conc: 2.50 ug Pb/dL

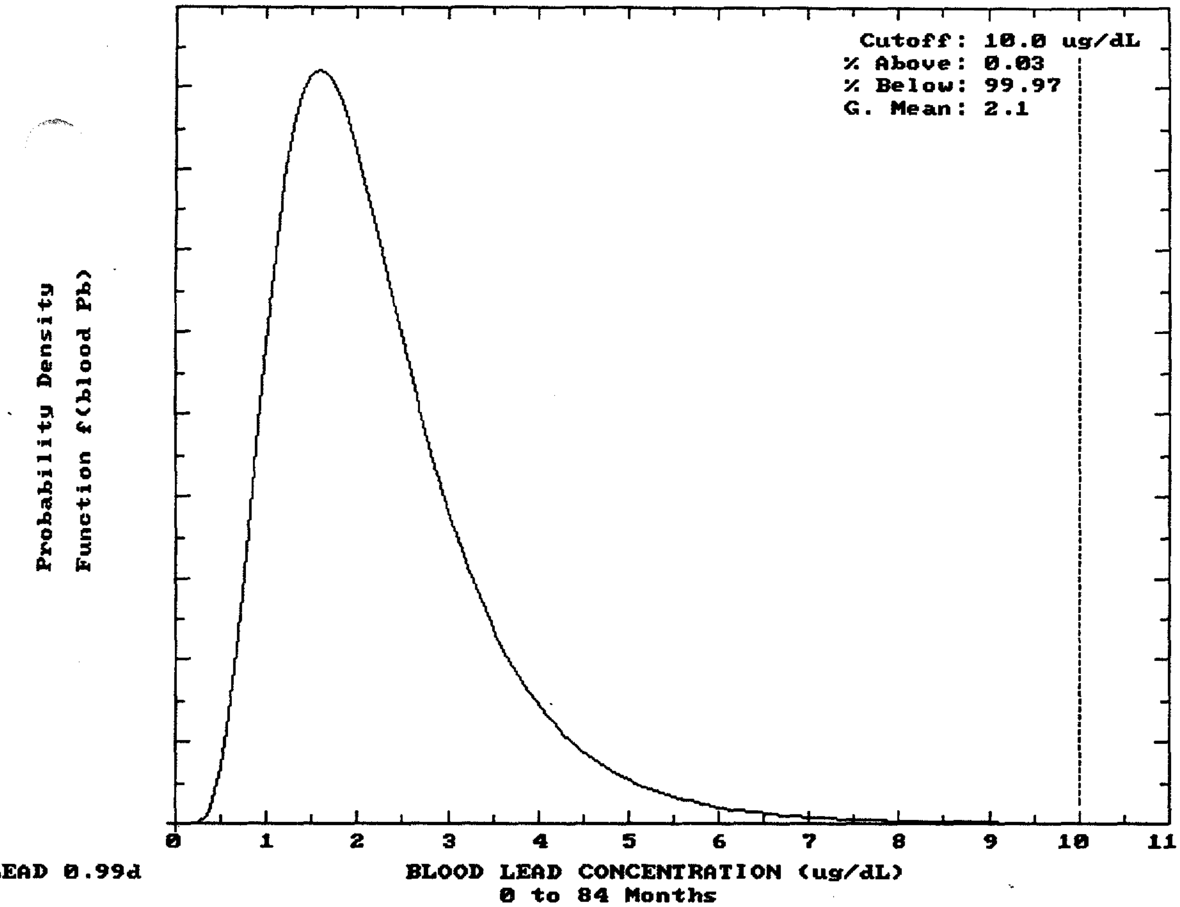
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	2.3	4.21	1.17
1-2:	2.4	5.60	1.86
2-3:	2.2	6.03	1.87
3-4:	2.1	5.98	1.88
4-5:	1.9	5.46	1.41
5-6:	1.7	5.58	1.27
6-7:	1.6	5.86	1.20

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.64	0.38	0.00	0.02
1-2:	2.75	0.95	0.00	0.03
2-3:	3.10	0.99	0.00	0.06
3-4:	3.01	1.02	0.00	0.07
[illegible]	2.92	1.07	0.00	0.07
5-6:	3.09	1.13	0.00	0.09
6-7:	3.41	1.15	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 2.1
Intersect: 0.03 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months



Cutoff: 10.0 ug/dL
% Above: 0.03
% Below: 99.97
G. Mean: 2.1
Probability Density
Function f(blood Pb)
0
1
2
3
4
5
6
7
8
9
10
11
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD 0.99d

HISTOGRAMS FOR
BACKGROUND - SURFACE SOIL DATA
BASED ON CTE EXPOSURE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	15.7	15.7
1-2	15.7	15.7
2-3	15.7	15.7
3-4	15.7	15.7
4-5	15.7	15.7
5-6	15.7	15.7
6-7	15.7	15.7

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

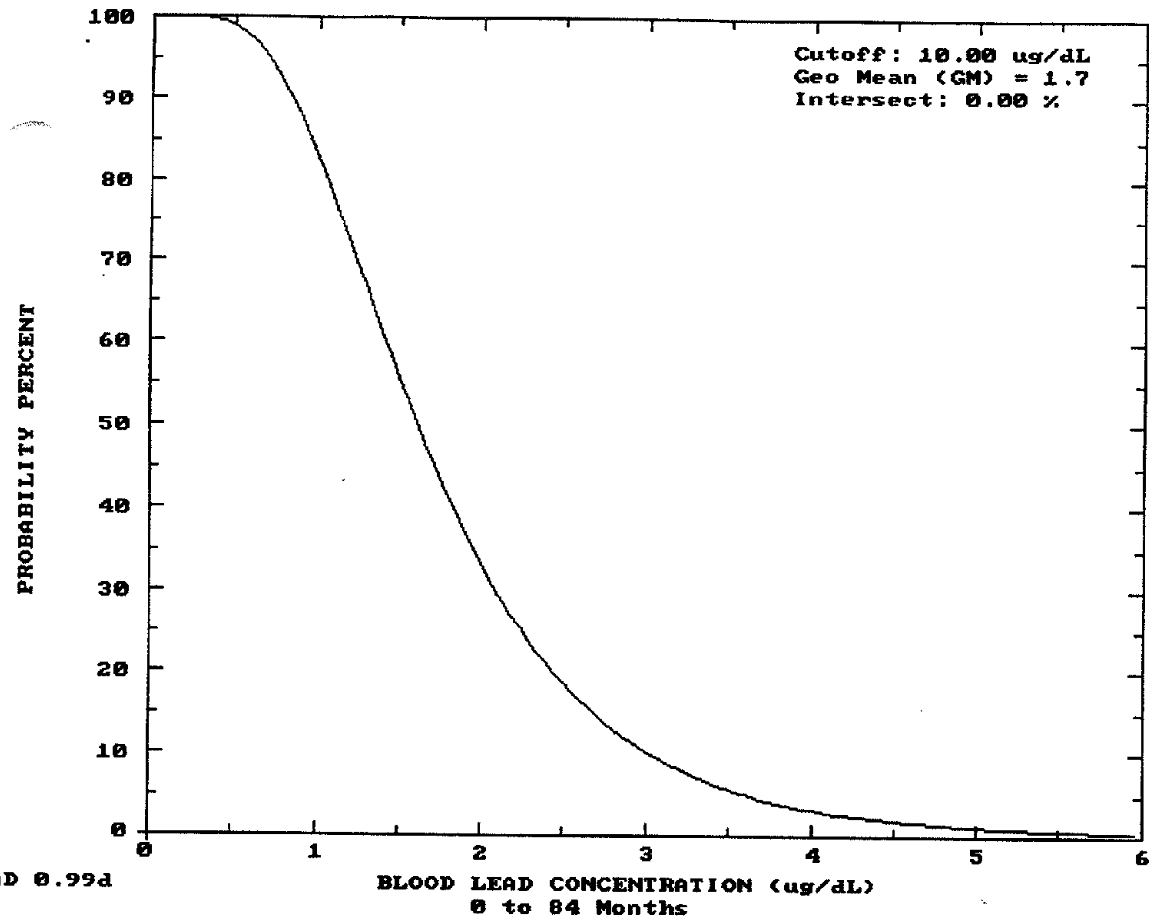
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

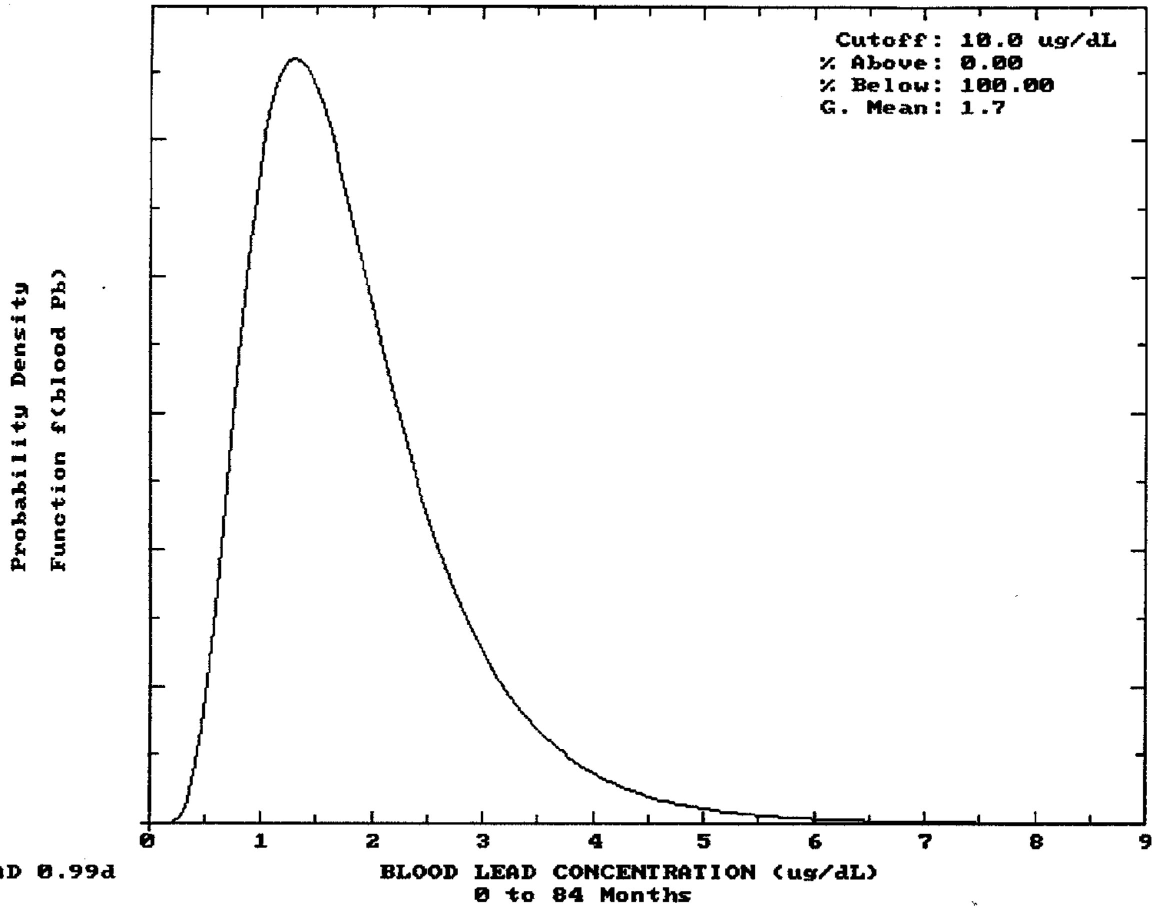
YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	1.9	3.45	0.38
1-2:	1.9	4.39	0.61
2-3:	1.8	4.81	0.61
3-4:	1.7	4.74	0.62
4-5:	1.5	4.53	0.46
5-6:	1.5	4.74	0.41
6	1.4	5.06	0.39

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)

0.5-1:	2.66	0.38	0.00	0.02
1-2:	2.78	0.96	0.00	0.03
2-3:	3.13	1.00	0.00	0.06
3-4:	3.03	1.03	0.00	0.07
4-5:	2.93	1.07	0.00	0.07
5-6:	3.10	1.13	0.00	0.09
6-7:	3.42	1.15	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 1.7
Intersect: 0.00 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD 0.99d



Cutoff: 10.0 ug/dL
% Above: 0.00
% Below: 100.00
G. Mean: 1.7
Probability Density
Function f(blood Pb)
0
1
2
3
4
5
6
7
8
9
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LEAD 0.99d

APPENDIX B

ECOLOGICAL RISK ASSESSMENT SUPPORTING DOCUMENTATION

APPENDIX B. PART 1 - ECOLOGICAL SAMPLING AND ANALYSIS PLAN ADDENDUM

AIK-OES-96-5706

ECOLOGICAL SAMPLING AND ANALYSIS PLAN ADDENDUM

SUPPLEMENTAL RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION PHASE II FOR NAVAL AIR STATION KEY WEST BOCA CHICA KEY, FLORIDA

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Brown & Root Environmental
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0007

August 1996
Revision 1

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1.0 INTRODUCTION

This sampling and analysis plan addendum describes the ecological sampling to be conducted at three solid waste management units (SWMUs), four Installation Restoration (IR) Sites, and one Area of Concern (AOC) at Naval Air Station (NAS) Key West. This addendum is provided in accordance with the Supplemental Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and Sampling and Analysis Plan (SAP) prepared by ABB Environmental, Inc., dated December 6, 1995. The sites to be investigated include SWMU-4, SWMU-5, SWMU-7, IR-1, IR-3, IR-7, IR-8, and AOC-B.

No biological sampling at these eight sites has been conducted as part of the RFI/RI process to date. Based on the results of contaminant screening described in the RFI/RI report (IT, 1994), Brown & Root Environmental (B&R ENVIRONMENTAL) proposes to conduct tissue analyses of biological samples collected at seven of the eight sites to obtain additional information on the toxicity of contaminants to ecological receptors at those sites. Chemical analyses of tissue will provide a direct measurement of contaminant accumulation in ecological receptors. This is especially important where migration of contaminants to marine waters is potentially occurring.

The objectives of the ecological (i.e., biological) sampling are to measure contaminant concentrations in ecological receptors at or near the sites using laboratory tissue analysis; and to determine the potential impacts on individual organisms resulting from exposure to contamination, and subsequent community-level effects, if any. Thus, the ecological effects of site-associated contamination will be assessed by characterizing the nature and extent of contamination in biota located at the sites.

This document provides details of the biological sampling events to be conducted at the sites mentioned above, as well as at five locations that have been chosen to represent background conditions in the Key West area. Three background locations and four SWMUs on Boca Chica Key were sampled in January and February, 1996. Procedures and protocols for sampling and analyses of groundwater, surface water, sediment, and soil will be conducted in accordance with the final work plan and SAP submitted by ABB Environmental Services (1995), and are not discussed in this addendum.

Section 2.0 of this document describes each investigation site and associated ecological sampling requirements. Section 3.0 provides similar information on background sites. Section 4.0 briefly describes the life histories of aquatic organisms selected for collection. Section 5.0 describes sampling procedures and protocols.

Pertinent documents were reviewed prior to the preparation of this sampling plan addendum, with emphasis on two documents: (1) Ecological Survey of U.S. Navy Property in the Lower Florida Keys, Monroe County, Florida, August 1994, prepared by the Florida Natural Areas Inventory; and (2) Final Report of RFI/RI (Phase I) for NAS Key West, June 9, 1994, by IT Corporation. In addition, B&R ENVIRONMENTAL biologists conducted a qualitative ecological survey of all sites during June 24-27, 1996. During the survey, potential ecological receptors and exposure pathways were investigated, and habitats were characterized by identifying vegetative cover types and dominant taxa. Based on the field surveys, locations have been determined from which soil, water, sediment, and biological samples will be collected for chemical analyses.

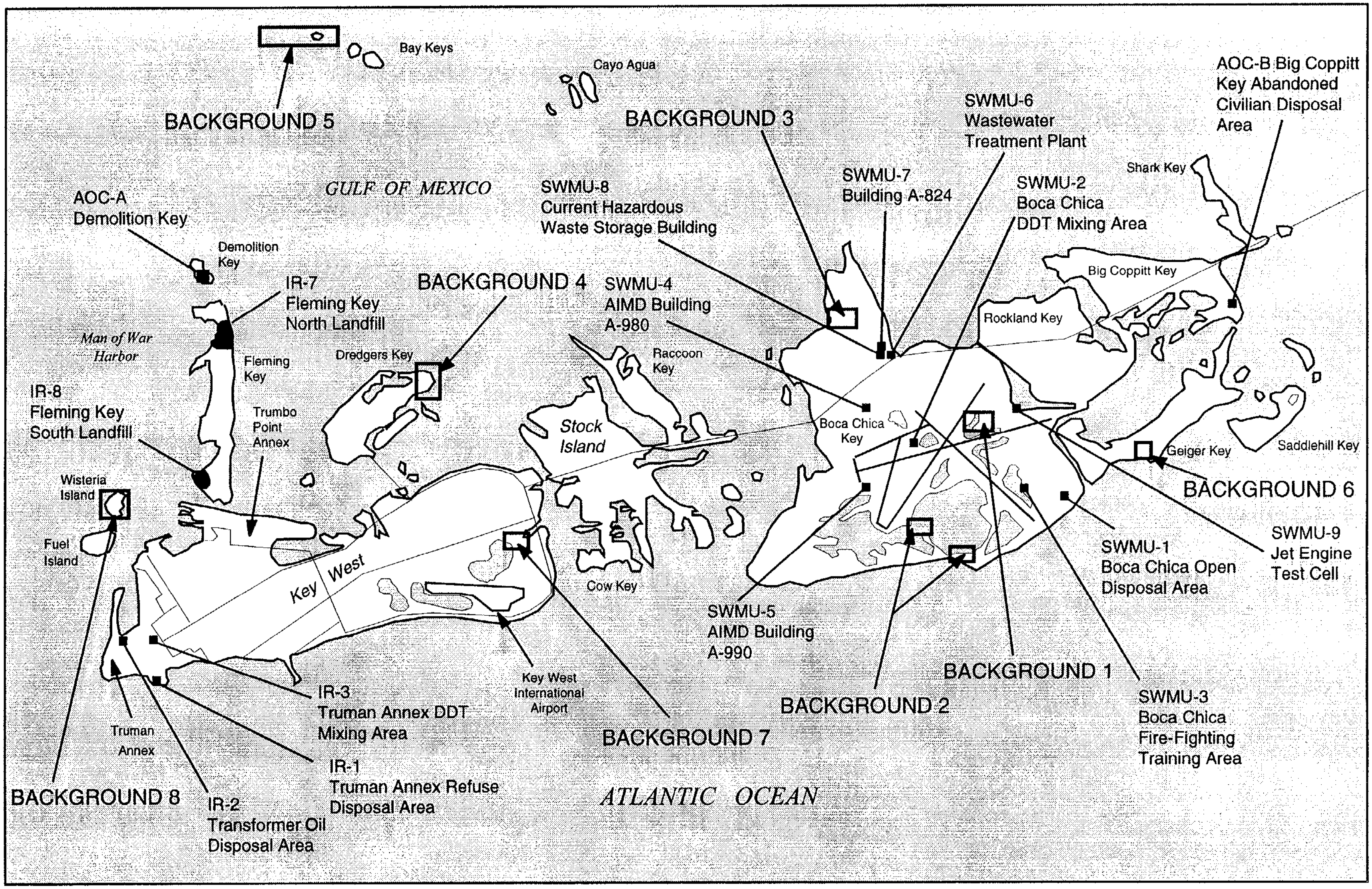
2.0 INVESTIGATION SITES AND ACTIVITIES

Site locations are shown in Figure 2-1, and the number and types of samples proposed for collection and subsequent laboratory analyses are listed in Table 2-1. Site descriptions, histories, and previous sampling results are discussed in detail in Appendix K of the RFI/RI (IT, 1994) and are summarized in the RFI/RI Work Plan and SAP (IT, 1994).

Standard laboratory toxicity tests, using a variety of species introduced to surface-water, sediment, and soil samples, were considered for this project. However, the results of toxicity tests depend on a variety of factors (salinity, test species, etc.) and conclusions from such tests are often confounded by conditions other than site-related contamination. Tissue analysis, on the other hand, provides a direct measurement of contaminant accumulation. Thus, biological sampling will be limited to tissue analyses, and toxicity tests will not be conducted in this study. Previous investigations at other SWMU and at three background sites on Boca Chica Key in January-February, 1996 employed toxicity testing. The results of these extensive tests were inconclusive and led to the decision that further toxicity tests would be of limited value at NAS Key West.

In general, aquatic sampling sites at NAS Key West consist either of water bodies with little or no connection to marine waters, and sites that are adjacent to the Gulf of Mexico or the Atlantic Ocean. Aquatic biological samples at the "inland" sites will consist largely of fish and crabs. Most of the inland sites are shallow water lagoons where only minnow-sized fish are expected. Nevertheless, larger fish will be collected from these sites if available. However, fish will not be targeted for collection from the "shoreline" sites. Since these sites are adjacent to open marine waters, it is assumed that fish are transient in these areas. Thus, the analyses of fish tissue from waters near these sites would probably not provide useful data. Aquatic biological samples at shoreline sites will consist of species that are less transient than fish. Primary target organisms at shoreline sites are crabs and sea urchins, supplemented by clams, oysters, snails, lobsters, seagrass, etc. (See Section 4.0).

The sampling of macroinvertebrates was considered for this sampling plan, but macroinvertebrates are so small that collection of a quantity sufficient for tissue analyses of more than a few samples would not be feasible. A study of the abundance and diversity of macroinvertebrates was also considered. However, the unique nature of each proposed sampling site would probably result in differing macroinvertebrate community structure among sites, even in the possible absence of contamination. Thus, macroinvertebrate sampling is not proposed for this project.



Brown & Root Environmental

0 1.5 3.0

Scale in Miles (Approximate)

FIGURE 2-1. NAS KEY WEST
INSTALLATION RESTORATION AND BACKGROUND SITES
NAS KEY WEST KEY WEST, FLORIDA

DRAWN BY: LHO	SCALE:	DATE: 03/31/97	REV. 1
CHECKEY BY:	CONTRACT NO.:	FILE NAME: 7046-24PC-Mod1RFI/App-B/F2-1NASk	

TABLE 2-1

NUMBER OF BIOLOGICAL SAMPLES PROPOSED FOR COLLECTION AND CHEMICAL ANALYSIS
NAS KEY WEST
BOCA CHICA KEY, FLORIDA

Site	Fish	Crab	Sea Urchin and Other[1]	Terrestrial Vegetation[2]	Aquatic Vegetation
SWMU-4	15	5	-	3	-
SWMU-5	15	5	5	3	-
SWMU-7	-	-	-	3	-
IR-1	-	10	10	-	3
IR-7	-	10	10	-	3
IR-8	-	10	10	-	3
AOC-B	25	10	10	-	-
Background Sites					
Background 4 (Dredgers Key)	-	10	10	-	3
Background 5 (Cayoagua Island)	-	10	10	-	3
Background 6 (Coppitt Key)	15	10	-	-	-
Background 7 (Eastern Key West)	15	10	-	-	-
Background 8 (Wisteria Island)	-	10	10	-	3
Total Analyses:	85	95	75	9	18
Total Analyses: 282					

[1] Depending on availability, sea urchins will be supplemented with species such as clams, oysters, lobsters, snails, etc.
[2] Terrestrial vegetation will be sampled only where habitat for the endangered lower keys marsh rabbit exists on or near the site.

2.1 SWMU-4, BOCA CHICA AIMD BUILDING A-980

A large, shallow (<8 inches) lagoon is located north of AIMD Building A-980. The lagoon receives surface-water runoff, and possibly groundwater seepage, from the area surrounding AIMD Building A-980. Wading birds are known to forage on small minnows in this area. Therefore, minnows will be collected from the lagoon to determine body burdens of contaminants in aquatic receptors and possible food chain transfer. In addition, because the marshy areas surrounding the lagoon are utilized by the endangered lower keys marsh rabbit (*Sylvilagus palustris hefneri*), vegetation samples will be collected from plant species known to be used as forage by this mammal. Crabs are probably rare at this site (none were seen during the June 1996 site visit) but will be collected, if possible.

2.2 SWMU-5, BOCA CHICA AIMD BUILDING A-990

Runoff from this site drains to a concrete ditch, then through a grassy swale into a small, shallow ponded area west of the site. The ponded area is connected to a large lagoon by a culvert underneath a paved road. Aquatic receptors suitable for collection and tissue analysis from this ponded area may be limited to minnows. Therefore, minnows will be targeted for sampling. Terrestrial plant species known to be used as forage by marsh rabbits will be sampled from the grassy area between the end of the concrete drainage ditch and the ponded area west of the site.

2.3 SWMU-7, BOCA CHICA BUILDING A-824

A small pond, 30 ft x 30 ft in area, is located approximately 50 ft north of a chain link fence surrounding Building A-824. A short ditch cut into the surficial limestone adjoins the south end of the pond. Because of the small size of the pond and ditch, and their poor quality as aquatic habitat, no aquatic biological sampling is proposed. However, since the nearby area is known to be inhabited by marsh rabbits, vegetation samples will be collected from plant species known to be consumed by rabbits.

2.4 IR SITE 1, TRUMAN ANNEX OPEN DISPOSAL AREA

IR Site 1 is located adjacent to the Atlantic Ocean shoreline. The shoreline receives surface water runoff from the site, and groundwater beneath the site presumably seeps into the ocean. Because fish are transient in open marine waters, the analyses of fish tissue from water adjacent to this site would probably not provide data useful for a determination of site-related contamination. It is anticipated that crabs and sea urchins will be the most appropriate organisms to collect for tissue analyses. Sessile filter feeders, such as clams and oysters, are known to accumulate contaminants from the water column, and will be collected if available in quantities sufficient for laboratory analyses. Seagrass will also be collected for laboratory analyses.

2.5 IR SITE 3, TRUMAN ANNEX DDT MIXING AREA

The use of this small (¼ acre) area of turf grass by ecological receptors is insignificant. In addition, remediation of contaminated soil has been conducted at this site. As a result, no biological sampling is proposed for IR-3.

2.6 IR SITE 7, FLEMING KEY NORTH LANDFILL

This site is bounded on the east and west by the Gulf of Mexico. Both shorelines receive surface water runoff, and presumably groundwater seepage, from IR-7. Crabs and sea urchins are proposed as the most appropriate organisms to collect for tissue analyses. Sessile filter feeders, such as clams and oysters, will be collected if available in quantities sufficient for laboratory analyses. Seagrass will also be collected for laboratory analyses.

2.7 IR SITE 8, FLEMING KEY SOUTH LANDFILL

This site is adjacent to the Gulf of Mexico. The marine waters along the site receive surface water runoff, and presumably groundwater seepage, from IR-8. Species targeted for collection are the same as at IR-1 and IR-7 and consist of crabs, sea urchins, clams, oysters, and seagrass, if available.

2.8 AOC-B, BIG COPPITT KEY ABANDONED CIVILIAN DISPOSAL AREA

A canal near the north end of this site presumably receives surface water runoff and groundwater seepage from AOC-B. The canal is not connected to marine surface water. The aquatic habitat at this site differs from other sites by being deep enough for large fish that do not have access to open marine waters. Fish and crabs are proposed for collection from the canal. The number of fish targeted for collection at this site (n=25) includes 15 minnow composite samples and 10 larger fish taken in gill nets.

3.0 BACKGROUND SAMPLING LOCATIONS

In addition to biological sampling at the sites discussed above, five background sampling areas will be investigated. At each background site, biological and nonbiological samples will be collected for analysis. Analytical results from these background sites and from three previously sampled background sites on Boca Chica Key will form the basis for background comparison to SWMU/IR/AOC samples for both biological and nonbiological/contaminant samples.

3.1 BACKGROUND 4 (DREDGERS KEY)

Dredgers Key is ½ mile north of Key West and 1 mile east of Fleming Key. Various U.S. Navy facilities exist on the island, including the Navy Exchange and Commissary, and several homes. The northeastern portion of the island is relatively undeveloped. Mangroves grow adjacent to a narrow sandy shoreline in this area, and sea grass communities exist in nearshore waters. A small, undeveloped, mangrove-covered island is located approximately 200 meters south of the eastern tip of Dredgers Key; biological samples will be collected in the water between Dredgers Key and the nearby mangrove island. Crabs and sea urchins are proposed as primary species for tissue analyses, with seagrass oysters, clams, etc. as available.

3.2 Background 5 (Cayoagua Island)

Cayoagua is a group of four small mangrove islands located in the Gulf of Mexico approximately 3 miles north of Stock Island. The islands are largely covered by mangroves, and no buildings or structures of any type exist on the islands. Sea grass communities occur in the vicinity of the islands. Samples targeted for collection are the same as at Background 4, and consist of crabs and sea urchins, with oysters, clams, seagrass, etc. as available.

3.3 BACKGROUND 6 (COPPITT KEY)

Background 6 is a shallow lagoon in the relatively undeveloped eastern portion of Coppitt Key. Scattered mangroves occur along the shoreline. Organisms targeted for collection here consist primarily of minnows and crabs.

3.4 BACKGROUND 7 (EASTERN KEY WEST)

Background 7 is located in the northeastern section of a large pond/lagoon north of the Key West International Airport. The eastern edge of the lagoon is covered by mangroves. Samples will be collected from locations in the area that appear to be least impacted by development. Organisms targeted for collection here consist primarily of minnows and crabs.

3.5 BACKGROUND 8 (WISTERIA ISLAND)

Wisteria Island is located approximately ½ mile northwest of Key West. No development exists on the island, which is covered with Australian Pines. The sandy shoreline consists of crushed limestone and coral. Samples targeted for collection are the same as at Background 4, and consist of crabs and sea urchins, with oysters, clams, seagrass, etc. as available.

4.0 AQUATIC SPECIES PROPOSED FOR SAMPLING

4.1 FISH

Several small, minnow-like fish species are found in the lower Florida Keys. The most common minnows found at the sites described above include the sailfin molly (*Poecilia latipinna*), mosquitofish (*Gambusia* sp.), sheepshead minnow (*Cyprinodon variegatus*), killifish (*Fundulus* sp.), crested goby (*Lophogobius cyprinoides*), and fat sleeper (*Dormitor maculatus*). The sailfin molly feeds mostly on algae and vascular plants, but will eat mosquito larvae when available. Mosquitofish feed primarily on mosquito larvae, but also eat larvae of other insects and zooplankton. Gobies and sleepers feed on small crustaceans and insect larvae. Killifish and sheepshead minnow are omnivorous, feeding on algae, insect larvae, small crustaceans, and annelid worms. All of these species are relatively short lived, less than three years in most instances. Schools of minnows (some of which were identified as sheepshead minnow) were observed in the small ponds at SWMU-4 and SWMU-5 during the June 1996 site visit.

Larger predators, such as ladyfish and tarpon, are also found in NAS Key West ponds and lagoons and may be present at AOC-B. Ladyfish (*Elops saurus*) tolerate a wide range of salinities, occurring in low-salinity estuaries and tidal creeks as well as offshore in the open ocean. Ladyfish are primarily piscivorous, feeding on menhaden, mosquitofish, pinfish, sheepshead minnows and other small bait fish. They may live as long as 10 years. Tarpon (*Megalops atlanticus*) also occur in coastal waters, where they feed on crabs and small fish. Tarpon reach sexual maturity at six or seven years of age and may live as long as 15-20 years.

4.2 SEA URCHIN

Sea urchins are members of the Class Echinoidea, which includes sea urchins and sand dollars. Most sea urchins are adapted for life on hard bottoms, on which they move with their tube feet and to a lesser extent their spines. They graze on algae and other microorganisms attached to rocks and shells, scraping the encrusted algae with their complex jaw apparatus, called Aristotle's lantern. Most sea urchins are secretive, hiding during the day in protected locations (among coral, in rock crevices) and emerging at night to feed in the open. Sea urchins require relatively clean, well oxygenated, circulating water, and avoid still, shallow areas that are silty or that become too hot during the day (above 35°C). Sea urchins grow rapidly in the first two years of life, then growth slows considerably. They may live as long as four or five years. Known predators of sea urchins include wrasses (e.g., the hogfish), triggerfishes, grunts, porgies, porcupinefishes, and toadfishes. Several species of sea urchin are found in Key West waters.

These include the long-spined black sea urchin, the brown rock urchin, and several rock-boring and reef urchins of the genus *Echinometra*. Population densities of sea urchins appear to be particularly high in the vicinity of IR-7 and IR-8.

4.3 BLUE CRAB

Blue crabs (*Callinectes* sp.) belong to the "swimming crab" family Portunidae, whose members include the lady crabs of the genus *Ovalipes* and the speckled crab, *Arenaeus cribarius*. The fifth set of legs (hind legs) in this group are flat and paddle-shaped, adapted for swimming. The blue crab is harvested by commercial fishermen throughout Florida coastal waters. Female blue crabs spawn in high salinity bays or offshore ocean waters where eggs hatch into planktonic larvae. Planktonic larvae begin developing in the open ocean and then migrate as post-larvae into estuaries where they settle to the bottom and continue growing and molting, ultimately becoming mature adults. Mating occurs in lower salinity estuaries. The females then migrate back to high salinity areas to spawn while the males remain in the estuaries. In nearshore areas, blue crabs are generally found in shallow water over sand or mud bottoms and are often associated with submerged aquatic vegetation. Blue crabs have a varied diet, and will feed on many species of animals including fiddler crabs. They will also eat dead and dying animals. Blue crabs are believed to be present at most, if not all, of the SWMUs and IR sites that have an outlet to the Atlantic Ocean or the Gulf of Mexico. Fish that feed on crabs include tarpon, cobia, snook, bonefish, skates, and rays.

4.4 STONE CRAB

The stone crab (*Menippe mercenaria*), another important commercial species, is found along the southwest Gulf Coast from the Florida Keys to Tampa Bay. Juvenile stone crabs are found in estuaries with shell, rock, or sea grass substrates, but adult crabs move to deeper water, where they burrow in soft substrates or live in sea grasses. Stone crabs belong to the family Xanthidae, which includes the stone crab and a number of other so-called mud crabs that are not pursued by divers and commercial crabbers. Dead stone crabs and stone crab shells were seen washed up on shore at IR Sites 7 and 8 during the June 1996 site visit, and crab traps (floats) were also seen in these areas generally 50 meters or more from shore. It may be possible to collect juvenile stone crabs near the shoreline. As noted previously, a variety of fish feed on crabs in estuarine and marine waters.

4.5 OYSTERS

Flat tree oysters (*Isognomon* sp.), sometimes referred to as "mangrove" oysters, are found at several SWMUs and may be present at some background sites and at AOC 8. They range from south Florida to Brazil. These oysters are very flat and thin shelled, and are found growing in clumps on rocks and on the roots of mangroves, most often the prop roots of the red mangrove. Like all bivalves, tree oysters are filter feeders that pump water through their gills and strain out microscopic organic matter. A number of south Florida fish species are known to feed on mollusks and may feed to some extent on mangrove oysters. These include pigfish, sheepshead, pinfish, Atlantic croaker, and black drum.

4.6 SPINY LOBSTER

The spiny lobster (*Panulirus argus*) supports major commercial fisheries in south Florida and the Caribbean. It feeds on a variety of slow-moving animals, including gastropod and bivalve mollusks, crustaceans, and echinoderms. The spiny lobster spawns in offshore waters along the fringes of reefs in late spring and early summer. Planktonic larvae inhabit the open ocean and, after metamorphosing into post-larvae (which swim rather than drift), move shoreward. After another series of molts, benthic post-larvae become juveniles that hide among seagrass beds, rocks, and rubble. Late juveniles and adults aggregate in sheltered areas in protected bays and estuaries with high salinity. Sheltered areas include mangrove roots, holes in limestone rock, rocky outcroppings and ledges. Many lobsters approaching sexual maturity emigrate offshore in the spring, dispersing along the reefs that parallel the Florida Keys. Research indicates that more females than males emigrate offshore. There is apparently a return migration to shallow waters after larvae are released in early summer. Adults remain in shallow waters until fall, when water temperatures drop and fall storms arrive. At this time, adults of both sexes move offshore to deeper waters. Octopi, crabs, and small fish feed on early benthic stages (post-larvae). Large predators (groupers, jewfish, sharks, and sea turtles) prey on both juvenile and adult lobsters. Spiny lobsters were observed at IR 8 in June 1996, and may be sampled if present in sufficient numbers.

4.7 GASTROPODS

The Class Gastropoda includes snails, limpets, periwinkles, conchs, and whelks. Representatives of each of these groups are found in the Florida Keys and the Caribbean. Snails were observed in rocky, intertidal areas of IR Sites 1, 7, and 8 in June 1996. Specimens were collected and attempts are being made to identify the species. Two conch species, *Strombus gigas* and *Strombus raninus*, were found in seagrass beds adjacent to IR 7 and IR 8. Tissue samples from snails may be analyzed if (1) snails are numerous enough to yield sufficient tissue and (2) there is adequate life history information on the species in question to permit interpretation of tissue levels of contaminants. The use of conchs as a species for collection is uncertain because numbers have been drastically reduced by over-harvesting.

5.0 SAMPLING PROCEDURES AND PROTOCOLS

Biological samples will be analyzed for metals, pesticides, and PCBs. Based on previous experience with fish and oyster tissue from Boca Chica Key, analyses will not be conducted for volatile and semivolatile organic compounds. During January, 1996, fish and mangrove oysters were collected from background and SWMU sites on Boca Chica Key and analyzed for a wide range of contaminants. No volatile or semivolatile compounds were detected in any of the 60 fish and oyster samples collected from SWMU sites. No volatile compounds were detected in any of the 56 fish and oyster samples collected from three background sites. Semivolatile compounds detected in tissue from background sites were limited to bis(2-ethylhexyl)phthalate in 5 of 53 fish, phenol in 4 of 53 fish, and pyridine in 4 of 53 fish and in 3 oyster samples. Because of the low concentrations detected and the extremely low frequency of detection of volatile and semivolatile compounds, analyses of these compounds will not be conducted on tissue collected during the present study.

Small fish will be collected using seines, dip nets, and funnel traps. Larger fish will be collected where available at inland sites such as AOC-B, using gillnets. Crabs will be collected using standard crab traps. Sea urchins, clams, oysters, conchs, and lobsters may be collected by hand where available in shallow water. Appropriate collection permits will be obtained. All samples will be collected, frozen, and shipped to the analytical laboratory in accordance with established chain-of-custody procedures.

There is a possibility that key silversides (*Menidia conchorom*) and mangrove rivulus (*Rivulus marmoratus*) occur at some sites. The Florida Game and Fresh Water Fish Commission lists the key silversides as threatened and the mangrove rivulus as a species of special concern. If any individuals of either of these species are captured, they will be immediately released.

5.1 GENERAL AQUATIC SURVEY

General field observations of physical conditions (water depth, bottom type, cover type and extent, channel/basin morphology) and diurnal field measurements of physical/chemical water quality parameters (pH, conductivity/salinity, dissolved oxygen, and water temperature) will be made using portable field instrumentation at each site at least once during the sampling period to assist in interpretation of tissue sampling results.

Fish will be removed from collection devices at frequencies appropriate to minimize fish mortality or deterioration. Other aquatic samples (shellfish and sea urchins) will be collected by hand or with substrate rakes. Only live organisms will be taken. Upon collection, samples will be identified to species and enumerated. In this process, priority will be given to segregating and returning to the source water as soon as possible any special status species (e.g., key silverside, mangrove rivulus) noted in the collection to minimize the potential for mortality. Individuals of species targeted for tissue analysis will be segregated by species in plastic bags and placed on wet ice immediately for later processing, as noted below. Standard measurements (total length, etc.) will be obtained for individuals of remaining (non-target) species as appropriate to provide indication of general health of resident populations (e.g., presence of multiple size classes, evidence of stunting, etc.). Healthy non-target fish will be returned to the source waterbody; expired or disabled fish will be disposed of in accordance with provisions in the scientific collecting permit issued for this work. Any observed physical abnormalities (e.g., lesions ectoparasites, fungal/bacterial infections) will be documented during the collection of the biological samples.

General field observations, sampling/measurement parameters and methods (e.g., gear type, methods, calibration data, sampling times, responsible crew member) and resulting sampling/measurement data (e.g., physical/chemical measurements; fish and shellfish species composition, abundance, lengths, weights) will be recorded in ink on standard aquatic field survey data sheets. A formal field notebook will be maintained to document field activities, including any problems and deviations from plans and procedures, with appropriate references to standard data sheets, for all field sample collection and processing activities (i.e., general aquatic survey and tissue sample collection and preparation).

5.2 TISSUE SAMPLE COLLECTION AND PREPARATION

Laboratory chemical analyses will be conducted on whole-body samples of fish, small crustaceans, and soft-shell crabs. Analyses of soft tissue (muscle/viscera) will be conducted on bivalves, sea urchins, blue crabs, stone crabs, and large crustaceans. The soft tissue will be removed from these organisms at the testing laboratory.

Sample collection and preparation for tissue analysis will be conducted in accordance with Florida Department of Environmental Protection (FDEP) standard operating procedures (FDEP 1992) and relevant guidance (e.g., EPA 1981, 1993) to the extent appropriate for whole fish and shellfish analysis for ecological risk assessments. Any deviation from FDEP SOPs will be discussed and resolved with FDEP prior to sampling. Essential elements of this protocol are as follows:

Sample Composition - Organisms potentially useful as samples for tissue analysis will be segregated by species and size class, placed in plastic bags, temporarily labeled, and placed on wet ice upon collection.

Each sample will consist of a single species and may consist of one or more individuals, depending on sampling success and minimum sample weight requirements for analysis. A minimum of 30 grams per sample is established as an initial target; final minimum weight requirements will be established in consultation with the selected analytical laboratory. Other organisms useful as samples will be segregated by species and size class, and processed as described above.

Preservation of Sample Integrity - All reasonable efforts will be made to preserve sample integrity in collecting, processing, preserving, and packaging samples for shipping by preventing loss of contaminants from samples, by preventing contamination of these samples from other sources, and preventing deterioration of tissue. Specific measures will include (1) segregating individual fish or fish in a size class potentially comprising separate samples in plastic bags upon collection; (2) decontaminating sampling equipment that could potentially come in contact with samples (e.g., measuring boards, balances) using Liquinox, Alconox, or comparable detergent and rinsates as required by FDEP SOPs prior to initiating sampling, between sampling sites, and between processing of individual samples; (3) wearing disposable gloves for processing and changing gloves as necessary to minimize cross-contamination; and (4) packaging samples or sample components separately for shipment. Care will be taken during collection not to breach individual shellfish shells with sampling equipment, such as rakes or knives. Only live individuals will be taken. Proper decontamination procedures and cross-contamination avoidance methods will be employed during shellfish collection, as per EPA guidance (EPA, 1993).

Sample Processing, Packaging and Shipping - Tentatively designated biological samples (consisting of appropriately segregated, bagged, and tagged specimens placed on wet ice upon collection) will be processed and packaged for shipment as soon as possible after collection. Individual specimens will be measured for wet weight and maximum total length. Only length ranges and total weight will be recorded for composite samples of enumerated small fish specimens. Data will be recorded on standard field data sheets. Sample specimens will then be wrapped in extra-heavy-duty aluminum foil (spines will be clipped before wrapping to prevent puncture of packaging). If deemed acceptable based on discussions with FDEP and the analytical laboratory, composite samples consisting of numerous small specimens might be wrapped as unit samples. A standard sample identification tag will be completed and taped to each foil package, which will in turn be sealed in a plastic bag and either frozen for later shipment or packed in ice for immediate shipment. Frozen samples will be packed in dry ice to ensure they do not thaw prior to receipt by the analytical laboratory; arrangements will be made to ensure that fresh samples shipped in wet ice will be received by the analytical laboratory within 24 hours of collection. Each sample package (e.g., ice chest) will be sealed for shipment and will be accompanied by a properly completed chain-of-custody form. The laboratory will be consulted prior to field collection to ascertain the proper number of individuals and/or weights needed for each species for each sample. All relevant sample data specified by EPA (1993) will be recorded on standard field data sheets. Each sample will be accompanied by the properly completed chain-of-custody form.

REFERENCES

ABB Environmental Services, Inc. 1995. Supplemental Resource Conservation and Recovery Act Facility and Remedial Investigation Workplan - Volume I; Sampling and Analysis Plan - Volume II, NAS Key West. ABB Environmental Services, Inc., Tallahassee, Florida.

Florida Department of Environmental Protection (FDEP). 1992. Standard Operating Procedures for Laboratory Operations and Sample Collection Activities, DEP - QA-001/92. Florida Department of Environmental Protection, Tallahassee.

IT Corporation. 1994. Final Report RCRA Facility Investigation/Remedial Investigation, June 7, 1994, Naval Air Station Key West, Key West, Florida. Contract No. N62467-88-C-0196. IT Corporation, Tampa, Florida.

U.S. Environmental Protection Agency (EPA). 1981. Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue. EPA-600/4-81-055. EPA Environmental Monitoring and Support Laboratory, Cincinnati.

U.S. Environmental Protection Agency (EPA). 1993. Guidance in Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1. Fish Sampling and Analysis. EPA-823/R-93-002, EPA Office of Water, Washington, D.C.

APPENDIX B. PART 2 - MARINE ORGANISM COLLECTION REPORT TO FDEP

Brown & Root Environmental

900 Trail Ridge Road
Aiken, SC 29803

(803) 649-7963
FAX: (803) 649-4805

AIK-OES-96-6077
October 25, 1996

Mr. Steve Adams
Florida Department of Environmental Protection
3900 Commonwealth Boulevard
Tallahassee, FL 32399

REFERENCE: NAS Key West Project HK 7046 (CTO 007)

SUBJECT: Marine Organism Collection Report

Dear Steve:

The following end of project report is submitted in accordance with Chapter 62R-1, F.A.C., and is a summary of the activities conducted under the terms and conditions of FDEP Special Permit # 96S-250, issued to me on August 1, 1996.

Marine organisms were collected during August 24 through October 3, 1996, at ten locations on and near Naval Air Station Key West, FL. These locations consisted of six sites where contamination of aquatic resources is being investigated, as well as four background (i.e., reference) sites. The six potentially contaminated sites included two inland lagoons on Boca Chica Key, two shoreline sites on Fleming Key, one shoreline site at Truman Annex on Key West, and one inland borrow pit on Big Coppitt Key. The background sites consisted of an inland lagoon near the eastern end of Key West, the shoreline of Dredgers Key (also known as Sigsbee Park), the shoreline of Wisteria Island, and an area of open water near Bluefish Channel (approximately 4 miles north of Key West).

Specimens consisted of fish and crabs at the inland sites, while crabs, lobsters, conchs, snails, and turtle grass were collected at the shoreline sites. The number of samples collected and associated measurements are provided for each species in Table 1. Individual minnow-sized fish (sheepshead minnows, killifish, sailfin mollies, and crested gobies) were not enumerated. Instead, minnows were pooled by species to create composite samples of 30-50 grams (g) each. Table 1 provides the number of composite minnow samples rather than the number of individual specimens. For all other species collected, the number of samples is synonymous with the number of individual specimens.

Two tarpon were collected from a borrow pit on Big Coppitt Key using gill nets at a depth of 0 to 10 feet. All other fish were collected using minnow traps at depths of 0 to 4 feet. Crabs were collected in wire mesh traps and by hand in water 5 to 12 feet deep. Florida spiny lobsters were collected by hand and in standard lobster traps in water 5 to 12 feet deep. Conchs and true tulip snails were collected by hand in water 5 to 10 feet deep.

Twenty-six samples of turtle grass (*Thalassia testudinum*) shoots were collected by hand in water three to five feet deep. Each sample consisted of approximately 100 g of vegetation. Please note that the permit application did not request the collection of this species.

All specimens were frozen and shipped to Savannah Laboratories and Environmental Services, Inc., in Savannah, Georgia, for laboratory analyses of contaminants potentially present in the specimens. The analytical data are needed to conduct ecological risk assessments at sites where terrestrial and aquatic resources may be at risk due to contamination from past military-related activities. The results of the risk assessments will be used to determine remediation goals at Naval Air Station Key West.

Thank you for your assistance in obtaining the FDEP permit. If you have any questions, please do not hesitate to call me at 803-649-7963.

Sincerely,

Michael L. Whitten
Senior Scientist

Enclosure

cc w/enclosure:
K. Donnelly, B&RE-Pittsburgh
K. Walter, B&RE-Aiken
D. Patrick, NAVFACENGCOM
P. Williams, NAS Key West
File 7046 (CTO 007)

Table 1. Fish, Mollusks, and Crustaceans Collected During August 24-October 3, 1996, at and near Naval Air Station Key West, Monroe County, Florida.

SPECIES	NUMBER OF SAMPLES	LENGTH[1] (mm)	WEIGHT[2] (g)
FISH			
Tarpon (*Megalops atlanticus*)	2	496 526	946 828
Sheepshead minnow (*Cyprinodon variegatus*)	36	22-57	1367
Gold-spotted killifish (*Floridicthys carpio*)	9	26-64	384
Killifish (*Fundulus spp*)	24	32-116	1072
Sailfin molly (*Poecilia latipinna*)	17	24-54	573
Crested goby (*Lophogobius cyprinoides*)	18	26-77	634
MOLLUSKS			
Milk conch (*Strombus costatus*)	18	139-198	10954
Hawkwing conch (*Strombus raninus*)	1	90	114
Florida horse conch (*Pleuroploca gigantea*)	2	285-373	3090
True tulip (*Fasciolaria tulipa*)	8	94-182	1685
Caribbean vase (*Vasum muricatum*)	25	57-99	3340
CRUSTACEANS			
Spiny lobster (*Panulirus argus*)	49	100-270	12179
Blue crab (*Callinectes sapidus*)	15	145-169	3079
Stone crab (*Menippe mercenaria*)	13	77-114	4657
Spiny spider crab (*Mithrax spinosissimus*)	10	58-116	2927
Mud crab (*Panopeus herbstii*)	16	14-32	98
Giant hermit crab (*Petrochirus diogenes*)	3	116-180	335

1 Body length was measured for fish, mollusks, lobsters and hermit crabs; carapace width was measured for all other crabs. Measurements given above indicate the range of the smallest to the largest specimen.

2 Aggregate weight.

APPENDIX B. PART 3 - TOXICOLOGICAL PROFILES FOR ECOLOGICAL COPCS

APPENDIX B. PART 3 - TOXICOLOGICAL PROFILES FOR ECOLOGICAL COPCs

Acetone

Acetone is a colorless volatile liquid that is a normal microcomponent in blood and urine. It has widespread use as a solvent and is used in the manufacture of paints, varnishes, lacquers, pharmaceuticals, sealants, and adhesives. It has been found in cigarette smoke at 1,100 parts per million (ppm) and in gasoline exhaust at 2.3 to 14.0 ppm (Verschueren, 1983).

The 96-hour lethal concentration-50 (LC_{50}) for bluegill sunfish exposed to acetone in water was 8,300 mg/l; the 2-hour LC_{50} for fingerling trout was 6,100 mg/l. A "single oral lethal dose" in rabbits was 10 milliliters per kilogram (ml/kg) (Verschueren, 1983).

Aldrin/Dieldrin

Aldrin and dieldrin have been among the most widely used and distributed chlorinated hydrocarbon insecticides in the United States. Once released to the environment, aldrin readily transforms into dieldrin (EPA, 1980a). Based on concerns related to human health toxicity, EPA banned aldrin and dieldrin from most uses in 1974; production was terminated in 1987. However, as a result of the relatively long half-life of dieldrin, it continues to be detected nationwide (EPA, 1994a). Like other organochlorine pesticides, dieldrin is lipophilic and is ultimately stored primarily in fat and tissues with lipid components. Mammalian sex and species differences have been reported in the metabolism and tissue distribution of dieldrin; males appear to metabolize and excrete dieldrin more rapidly than females (EPA, 1994a).

Aquatic toxicity tests have demonstrated that dieldrin in concentrations as low as 1.1 to 9.9 micrograms per liter (µg/L) were acutely toxic to sensitive fish species (e.g., rainbow trout). Goldfish represent more resistant species: 96-hour LC_{50} = 41 µg/L. Saltwater species are even more sensitive to dieldrin; concentrations as low as 0.28 to 50 µg/L were acutely toxic to saltwater invertebrates. All saltwater fish species were sensitive to acute exposures of either aldrin or dieldrin (EPA, 1980a). Avian oral LD_{50}s reported by Hudson et al. (1984) for aldrin range from 6.59 milligrams per kilogram (mg/kg) in bobwhite quail to 520 mg/kg in mallards. Avian oral LD_{50}s for dieldrin range from 8.78 mg/kg in California quail to 381 mg/kg in mallards (Hudson et al., 1984).

Aluminum

Although present in food in varying amounts, aluminum is not an essential element for mammals. The aluminum content of plants typically depends on the soil aluminum concentration and ranges from 10 to 30 mg/kg fresh weight; studies have indicated that this element stimulates the growth of several pasture plant species (Hackett, 1962). As summarized in Venugopal and Luckey (1978), aluminum is not readily absorbed through the skin, and gastrointestinal absorption of ingested aluminum is poor due to the transformation of aluminum salts into insoluble aluminum phosphate. The lack of accumulation of aluminum in animals with age or of any increase in tissue levels of aluminum following fairly high dietary intake suggests that mammals posses a homeostatic mechanism for this element. For most terrestrial organisms, aluminum compounds are generally not harmful and are considered to be toxicologically inert, except in cases of high experimental doses or prolonged inhalation (Venugopal and Luckey, 1978).

Data on the toxicity of aluminum to aquatic organisms is somewhat limited. EPA (1988a) stated that freshwater organisms should not be adversely affected if aluminum concentrations do not exceed 87 μg/L when pH is between 6.5 and 9.0. Some studies have shown that the acute toxicity of aluminum increases with pH, whereas other studies found the opposite to be true (EPA, 1988a). The occurrence of pH effects in fish depends on aluminum and calcium concentrations in the water. Laboratory studies have established that low pH is toxic to fish, that aluminum concentrations found in acidified waters (particularly inorganic monomeric aluminum) are toxic, and that calcium is ameliorative (Suter, 1993).

Sublethal effects were also reviewed by EPA (1988a). It was found that 169 μg/L at a pH of 6.5 to 6.6 caused a 24 percent reduction in the growth of young brook trout (*Salvelinus fontinalis*). Cleveland et al. (1991) determined that brook trout accumulated significantly higher aluminum residues at pH 5.3 than at pH 6.1 or pH 7.2. They also determined that elimination of aluminum during depuration was more rapid at pH 5.3 than at pH 6.1 or pH 7.2. Data reported in EPA (1988a) indicated this metal does not bioconcentrate; bioconcentration factors range from 50 to 231 for brook trout (geometric mean value = 82).

Antimony

Antimony is frequently associated with nonferrous ore deposits and is commonly encountered in industrial environments, including smelters. It is considered a nonessential metal and is easily taken up by plants if present in a soluble form (Kabata-Pendias and Pendias, 1992). Plants growing in soils contaminated by industrial emissions may be expected to contain elevated tissue concentrations of this metal. However, there are no reports of plant toxicity resulting from uptake of antimony (Kabata-Pendias and Pendias, 1992). Antimony has been shown to produce liver damage in rabbits at 5.5 mg/kg in their diet (NRC, 1980).

Arsenic

Arsenic is a relatively common element; its industrial uses center primarily on the manufacture of pesticides, wood preservatives, and growth stimulants for plants and animals (USFWS, 1988a). The chemistry of arsenic in water is complex, and is a function of chemical, biological, and geochemical reactions that interact to control the concentration, oxidation state, and the form of arsenic in water (EPA, 1984a). Arsenic exists in four oxidation states, both as inorganic and organic forms. Its bioavailability and toxicity are significantly influenced by the physical and chemical forms of arsenic tested, route of exposure, dose, and species of animal tested (USFWS, 1988a). Inorganic forms are generally regarded as being more toxic than organic forms, and trivalent forms are more toxic than pentavalent species (USFWS, 1988a; EPA 1984a). Tests conducted to date indicate that this contaminant does not readily bioconcentrate (EPA, 1984a).

Arsenic is a constituent of most plants, but little is known about its biochemical role. In general, arsenic availability to plants is highest in coarse-textured soils having little colloidal material and little ion exchange capacity, and lowest in fine textured soils high in clay, organic material, iron, calcium, and phosphate (USFWS, 1988a). Reports suggest that plants absorb arsenic passively via the roots with water and that this metal is readily taken up by various plant species (Thoresby and Thornton, 1979). Apparently arsenic is translocated in plants since its concentration in grain also has been reported (Kabata-Pendias and Pendias, 1992). Except for locations where arsenic content is high, (e.g., around smelters) arsenic is distributed throughout the plant body in non-toxic amounts (USFWS, 1988a).

Median lethal dietary concentrations for wildlife range from 99.8 mg/kg in cowbirds (*Molothrus ater*) to greater than 5,000 mg/kg in mallards (*Anas platyrhynchos*) (NAS, 1977). Very little information exists regarding sublethal effects on birds. Chronic arsenic poisoning in mammals is rare because detoxification and excretion are rapid. Chronic toxicity has been associated with reduced growth, weakness, dermatitis, liver damage, and decreased resistance to infection. These effects have been recorded in various mammals at dietary levels of 5 to 50 mg/kg (USFWS, 1988a).

Barium

The concentration of barium in natural waters is controlled by the solubility of barite ($BaSO_4$), a fairly common mineral. Other factors influencing barium solubility in natural waters include metal oxides or hydroxides (Hem, 1970). Sulfates also govern the solubility of barium in soil as do carbonates, and it is strongly adsorbed to clays. Although commonly reported in plant tissues, it is apparently a nonessential component (Kabata-Pendias and Pendias, 1992). While barium is readily taken up by plants in acidic soil, few reports exist regarding its toxicity to plants. Chaundry et al. (1977) reported 1 to 2 percent barium (dry weight) in plants as highly toxic while 220 mg/kg (ash-free dry weight) has been reported to be moderately toxic (Shacklette et al., 1978). Calcium, magnesium, and sulfur appear to act antagonistically with barium and may serve to reduce its toxicity (Kabata-Pendias and Pendias, 1992).

Beryllium

The major source of beryllium in the environment is the combustion of fossil fuels (Tepper, 1972). Beryllium enters the waterways through weathering of rocks and soils, atmospheric fallout, and discharges from industrial and municipal operations (EPA, 1980b). Most common beryllium compounds are readily soluble in water. In aqueous solution, beryllium does not exist as actual Be^{+2} ions but as hydrated complexes. Like a number of other metals, water hardness significantly affects the toxicity of this metal. Only a limited number of aquatic species have been tested, but the results of these tests suggest that freshwater invertebrates exhibit similar sensitivities to this metal. Acute and chronic toxicities of beryllium to aquatic species occur as low as 130 and 5.3 μg/L, respectively (EPA, 1980b).

Benzene hexachloride (BHC)

Benzene hexachloride, also known as hexachlorocyclohexane (HCH) or lindane, is an organochlorine insecticide consisting of eight stereo isomers, of which four (alpha, beta, gamma, and delta) predominate in the technical product due to relatively strainless bonds. BHC isomers degrade to chlorophenols at different rates in order of their solubilities in fat (delta > gamma > alpha > beta) (Deo et al., 1982). The gamma isomer is the only isomer that is highly insecticidal (Deo et al., 1982), and constitutes at least 99 percent of lindane (Manahan, 1992). Signs of toxicity are very similar to those of DDT, and include tremors, ataxia, and convulsions (Murphy, 1986).

Newell et al. (1987) selected 0.1 mg/kg total BHC as a non-carcinogenic based wildlife criterion, and 0.51 mg/kg total BHC as a 1 in 100 cancer risk level for piscivorous wildlife.

2-butanone

2-butanone, also known as methylethylketone, is used as a solvent, paint stripper, cleaning fluid, and in cements and adhesives. It has a sweet sharp odor and has 100 percent recognition at 6.0 ppm. Toxicity and fate and transport data for 2-butanone are lacking. The single oral lethal dose in rats was reported by Verschueren (1983) to be 3.3 g/kg.

Cadmium

To date, no evidence exists to suggest that cadmium is either biologically essential or beneficial (Venugopal and Luckey, 1978; USFWS, 1985). Freshwater biota are particularly sensitive to this heavy metal; concentrations as low as 0.8 to 9.9 μg/L produce lethality among insects, crustaceans, and fish (USFWS, 1985; EPA, 1985a). This heavy metal does not bioconcentrate to an appreciable extent; bioconcentration data listed in EPA (1985a) for freshwater species range from 3 (brook trout) to 4,190 (caddisfly; *Hydropsyche betteni*) with a geometric mean value of 404.

Elemental cadmium is insoluble in water, although its chloride and sulfate salts are freely soluble (USFWS, 1985). The availability of cadmium to aquatic biota from their immediate physical and chemical environs depends on numerous factors, including adsorption and desorption rates of cadmium from terrigenous materials, pH, Eh, chemical speciation, and many other modifiers. Adsorption and desorption processes are likely to be major factors in controlling the concentration of cadmium in natural waters and tend to counteract changes in the concentration of cadmium ions in solution (USFWS, 1985). Water hardness also alters the bioavailability of cadmium. Adsorption and desorption rates of cadmium are rapid on mud solids and particles of clay, silica, humic material, and other naturally occurring solids. It should be borne in mind that mobility and availability of cadmium, like most heavy metals, is a function of a large number of interrelated factors (e.g., CEC). Beyer et al. (1985) demonstrated that only a small portion of all metals measured in the soil become incorporated into plant foliage and suggested that most of the metal contamination detected in biota came from aerial deposition.

Compared to aquatic biota, mammals and birds are relatively less sensitive to cadmium exposure. Adult mallards fed a diet containing up to 200 mg Cd/kg survived and exhibited no loss in body weight, although egg production of laying hens was suppressed (White and Finely, 1978). The lowest oral doses producing lethality among mammals were 250 and 150 mg/kg body weight in rats and guinea pigs, respectively (EPA, 1985a).

Carbon tetrachloride

Carbon tetrachloride is a colorless liquid with a wide range of industrial and chemical applications. For the most part, this chemical is used in the manufacture of refrigerants, aerosols, and propellants. It is also used as a solvent, metal degreaser, and fumigant (Verscheuren, 1983). Historically, carbon tetrachloride was used as an inhalation anesthetic and as a waterless shampoo. In the early 1900s, recommendations were made to label the compound as a poison after its use in these capacities resulted in deaths. As early as 1915, health hazards were being reported from industrial uses of carbon tetrachloride (EPA, 1980c).

Studies have indicated that carbon tetrachloride has a full spectrum of toxic effects. Industrial and accidental exposures by ingestion, inhalation, and dermal routes have produced acute, subacute, and chronic poisonings, some of which were fatal. Carbon tetrachloride is readily absorbed through the lungs and more slowly through the gastrointestinal tract. It can also enter the body by penetration through the skin (EPA, 1980c). Upon entering the body, the distribution of carbon tetrachloride varies with the route of administration, its concentration, and the duration of exposure. Studies involving oral administration have found the highest concentrations in bone marrrow, while other studies involving inhalation found concentrations in the brain higher than in the heart, liver, or blood (EPA, 1980c). Pathological changes resulting from inhalation and ingestion of carbon tetrachloride are generally limited to findings in the liver and kidney. When carbon tetrachloride is administered to mammals, it is metabolized to a small extent but mostly excreted through the lungs. EPA (1980c) reports that as much as 78.7 percent of the amount of inhaled carbon tetrachloride is excreted through the lungs within 6 hours after exposure. Other studies have shown that 85 percent of the excretion products are the parent compound, 10 percent carbon dioxide, and smaller quantities of other metabolites (EPA, 1980c).

Verschueren (1983) reports 96-hour LC_{50}s for fish, *Lepomis macrochirus* and *Menidia beryllina*, to be 125 ppm and 150 ppm, respectively. The LD_{50} for rats administered carbon tetrachloride orally was 2.92 g/kg (Verschueren, 1983). In humans, symptoms of illness occurred after 60 minute exposure to 500 ppm, and severe toxic effects were reported after 60-minute exposure to 2,000 ppm (Verschueren, 1983). The most significant effect to consider in terms of dose/response is the cancer-causing potential of the chemical. A number of studies reviewed by the EPA (1980c) showed carbon tetrachloride to be carcinogenic in animals, with the target organ being the liver. Current knowledge leads to the conclusion that carcinogenesis is a nonthreshold, nonreversible process. Based upon the potential carcinogenic effects from exposure to carbon tetrachloride through the ingestion of contaminated water or aquatic organisms, the ambient water concentrations should be zero. However, zero level is not attainable, at present. Based upon a 10^{-6} incremental increase of cancer risk over a lifetime, the recommended water quality criteria is 0.40 µg/L (EPA, 1980c).

Chlordane

Chlordane was used extensively until most uses were banned in 1983. Due to its long half-life and ability to concentrate in biological materials, it is still widely distributed in fish in the United States (EPA, 1980d).

Like other organochlorine pesticides, chlordane bioaccumulates in biological tissues. It is highly lipophilic and readily absorbed via all routes. Oxidative metabolation of chlordane results in the production of a number of metabolites, including oxychlordane, which is very persistent in body fat. Reductive dehalogenation of the chlordane forms free radicals hypothesized to contribute significantly to chlordane's toxicity (EPA, 1994a).

Reduced fertility and survivability in mice and rats has occurred at chlordane doses of 25 and 16 mg/kg, respectively. These chronic effects may be associated with reduced binding of progesterone in the endometrium or with altered metabolism and circulating levels of steroid hormones (EPA, 1994d). Reduced survival in sensitive bird species has been observed at 1.5 mg chlordane/kg diet, and after single oral doses of 14.1 mg chlordane/kg body weight (USFWS, 1990).

2-chloro-1,3-butadiene

Toxicity data and information on chloroprene, or 2-chloro-1,3-butadiene, are scarce. An oral LD_{100} of 0.67 g/kg has been reported (Verschueren, 1983).

Chromium VI

Chromium VI generally does not exist in biological systems, as it is reduced rapidly to chromium III. Chromium VI, however, is much more toxic to living systems than chromium III. Several studies exist regarding the toxicity of chromium VI in mammals. Mice given oral doses of 57, 120, and 234 mg/kg/day during early gestation experienced increased preimplantation and postimplantation losses, along with decreased litter size (ATSDR, 1993). A LOAEL of 57 mg/kg/day was reported for reproductive effects. A decrease in motor activity was seen in rats given oral doses of chromium VI at 98 mg/kg/day for 28 days, and a NOAEL of 9.8 mg/kg/day was reported for these effects (Diaz-Mayans et al., 1986). In addition, mice fed potassium dichromate at 4.6 mg/kg/day exhibited reduced sperm count after 7 weeks, and morphologically altered sperm at 9.1 mg/kg/day after 7 weeks (Zahid et al., 1990).

Since Diaz-Mayans et al. (1986) established a clear dose-response relationship, the NOAEL was chosen for derivation of a benchmark value.

Only one avian study exists for chromium VI. Chickens were fed diets up to 100 ppm chromium VI and no adverse effects on survival or growth were observed after 32 days, suggesting a NOAEL of 100 ppm (Rosomer et al., 1961).

A multitude of studies exist on the effects of chromium VI on fish. Since the National Ambient Water Quality Criteria value of 0.011 mg/L was the most conservative value, it was chosen as the value for forage, small, and large fish. For fish and terrestrial organisms, the data show that chromium VI does not effectively bioaccumulate.

Copper

Copper is an essential component of many enzymes, and most animals have some ability to regulate its balance. Higher organisms typically employ cellular mechanisms to conserve copper when it is deficient and excrete it when body burdens increase. These copper regulatory mechanisms may successfully prevent severe abnormalities if neither periods of deficiency nor excess are extreme (Rand and Petrocelli, 1985).

The toxicity of copper to aquatic biota has been shown to be related primarily to the activity of the cupric ion (Cu^{+2}), and possibly to some of the hydroxy complexes. The cupric ion is highly reactive and forms moderate to strong complexes and subsequently precipitates with any inorganic and organic constituents of natural waters. The portion of copper present as a free cupric ion is generally low and may be less than 1 percent in eutrophic waters where complexation predominates. It appears that organic and inorganic copper complexes and precipitates are less toxic than free cupric ion, thus reducing the toxicity attributable to total copper. The chemistry of copper complicates the interpretation of its toxicity because the portion of free cupric ion present in solution is highly variable (Rand and Petrocelli, 1985). Like a number of other cation metals, both calcium hardness and carbonate alkalinity are also known to reduce the acute toxicity of copper; expression of Virginia water quality criteria allows adjustment for these water quality effects.

Data compiled by EPA (1984b) indicated that both freshwater invertebrates and fish exhibit a wide range of sensitivities to acute exposures to copper; neither group appeared to be more sensitive than the other to copper. Embryos of the blue mussel and the Pacific oyster were the most sensitive saltwater species tested, with acute values of 5.8 and 7.8 µg/L, respectively. Acute values for saltwater fish ranged from 13.93 to 411.7 µg/L, with embryo-larval forms more sensitive than adults.

2,4-dichlorophenoxyacetic acid (2,4-D)

The compound 2,4-D was used as a post-emergent herbicide for the control of annual and perennial broadleaf weeds around fruits, vegetables, turfs, and ornamentals. In most soils, 2,4-D degrades to 2,4-dichlorophenol and 2,4-dichloroanisole before degrading completely to carbon dioxide (Montgomery, 1993), and it has numerous metabolites in plants. The reported half-life in soil is 15 days with residual activity limited to approximately 6 weeks. It has an octanol/water partition coefficient of log 2.81 (Verschueren, 1993).

LC_{50}s (48-hour) of 0.9 and 1.1 mg/L have been reported for the bluegill and rainbow trout, respectively (Montgomery, 1993). Also, LC_{50}s of 70.1, 300.6, and 96.5 have been reported for the striped bass, american eel, and guppy, respectively (Verschueren, 1993). In addition, an oral LD_{50} for rats of 375 mg/kg has been reported (Montgomery, 1993). Other oral LD_{50}s include 375 and 521 mg/kg in mice and 100 mg/kg in dogs (Verschueren, 1993).

<u>DDT</u>

DDT has not been marketed in the United States since 1972 but is ubiquitous due to its widespread use in previous decades and its relatively long half-life. DDT's close structural analogs, DDE and DDD, are metabolites of DDT and have also been formulated as pesticides in the past (Hayes, 1982). Because of its persistent nature, coupled with its hydrophobic properties and solubility in lipids, DDT and its metabolites are concentrated from water by aquatic organisms at all trophic levels. It also readily enters the food web and is bioaccumulated by organisms at higher trophic levels (EPA, 1980e).

DDT is intermediate in toxicity to fish in comparison to other chlorinated hydrocarbon pesticides. It is less toxic than aldrin, dieldrin, endrin, and toxaphene, but more toxic than chlordane, lindane, and methoxychlor (EPA, 1980e). Invertebrates are, for the most part, more sensitive than fish species, but the range of species LC_{50}s for macroinvertebrates (10,000) is much greater than that for fish (300). The least sensitive species listed in EPA (1980e) was a stonefly (*Pteronarcys californica*) with a 96-hour LC_{50} of 1.8 mg/L. Week-old crayfish were the most sensitive reported species (LC_{50} = 0.00018 mg/L), although 10-week old crayfish of the same species had an LC_{50} of 0.003 mg/L. EPA (1980d) reported that of the species for which data were available, yellow perch was the most sensitive freshwater species tested (96-hour LC_{50} of 0.6 µg/L) whereas the least sensitive species was the goldfish (96-hour LC_{50} = 180 µg/L).

Bioconcentration factors from laboratory tests with DDT and saltwater organisms ranged from 1,200 to 76,300 for fish and shellfish, respectively (EPA, 1980e).

Data for DDE indicate that long-term dietary dosage at 2.8 to 3.0 mg/kg DDE (wet weight) can have adverse effects on reproduction of mallards, black ducks, and screech owls. Species that feed on saltwater animals containing DDT and its metabolites have exhibited reductions in their reproductive capacity (Rand and Petrocelli, 1985). Anderson et al. (1975) studied the impacts of DDT in northern anchovies (a species with a high lipid content) on the reproductive success of brown pelicans. The concentrations of this contaminant steadily declined in anchovies over this 5-year study, and pelican reproduction improved. The authors concluded that even the lowest concentrations detected in anchovies (0.15 mg/kg) and the subsequent 97 mg/kg concentration in pelican eggs was unacceptably high because pelican eggshell thickness was still too low and pelican recruitment was still not high enough to sustain a stable population.

Dichlorobenzene

Dichlorobenzenes are a class of halogenated aromatic compounds represented by three structurally similar isomers: 1,2-dichloro-; 1,3-dichloro-; and 1,4-dichlorobenzene. 1,2-dichlorobenzene and 1,3-dichlorobenzene are liquids at normal environmental temperatures while 1,4-dichlorobenzene is a solid. The major uses of 1,2-dichlorobenzene are as a process solvent in the manufacturing of toluene diisocyanate and as an intermediate in the synthesis of dyestuffs, herbicides, and degreasers (EPA, 1980f). The production, use, transport, and disposal of dichlorobenzene result in widespread dispersal to environmental media with resulting opportunity for exposure of the biosphere (EPA, 1980f). The 96-hour LC_{50} for the bluegill (*Lepomis macrochirus*) and silverside minnow (*Menidia beryllina*) was 27 ppm and 7.3 ppm, respectively (Verschueren, 1983). Fathead minnows had a 96-hour LC_{50} of 57 mg/L, while grass shrimp were more sensitive (96-hour LC_{50} = 9.4 mg/L). A "single oral lethal dose" for guinea pigs was 2.0 g/kg. Based on a 192-day exposure, the NOAEL in rats ranged from 18.8 to 188 mg/kg/day (Verschueren, 1983).

1,4-dichlorobenzene is primarily used as an air deodorant and an insecticide, which account for 90 percent of the total production of this isomer (EPA, 1980f). LC_{50} values for rainbow trout, fathead minnows, and bluegill are 1.12 mg/L, 4.0 mg/L, and 4.28 mg/L, respectively (EPA, 1980f). The results of a 96-hour LC_{50} test for bluegill with 1,2-, 1,3-, and 1,4-dichlorobenzene (5.59, 5.020, and 4.28 mg/L, respectively) indicate that the position of the chlorine atom on the benzene ring probably does not influence the toxicity of dichlorobenzene. A "single lethal oral dose" for guinea pigs as 2.8 mg/L (EPA, 1980f).

Bioconcentration factors for the bluegill were 89, 66, and 60 for 1,2-, 1,3-, and 1,4-dichlorobenzene, respectively. Equilibrium occurred within 14 days, and the half-life of each dichlorobenzene was less than 1 day (EPA, 1980f). These results suggest dichlorobenzenes are unlikely to be a bioconcentrate in the aquatic environment.

Dichloroethene

1,1-dichloroethene is a colorless liquid used in adhesives and as a component of synthetic fibers. The 96-hour LC_{50} for bluegill sunfish was 220 mg/l; the 96-hour LC_{50} for the inland silverside minnow (*Menidia beryllina*) was 250 mg/l (Verschueren, 1983). 1,2-dichloroethene is a colorless liquid used as a solvent in a wide variety of manufacturing processes. It is an additive to dye and lacquer solutions and is a constituent of perfumes and thermoplastics; it is also used in organic synthesis and medicine. Data on effects to aquatic organisms and terrestrial wildlife were not available (Verschueren, 1983).

1,4-Dioxane

Dioxane is a volatile colorless liquid primarily used as a solvent for cellulosics and a wide range of organic products including lacquers, paints, varnishes, detergents, cements, cosmetics, deodorants, and fumigants. An octanol/water partition coefficient of -0.419 has been estimated (Howard, 1993). The compound is volatile, and will therefore evaporate from water, but it is also expected to leach in soil due to its miscibility in water (Howard, 1993). No data are available pertaining to the biodegredation of dioxane in the environment.

Dioxane has been determined to cause cancer in rats and guinea pigs (Sittig, 1985). Oral LD_{50}s include 5.66, 5.17, and 3.9 g/kg for the mouse, rat, and guinea pig, respectively. An estimated aquatic bioconcentration factor of 0.3 has been reported (Howard, 1993), indicating that aquatic bioconcentration is minimal.

Endosulfan (and endosulfan sulfate)

Endosulfan is an organochlorine insecticide and is comprised of sterioisomers designated I and II that have similar toxicities (EPA, 1993a). Endosulfan has been found widely in food samples, from which it is absorbed through the GI tract and distributed throughout the body. Endosulfan is metabolized to lipophilic compounds (including endosulfan sulfate), and both parent and metabolites are found initially primarily in the kidney and liver and fatty tissue, with distribution to other organs occurring over time. Endosulfan can induce microsomal enzyme activity. Based on laboratory studies, females may accumulate endosulfan more readily than males; this phenomenon may account for the higher toxicity seen in females (EPA, 1994a). The oral LD_{50} of endosulfan in three studies where mallards were dosed with endosulfan was 31.2, 33.0, and 45.0 mg/kg (Hudson et al., 1984).

Endrin (and endrin aldehyde)

Endrin was widely used as a broad spectrum pesticide until its registration was canceled in 1984. This chlorinated cyclodiene is highly toxic to humans; its long-term persistence and mammalian toxicity had been recognized at least as early as 1964 (EPA, 1993a). Like other organochlorine pesticides, endrin (and edrin aldehyde, its metabolite) is lipophilic and bioaccumulates in lipid. Studies indicate that this pesticide can move across the placenta (EPA, 1994a). Avian oral LD_{50}s for endrin range from 1.06 mg/kg in sharp-tailed grouse to 5.0 mg/kg in rock doves (Hudson et al., 1984).

Heptachlor

Heptachlor epoxide is a breakdown product of the organochlorine pesticides, heptachlor and chlordane. It is a contaminant of both products (EPA, 1994a). It is more toxic than either parent compound (EPA, 1993a). Although most uses of heptachlor were suspended in 1978 and chlordane was removed from the market in 1988 (EPA, 1993a), heptachlor epoxide continues to be a widespread contaminant due to its relatively long biological half-life. Based on animal and limited human data, heptachlor epoxide is absorbed through the GI tract and is found primarily in the liver, bone marrow, brain, and fat, although it is distributed widely to other tissues as well. Heptachlor epoxide has a high affinity for adipose tissue. In a single LD_{50} study reported by Hudson et al. (1984), the oral LD_{50} in mallards was $\geq$ 2,080 mg/kg; signs of toxicity consisted of ataxia and other behavioral abnormalities.

Cyanide

Hydrocyanic acid is very reactive and occurs only rarely in nature. The cyanide ion is highly water soluble and readily forms complexes with a variety of metal ions, especially those of the transition series. Compounds containing cyanide are often associated with steel, petroleum, plastics, synthetic fibers, metal plating, and chemical industries (EPA, 1984c). The toxicity to aquatic organisms of most simple cyanides and metallocyanide complexes is due mostly to the presence of HCN as derived from ionization, dissociation, and photodecomposition of cyanide-containing compounds, although the cyanide ion is also toxic. Cyanide appears to be more toxic to fish than to most invertebrates, although *Daphnia pulex* is apparently as sensitive to cyanide as are most fish. Concentrations as low as 50 µg/L can be fatal to sensitive fish species while exposure to concentrations much above 200 µg/L result in lethality to almost all fish species (EPA, 1984c). Cyanide is known to uncouple oxidative phosphorylation.

Iodomethane

Iodomethane, or methyliodide, is used in medicine, organic synthesis, microscopy, and testing for pyridine. Toxicity and fate and transport data for iodomethane are scarce. In the rat, a subcutaneous LD_{50} of 0.15 to 0.22 was observed, and an oral LD_{50} of 0.15 to 0.22 was observed (Verschueren, 1983). The carcinogenicity of the compound is unknown, though it is known to be weakly mutagenic.

Lead

As summarized in USFWS (1988b), research to date has determined that lead is neither essential nor beneficial, and that all measured effects are adverse. Invertebrates exhibit a wide range of sensitivities to lead, and the toxicity of lead to fish has been found to be greater in soft water than in hard water. Organolead compounds are typically more toxic than inorganic compounds, food chain biomagnification is generally negligible, and younger organisms tend to be more sensitive to lead exposure than older individuals (USFWS, 1988b). Reported bioconcentration factors range from 42 for brook trout to 1,700 for a gastropod (*Lymnaea palustris*); the geometric mean value of data listed in EPA (1985b) for freshwater species is 403. Studies summarized by USFWS (1988b) show that among sensitive species of birds, survival was reduced at doses of 50 to 75 mg Pb^{2+}/kg body weight or 28 mg organolead/kg body weight, reproduction was impaired at dietary levels of 50 mg Pb^{2+}/kg, and symptoms of toxicity (hyperactivity, reduced food consumption) were seen at doses as low as 2.8 mg organolead/kg body weight.

As with a number of other metals, hardness has a major effect on the bioavailability of lead, although the observed effect is probably due to the presence of one or more interrelated ions such as hydroxide, carbonate, calcium, or magnesium (EPA, 1985b).

Plants readily accumulate lead from soils of low pH or low organic content (USFWS, 1988b). Lead seems to be tightly bound in most soils, and substantial amounts must accumulate before it affects growth of higher plants. There is no convincing evidence that any terrestrial vegetation is important in food chain biomagnification of lead (USFWS, 1988b; Kabata-Pendias and Pendias, 1992).

Manganese

Manganese does not occur naturally as a metal but is found in various salts and minerals, frequently in association with iron compounds (EPA, 1986). Manganese is a vital micronutrient for both plants and animals. McKee and Wolfe (1963) summarized the data concerning the toxicity of manganese to freshwater life. Manganese ions rarely occur in concentrations above 1 mg/L. The reported tolerance values for freshwater organisms range from 1.5 to >1,000 mg Mn/L.

All plants require manganese; its most important functions in plants appear to be associated with oxidation-reduction reactions. Like that of many other soil constituents, the chemistry of manganese is relatively complex and closely related to the formation of iron hydroxides and redox reactions (Kabata-Pendias and Pendias, 1992). While toxicity of manganese to plants has been reported in acid soils (pH < 5.5) containing high concentrations of this metal, like iron, manganese toxicity is the function of a number of other environmental factors. Soil concentrations associated with plant toxicity range from 1,500 to 3,000 mg/kg (Kabata-Pendias and Pendias, 1992).

Mercury

Mercury is widely distributed in the environment due to both natural and industrial processes. In a review of the hazards of mercury (Hg) to fish, wildlife, and invertebrates, USFWS (1987a) noted that mercury and its compounds have no known biological function; its presence is regarded as undesirable and potentially hazardous; and it is a mutagen, teratogen, and carcinogen. Forms of mercury with relatively low toxicity can be transformed into forms with very high toxicity through biological and other processes. Methylmercury is lipophilic, allowing it to pass through lipid membranes of cells and facilitating its distribution to all tissues, following absorption through the gills and gastrointestinal tract. Methylmercury also binds readily to protein sulfhydryl groups. Methylmercury and other organic mercury compounds are transformed via an oxidation-reduction cycle into an inorganic form in most tissues, most significantly in the liver, kidney, and brain. The central nervous system is a major target organ for methylmercury-induced toxicity (EPA, 1994a).

Methylmercury can be bioconcentrated in organisms and biomagnified through foodchains, returning mercury to upper trophic level consumers in a concentrated form. Bioconcentration factors for methylmercury range from 10,000 for brook trout to 81,670 for fathead minnows (*Pimephales promelas*); the geometric mean value of bioconcentration values listed in EPA (1985c) for freshwater organisms is 25,400. For all organisms tested, early developmental stages were the most sensitive, and organomercury compounds, especially methylmercury, were more toxic than inorganic forms. Numerous biotic and abiotic factors modify the toxicity of mercury compounds, sometimes by an order of magnitude or more, but mechanisms of action are unclear (USFWS, 1987a).

The chemical speciation of mercury is probably the most important variable influencing its ecotoxicology, but Hg speciation is complicated, especially in natural environments (Boudou and Ribeyre, 1983; USFWS, 1987a). Most mercury entering aquatic systems is inorganic (Hg II) although recent studies have measured methylated mercury (CH_3HgH^+) in rain and surface runoff (Bloom and Watras, 1989; Lee and Hultberg, 1990). Methylmercury is the major form of mercury in fish; methylation of inorganic mercury takes place in the terrestrial environment, the water column, and in sediment. The net amount of methylmercury in an aquatic system is the result not only of its rate of formation but also the result of the rates of those processes that alter the availability of inorganic mercury for methylation and methylmercury decomposition (demethylation) (Winfrey and Rudd, 1990).

Inorganic mercury readily adsorbs to inorganic and organic particles as well as dissolved organic carbon (DOC) (Benes and Havelik, 1979; Rudd and Turner, 1983; Rogers et al., 1984). The degree and extent of this binding, while not well understood, will affect the availability of mercury for methylation. Methylation of mercury in most aquatic systems is thought to be primarily a function of microbiological activity in the sediment (Winfrey and Rudd, 1990). Rates of methylation peak at the sediment-water interface and decrease in the overlying water and subsurface sediment (Korthals and Winfrey, 1987). Reduced pH also appears to increase the availability of methylated mercury by expediting its release from sediment into the water column.

Plants seem to take up mercury easily from solution culture. There is also much evidence that increasing soil concentrations of mercury generally cause an increase in the mercury contents of the plants. The rate of increase of mercury content in plants when the soil was the only source of mercury was reported to be highest for the roots, but leaves and grains also accumulated much mercury (Kabata-Pendias and Pendias, 1992). These findings show that mercury is easily absorbed by the root system and is also translocated within plants. However, in a report entitled *Environmental Mercury and Man* (Anon., 1976), it stated "for most plants, even when grown on soils having much higher concentrations of mercury, there is little additional uptake."

Adverse effects (predominantly on reproduction) have been reported in birds at 50 to 100 µg/kg diet and daily intakes of 640 µg/kg body weight. Mink are among the mammals most sensitive to mercury, and adverse effects in mink have been reported at dietary levels of 1,100 µg/kg (USFWS, 1987a).

Methyl Chloride

Methyl chloride, also known as chloromethane, is a solvent used in the manufacturing of silicones, rubber, refrigerants, and organic chemicals. An octanol/water partition coefficient of 0.91 has been reported for this compound (EPA, 1996). Biodegredation rates of 28 days in lakes and rivers have been reported (EPA, 1996).

LC_{50}s of 550 and 270 mg/L for the bluegill and *Menidia beryllina* have been reported, respectively (Verschueren, 1983). Mammalian toxicity data for this chemical is limited to inhalation data.

4-methyl-2-pentanone

Methylisobutylketone, also known as hexanone or 4-methyl-2-pentanone, is used as a solvent for paints, varnishes, and lacquers, in extraction processes, organic synthesis, and in the manufacture of methylamylalcohol. A 24-hour LC_{50} of 460 mg/L has been reported for the goldfish (Verschueren, 1983). An oral LD_{50} for rats of 2.08 g/kg has been reported for this chemical (Verschueren, 1983).

Nickel

Nickel is commonly found in most surface-water bodies and may exist in as many as 6 different valence states (EPA, 1986). However, under most natural conditions, the divalent form of this metal predominates. Like many other heavy metals, the bioavailability and toxicity of this metal to aquatic species is a function of water quality characteristics, including alkalinity, hardness, pH, salinity and humic acid concentrations (EPA, 1986). The toxic effects of nickel, like many other heavy metals, frequently take place at the level of the gills. Results of tests conducted to date indicate that this metal does not bioconcentrate to any appreciable extent nor does it biomagnify in foodchains (EPA, 1986).

Nickel is readily and rapidly uptaken from soils, and until certain nickel concentrations in plant tissues are reached, the absorption is positively correlated with soil nickel concentrations. Both plant and pedological factors affect the nickel uptake by plants, but the most pronounced factor is the influence of the soil pH. Soil concentrations that may result in toxic impacts range from 20 to 100 mg/kg (Kabata-Pendias and Pendias, 1992). Rats given a subchronic gavage study with nickel chloride in water experienced lethargy, ataxia, irregular breathing, reduced body temperature, and discolored extremities (EPA, 1994b). Inhalation of nickel subsulfide in rats increased the incidence of lung tumors (ATSDR, 1991). The CNS appears to be the target organ for nickel oral toxicity, while the lung is the target organ for inhalation exposure.

PAHs

Polycyclic aromatic hydrocarbons (PAHs) are base/neutral organic compounds that have a fused ring structure of two or more benzene rings. Those PAHs with two to five rings are generally of greatest concern for environmental health (EPA, 1993c). PAHs are ubiquitous in nature and usually occur as complex mixtures with other toxic chemicals. They are components of crude and refined petroleum products and of coal. They are also produced by the incomplete combustion of organic materials.

Major sources of PAHs found in marine and freshwaters include biosynthesis (restricted to anoxic sediments), spillage and seepage of fossil fuels, discharge of domestic and industrial wastes, atmospheric deposition, and runoff (Neff, 1985).

PAHs can accumulate in aquatic organisms from water, sediments, and food. Bioconcentration factors of PAHs in fish and crustaceans have frequently been reported to be in the range of 100 to 2,000 (USFWS, 1987b). In general, bioconcentration was greater for the higher molecular weight PAHs than for lower molecular weight PAHs. Biotransformation by mixed function oxidase in the fish liver can result in the formation of carcinogenic and mutagenic intermediates, and exposure to PAHs has been linked to the development of tumors to fish (USFWS, 1987b).

Sediment-associated PAHs can be accumulated by bottom-dwelling invertebrates and fish (USFWS, 1987b). For example, Great Lakes sediments containing elevated levels of PAHs were reported by Eadie et al. (1983) to be the source of the body burdens of the compounds in bottom-dwelling invertebrates. Varanasi et al. (1985) found that benzo[a]pyrene was accumulated in fish, amphipods, crustaceans, shrimp, and clams when estuarine sediment was the source of the compound. Approximate tissue-to-sediment ratios were 0.6 to 1.2 for amphipods, 0.1 for clams, and 0.05 for fish and shrimp. Varanasi et al. (1985) ranked benzo[a]pyrene metabolism by aquatic organisms as follows: fish > shrimp > amphipods > clams. Because of their limited ability to metabolize some PAHs, clams tend to readily bioaccumulate these compounds. For most other organisms, PAHs show little tendency to bioconcentrate, despite their high lipid solubility (Pucknat, 1981), probably because most PAHs are rapidly metabolized. Animals and microorganisms can metabolize PAHs to products that may ultimately experience complete degradation (USFWS, 1987b).

Physical and chemical characteristics of polycyclic aromatics generally vary with molecular weight. Of major environmental concern are mobile PAHs that range in molecular weight from 128.16 to 300.36. Higher molecular weight PAHs are relatively immobile because of their large molecular volumes and their extremely low volatility and solubility. The lower molecular weight, unsubstituted PAH compounds, containing 2 to 3 rings, can be acutely toxic to some organisms, whereas the higher molecular weight (4 to 7 ring) aromatics generally are not (USFWS, 1987b).

PAHs may be adsorbed or assimilated by plant leaves before entering the animal food chain, although some adsorbed PAHs may be washed off by rain, chemically oxidized to other products, or returned to the soil as plants decay (USFWS, 1987b). PAHs assimilated by vegetation may be translocated, metabolized, and possibly photodegraded within the plant. In some plants growing within highly contaminated areas, assimilation may exceed metabolism and degradation, resulting in an accumulation in the plant tissues (Edwards, 1983).

Plant uptake rates are governed, in part, by PAH concentration, PAH water solubility, soil type, and PAH physico-chemical state (vapor or particulate). Lower molecular weight PAHs are absorbed more readily than are higher molecular weight PAHs. Phytotoxic effects are rare; however, the database on this subject is small (USFWS, 1987b).

The degradation of most PAHs is not completely understood. Those in soils may be assimilated by plants, degraded by soil organisms, or accumulated to relatively high levels in soil. Wang and Bartha (1990) studied the persistence and toxicity of three types of fuels (jet fuel, heating oil, and diesel fuel) in soils. The results of their study indicated that of the three fuels tested, jet fuel exhibited the least amount of environmental persistence and toxicity to soil microbes and seedlings. Soil concentrations of jet fuel hydrocarbons decreased from 75 mg/g to approximately 5 mg/g in twenty weeks with no treatment. The concentration of easily metabolized aliphatics (C_{12} to C_{22}) in each fuel was correlated with its degradation rate. Of the three fuels tested, jet fuel was comprised of the greatest portion of aliphatics (Wang and Bartha, 1990).

Because of their complex chemical composition, the toxicity of PAHs is variable and not well understood (NAS, 1985). In addition, research has demonstrated that different organisms and different life stages for a given species can vary widely in sensitivity to PAHs (USFWS, 1987b; NAS, 1985; Neff and Anderson, 1981). However, it is generally agreed that in aquatic ecosystems, the toxicity of PAHs is correlated with water solubility (Neff and Anderson, 1981) and molecular weight, with high molecular weight PAHs exhibiting low acute toxicity (due to low water solubility) (USFWS, 1987b). In all but a few cases, PAH concentrations that are acutely toxic to aquatic organisms are several orders of magnitude higher than concentrations found in even the most heavily polluted waters. Sediment from polluted areas, however, may contain PAHs in concentrations approaching those similar to those which are acutely toxic, but their limited bioavailability would probably render them substantially less toxic than PAHs in solution (USFWS, 1987b).

Patton and Drieter (1980) fed mallards a diet that contained 4,000 mg/kg (primarily naphthalenes, naphthenes, and phenanthrene) for 7 months. No mortality or visible signs of toxicity were noted, but both liver weight and hepatic blood flow were significantly greater than that of the controls. However, the authors concluded that these modifications in the liver did not represent an adverse effect and that adult mallards could tolerate long-term exposures to relatively high concentrations of PAHs. Mammalian toxicity data are limited for PAHs, but the ability of some PAHs to induce tumor formation is well documented (USFWS, 1987b). Bioaccumulated PAHs with a four-ring structure or less are rapidly metabolized. Therefore, long-term partitioning into biota is not considered a significant fate process (USFWS, 1987b; EPA, 1993a).

PCBs

Polychlorinated biphenyls (PCBs) are a mixture of chlorinated biphenyl chemicals that occur individually as 209 congeners, comprised of various chlorine substitution patterns. PCBs are closely related to many chlorinated hydrocarbon pesticides (e.g, DDT, dieldrin, and aldrin) in their chemical, physical, and toxicological properties and in their widespread occurrence in the aquatic environment (Nimmo, 1985). Mixtures of PCBs were marketed under the trade name Aroclor, with a numeric designation that indicated their chlorine content. Although production and use were banned in 1979, the chemical group is extremely persistent in the environment and bioaccumulates through the foodchain. There is evidence that the most potent, dioxin-like PCB congeners are preferentially accumulated in higher organisms. Additional research indicates that there is evidence that PCB risks increase with increased chlorination because more highly chlorinated PCBs are retained more efficiently in fatty tissues (EPA, 1994a). The non-ortho-substituted coplanar PCB congeners and some of the mono-ortho-substituted congeners have been shown to exhibit dioxin-like effects. There is increasing evidence that many of the toxic effects of PCBs result from alterations in hormonal function. Consequently, the aggregate toxicity of a PCB mixture may increase as it moves up the foodchain (EPA, 1993b).

The three effects of PCB exposure on terrestrial wildlife are mortality, decreased reproductive success, and behavioral modifications (EPA, 1993b). Mink (*Mustela vison*) appear to be among the most sensitive species to the toxic effects of PCBs (Gillette et al., 1987). Single oral doses of PCBs administered to mink have produced LD_{50} values of 750 mg/kg for Aroclor-1221 and 4,000 mg/kg for Aroclor-1254 (Aulerich and Ringer, 1977; Ringer, 1983). The primary chronic effect documented as a result of dietary exposure to PCBs has been decreased reproductive success, as evidenced by reduced whelping rates, fetal death, and reduced growth among the young. Based on a review of available data, EPA determined that 30 µg/kg/d represented an no observable effect level (NOEL) value for reproductive effects of Aroclor-1254 (EPA, 1993b).

Birds have been shown to be more resistant than mammalian species to the acute effects of PCBs. PCB doses greater than 200 ppm in the diet (10 mg/kg body weight) caused some mortality among northern bobwhite (*Colinus virginians*), mallards (*Anas plythynchos*), and ring-necked pheasants (*Phasianus* *colchicus*). PCBs provided to these birds at dietary concentrations of 1,500 ppm (100 mg/kg body weight) caused extensive mortality (USFWS, 1986a). Exposure to PCBs resulted in some mortality among all the avian species tested, with lethal concentrations depending on the length of exposure and the particular PCB mixture (Aulerich et al., 1977). For all avian species, PCB residue concentrations of at least 310 g/kg fresh weight in the brain were associated with an increased likelihood of death from PCB poisoning (USFWS, 1986a). An evaluation of the results of various toxicity studies performed on a number of bird species led EPA (1993b) to conclude that 0.18 mg/kg/body weight represented an appropriate NOEL for avian wildlife.

Phthalates (bis(2-ethylhexyl)phthalate)

Phthalates, or phthalate esters such as bis(2-ethylhexyl)phthalate, represent a large family of chemicals widely used as plasticizers. For the most part, these colorless liquids have low volatility and are poorly water soluble (EPA, 1980g; Verschueren 1983). Available data indicate that the toxicity of phthalate varies widely. However, acute toxicity values reported by EPA (1980g) all exceed 1,000 μg/L while chronic values as low as 3 μg/L had been determined for di(2-ethylhexyl)phthalate. Reported bioconcentration values ranged from 14 to 2,680 (EPA, 1980g).

Selenium

Selenium is the most strongly enriched element in coal, being present as an organoselenium compound, a chelated species, or an adsorbed element. On combustion of coal, the sulfur dioxide formed reduces the selenium to elemental selenium (USFWS, 1986b). Selenium is an element that is required in trace amounts by some organisms. While considered to be an essential element for plants and animals, selenium is toxic at higher concentrations (Masscheleyn and Patrick, 1993).

Selenium biogeochemistry is complex and governed by many factors. The solubility of minerals containing selenium, the complexing ability of solid and soluble ligands, microbiologically mediated oxidation-reduction reactions, methylation, and volatilization are all potential processes controlling selenium concentration, mobility, and toxicity in both the aquatic and sedimentary environment (Masscheleyn and Patrick, 1993). The quantification of selenium species present at the sediment-water interface and the extent of species transformations are critical to understanding selenium biogeochemical behavior and its biotic and abiotic reactivity. According to Masscheleyn and Patrick (1993), redox potential and pH are the most important parameters determining chemical speciation and stability of selenium in aquatic systems. Its chemistry resembles that of sulfur. Selenium, like sulfur, can exist in four different oxidation states: selenide (Se II), elemental selenium (Se0), selenite (Se IV), and selenate (Se VI).

It has been suggested that selenite is more toxic than selenate, particularly to early life stages, and that these effects are most pronounced at elevated temperatures. Also, selenium salts may be converted to methylated forms by microorganisms, and these forms are readily accumulated by freshwater vertebrates (EPA, 1987a). Selenium is readily taken up and transferred in the aquatic food chain. The high availability and intrinsic toxicity of selenium oxyanions to aquatic organisms, plants, and wildlife make selenium a harmful trace element. At high concentrations, detoxification by means of the formation of volatile metallothien and subsequent excretion become increasingly important (Masscheleyn and Patrick, 1993).

Selenium metabolism and degradation is significantly modified by interaction with heavy metals, agricultural chemicals, microorganisms, and a variety of physico-chemical factors. Results of laboratory studies and field investigations with fish, mammals, and birds have led to the general agreement that elevated concentrations of selenium in diet or water are associated with reproductive abnormalities, including congenital malformations, selective bioaccumulation by the organisms, and growth retardation. These signs have been observed in birds fed diets containing selenium at concentrations as low as 5 ppm (USFWS, 1986b).

Accumulation of selenium by aquatic organisms is highly variable. In short-term tests, exposures to concentrations ranging from 0.015 to 3.3 μg/L, resulted in biological concentration factors of 460 for the mosquitofish (*Gambusia* sp.) to 32,000 for a freshwater gastropod (Nassos et al., 1980). Selenium accumulation is modified by water temperature, age of the organism, organ or tissue specificity, mode of administration, and other factors (EPA, 1987a).

In a lake in North Carolina receiving selenium (as flyash waste from a coal-fired power station), reproduction of green sunfish (*Lepomis cyanellus*) failed, and the population declined markedly. In these fish, selenium levels were elevated in liver and other tissues; kidney, heart, liver, and gills exhibited altered histopathology and blood chemistry. It is probable that selenium uptake by plankton [containing 41 to 97 ppm dry weight] from the lake water [9-12 parts per billion (ppb)] introduced selenium into the foodchain where it ultimately reached levels in fish through biomagnification (Cumbie and van Horn, 1978).

Silver

Numerous studies have indicated that free soluble silver is among the most toxic metals to freshwater organisms. In most natural waters, the monovalent form of silver is of greatest concern. Silver may exist as a simple hydrated monovalent ion, or it may exist in various degrees of association with inorganic ions such as sulfate, bicarbonate, or nitrate (EPA, 1980h). Silver is more toxic in soft water than in hard water (EPA, 1980h). The sorption of silver by manganese dioxide, various ferric compounds, and clay minerals, and its subsequent partitioning by the sediment layer is strongly pH-dependent (Dyck 1968). Olcott (1950) administered 0.1 percent silver nitrate to rats in drinking water for 218 days. Upon necropsy, advanced pigmentation and ventricular hypertrophy were observed, although the hypertrophy was not attributed to silver toxicity.

Silver exhibits a limited ability to bioconcentrate. Bioconcentration factors for freshwater species reported by EPA (1980h) ranged from <1 for bluegill sunfish (*Lepomis macrochirus*) to 240 for a mayfly (*Ephemeralla grandis)* with a geometric mean bioconcentration factor of 57. Based on studies of rats, chickens, and turkeys, the maximum tolerable level for silver in animal food is 100 mg/kg (NRC, 1980).

Styrene

Styrene, also known as vinylbenzene, cinnamene, phenylethylene, etheylbenzene, is a common compound used in the chemical industry. It is used in the manufacture of polystyrene, synthetic rubber, plastics, resins, insulators, and protective coatings.

A LD_{50} of 1,000 mg/kg has been observed in rats (Vershueren, 1983). In addition, a 24-hour LD_{50} of 26 mg/L has been observed for goldfish (Vershueren, 1983). Median lethal doses for 24-hour tests of 56.7, 25.1, 64.7, and 74.8 mg/L have been noted for fathead minnows, bluegills, goldfish, and guppies, respectively.

2,4,5-trichlorophenoxyacetic acid

The compound 2,4,5-T was used for the control of woody plants (Montgomery, 1993). It degrades in the environment into 2,4,5-trichlorophenol and 2,4,5-trichloroanisole. Half-lives (biodegradation) of 20 days in rivers and lakes have been reported (EPA, 1996). A log octanol water partition coefficient of 3.3 has been reported (EPA, 1996).

LC_{50}s of 350 and 355 mg/kg have been reported for the rainbow trout and carp, respectively. Additional LC_{50} values of 0.98, 14.6, 16.4, 41.1, and 28.1 have been reported for rainbow trout, striped bass, white perch, carp, and the guppy, respectively (Verschueren, 1983). Oral acute LD_{50} for rats range from 300 to 500 mg/kg (Montgomery, 1993). A bioconcentration factor for mosquitofish of 26.0 has been reported for this compound (Verschueren, 1983).

Tin

Inorganic tin compounds are used in a variety of industrial processes, such as the strengthening of glass, as a base for colors, as catalysts in chemical reactions, as stabilizers in perfumes and soaps, and as dental anticariogenic agents. Organotin compounds are used in antifouling marine paints, in molluscicides, and in pesticides. In addition, the uses of tin compounds are increasing.

Inorganic tin compounds are of low toxicological value due to their low solubility, poor absorption, low accumulation in tissue, and rapid excretion (USFWS, 1989). However, some organotin compounds, such as trialkyltins, are highly toxic. Bioconcentration of organotins is high, but excretion is sufficient to preclude biomagnification. Bioconcentration factors up to 1,900 in marine algae have been measured (Maguire et al., 1984). Benthic fauna are capable of transferring organotins from sediments to bottom-feeding teleosts.

The toxicity of organotins is diverse and complex due to the many different types of organotin compounds. Adverse effects on molluscs have been noted at water concentrations of 0.001 to 0.06 µg/L (USFWS, 1989). Diets containing 50 mg of tin as trimethyltin chloride/kg are fatal to all mallard ducklings within 75 days (Eisler, 1989). Toxicities of different organotin compounds also vary in mammalian species. Trimethyltin, triethyltin, and tributyltin compounds are highly toxic to animals and man. Mammals poisoned by organotin compounds exhibit muscular weakness, tremors, hyperexcitability, and paralysis (USFWS, 1989).

2,4,5-TP (silvex)

The chemical 2,4,5-TP, commonly known as silvex, was historically used as an herbicide. A log K_{ow} of 3.8 has been reported (EPA, 1996). Similar to 2,4-D and 2,4,5-T, silvex contained small amounts of TCDD.

Numerous studies have documented the ability of TCDD and/or silvex contaminated with TCDD to produce fetotoxic, teratogenic, and carcinogenic effects in test animals (Sittig, 1985). A 48-hour LC_{50} of 83,000 µg/L has been reported for the bluegill (Verschueren, 1983). An oral LD_{50} of 650 mg/kg has been reported for the rat (Verschueren, 1983).

Trichloroethane

1,1,1-trichloroethane, also known as methylchloroform, is a colorless liquid with a sweetish odor. The 96-hour LC_{50} for the fathead minnow was 105 mg/L (static bioassay) and 52.8 mg/L (flowthrough bioassay). The single oral LC_{50} for rats ranged from 10.3 to 12.3 g/kg; 5.66 g/kg for the female rabbit; and 9.47 g/kg for the male guinea pig. Humans exposed to 500 ppm 1,1,1-trichloroethane for 180 minutes complained of eye irritation and headache (Verschueren, 1983).

Trichloroethene (TCE)

A lack of data exists for TCE toxicity. Prolonged inhalation exposure of animals effected the liver and kidneys. The main target organs are the central nervous system, heart, liver, and kidney. Exposure to TCE has been shown to cause increased incidence of liver tumors (gavage) and lymphomas (inhalation) in mice, and increased renal tumors in rats (gavage; EPA, 1988b).

Vanadium

Vanadium is an ubiquitous element, frequently associated with petroleum refining and products. It is also used in the hardening of steel, production of pigments, and the manufacture of insecticides. It is common in many foods, particularly milk, cereals, and vegetables. While the majority of vanadium encountered in mammals is stored in fatty tissue, bone and teeth contribute to the body burden (Amdur et al., 1991). It has been postulated that homeostatic processes exist for this element in that normal tissue levels can be maintained in the face of excessive uptake. The toxic action of vanadium in mammals is largely confined to the respiratory tract. Acute vanadium poisoning via ingestion is characterized by effects on the nervous system, hemorrhage, and respiratory distress (Amdur et al., 1991). No reports exist regarding vanadium phytoxicity under field conditions. However, experimental greenhouse studies have indicated that concentrations of 140 mg/kg in the soil and 0.5 mg/kg in the nutrient solution may be toxic to plants (Kabata-Pendias and Pendias, 1992).

Vinyl Acetate

Toxicity data and information pertaining to vinyl acetate are scarce. TL_m values for the fathead minnow, bluegill, goldfish, and guppy of 19 to 39, 18, 42.3, and 31.1 have been reported, respectively

(Verschueren, 1983). LD_{50}s of 4,000 mg/kg and 2.9 g/kg for the rat have been reported (Verschueren, 1983).

Vinyl Chloride

Vinyl chloride is an industrial chemical which is widely and extensively produced due to its wide variety of uses and the low cost of producing polymers from it. Major end-use products include polyvinyl chloride (PVC) products, such as pipes, automotive parts, and wire coverings, as well as vinyl chloride-vinyl acetate copolymer products such as films and resins (ATSDR, 1995). It was also used in the past as a refrigerant, extraction solvent, and in the production of methyl chloroform.

Acute exposures to high levels of vinyl chloride ranging from 100,000 to 400,000 ppm have been shown to be fatal in rats, guinea pigs, and mice (ATSDR, 1995). Decreased longevity has been observed in intermediate and chronic studies. Substantial increases in mortality have been observed in mice and rats exposed to 250 vinyl chloride for 12 months (Lee et al., 1978). Common adverse effects associated with vinyl chloride exposure include cardiovascular, hematological, neurological, reproductive, genotoxic, musculoskeletal, hepatic, renal, and immunological effects.

In animals, vinyl chloride has been found to be almost completely absorbed from the gastrointestinal tract after oral exposure. Vinyl chloride metabolites have not been found to accumulate in tissues. Metabolism generally occurs via the oxidation of vinyl chloride by the mixed-function oxidase system. Vinyl chloride toxicosis exhibits many of the same signs as autoimmune diseases, and vinyl chloride is known to be carcinogenic to both humans and animals (ATSDR, 1995). Metabolic intermediaries are known to interact with specific locii on the chromosome (ATSDR, 1995). Hepatotoxicity is also common.

Xylene

Xylene is used in petroleum distillation and coal tar distillation; it is used extensively in the organic chemical industry. The chemical is relatively volatile, with a characteristic sweet odor. Xylene is found in the environment in ortho, meta, and para forms.

Bacteria are known to aggressively metabolize xylene. The 96-hour LC_{50} for shrimp (*Crangon francisorum*) was 1.3 ppm (Verschueren, 1983). A 96-hour LC_{50} of 13.5 mg/l was observed for rainbow trout (Verschueren, 1983). A bioconcentration factor of 23.6 was observed in the eel (*Anguilla japonica*). Humans have been observed to exhibit symptoms of illness after inhalation of xylene at 1,000 ppm (Verschueren, 1983).

Zinc

Zinc is the fourth most widely used metal in the world. Its major uses are for galvanizing steel and producing alloys and as an ingredient in paints and rubber. Zinc occurs in many forms in natural waters and sediment. At pH 6.0, the dominant forms of dissolved zinc are the free ion (98 percent) and zinc sulfate, whereas at pH 9.0, the dominant forms are the mono-hydroxide ion (78 percent), zinc carbonate (16 percent), and the free ion (6 percent). Like many other cationic metals, the concentration of dissolved zinc is a function of both water hardness and pH (EPA, 1987b).

This ubiquitous trace metal is essential for normal cell differentiation and growth in both plants and animals (Rand and Petrocelli, 1985). Although zinc is an essential micronutrient for all living organisms, acute values for freshwater invertebrates range from 32 to 40,930 μg/L, and those for fish range from 66 to 40,900 μg/L. Chronic values for invertebrates have been reported at concentrations as low as 46.7 μg/L, while exposure of fish to 36.4 μg/L has resulted in chronic toxicity. Acute and chronic toxicity of this metal is a function of water hardness (EPA, 1987a). Zinc toxicity in terrestrial animals is not well established. Experimental animals have been given zinc at 100 times the dietary requirements without perceived effects (Goyer et al., 1979).

The important factors controlling the mobility of zinc in soils are very similar to those listed for copper, but zinc appears to occur in more readily soluble forms. Zinc is considered to be readily soluble relative to other heavy metals in soils. Soluble forms of zinc are readily available to plants, and the uptake of zinc has been reported to be linear with concentration in the nutrient solution and in soils. The rate of zinc absorption differs greatly among both plant species and growth media. Roots often contain much more zinc than do tops, particularly if the plants are grown in zinc-rich soils (Kabata-Pendias and Pendias, 1992).

REFERENCES

Amdur, M. O., J. Doull and C. D. Klassen eds., 1991. Casarett and Doull's Toxicology: The Basic Science of Poisons. 3rd ed. Macmillan Press. New York, New York.

Anderson et al., 1975. Brown Pelicans: Improved Reproduction Off the Southern California Coast. Science. 190:806.

ATSDR, 1991. Draft Toxicological Profile for Nickel. U.S. Public Health Service, Atlanta, Georgia.

ATSDR, 1993. Toxicological Profile for Chromium. Public Health Service, U.S. Department of Health and Human Services, Atlanta, Georgia.

ATSDR, 1995. Toxicological Profile for Vinyl Chloride. Public Health Service, U.S. Department of Health and Human Services, Atlanta, Georgia.

Aulerich, R. J., and R. K. Ringer, 1977. Current status of PCB toxicity to mink, and effect on their reproduction. Arch. Environ. Cont. Toxicol. 6:279-292.

Benes, P. and B. Havelik, 1979. Speciation of mercury in natural waters. In: J. O. Nriagu (ed.) The Biogeochemistry of Mercury in the Environment. Elsevier/North-Holland Biomedical Press, New York, New York.

Beyer, W. N., O. H. Pattee, L. Sileo, D. J. Hoffman and B. M. Mulhern, 1985. Metal contamination in wildlife living near two zinc smelters. Environ. Poll. 38A:63-86.

Bloom, N. S. and C. J. Watras, 1989. Observations of methyl mercury in precipitation. Sci. of the Total Environ. 87/88:199-207.

Boudou, A. and F. Ribeyre, 1983. Contamination of aquatic biocenoses by mercury compounds: an experimental toxicological approach. In J. O. Nriagu (ed.) Aquatic Toxicology. John Wiley, New York, New York.

Chaundry, F. M., A. Wallace and R. T. Mueller, 1977. Barium toxicity in plants. Comm. Soil Sci. and Plant Analysis 15:795-802.

Cleveland, L., D. R. Buckler and W. G. Brumbaugh, 1991. Residue dynamics and effects of aluminum on growth and mortality in brook trout. Bull. of Environ. Contam. Toxicol. 10:243-248.

Cumbie, P. M. and S. L. van Horne, 1978. "Selenium accumulations associated with fish mortality and reproductive failure." Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies. 32:612-624.

Deo, P. G., S. P. Hasan, and S. K. Majumder, 1982. Interconversion of hexachlorocyclohexane isomers. J. Food Science and Technology 19:221-227. In Newell, A. J., D. W. Johnson, and L. K. Allen, 1987. Niagara River biota contamination project: fish flesh criteria for piscivorous wildlife. New York State Department of Environmental Conservation. Technical report 87-3. 181 pp.

Manahan, S. E., 1992. Toxicological Chemistry. Lewis Publishers, Boca Raton, Florida. pp. 449.

Diaz-Mayans, J., R. Laborda, and A. Nunez, 1986. Hexavalent chromium effects on motor activity and some metabolic aspects of Wistar albino rats. Comp. Biochem. Physiol. 83C:191-195.

Dyck, W., 1968. Adsorption and coprecipitation of silver on hydrous ferric oxides. Canadian J. Chem. 46:1441.

Eadie, B. J., W. R. Faust, P. F. Landrum, N. R. Morehead, W. S. Gardner, and T. Nalepa, 1983. "Bioconcentrations of PAH by some benthic organisms of the Great Lakes." In M. Cook and A. J. Dennis. eds. Polynuclear Aromatic Hydrocarbons: Formation, Metabolism and Measurement. Battelle Press. Columbus, Ohio.

Edwards, N. T., 1983. "Polycyclic Aromatic Hydrocarbons (PAHs) in the terrestrial environment: A review." J. Environ. Qual. 12:427-441.

EPA (U.S. Environmental Protection Agency), 1980a. Ambient Water Quality Criteria for Aldrin/Dieldrin. EPA 440/5-80-019. Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980b. Ambient Water Quality Criteria for Beryllium. EPA 440/5-80-024, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980c. Ambient Water Quality Criteria for Carbon Tetrachloride. EPA 440/5-80-026. Office of Water Regulations, Criteria Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980d. Ambient Water Quality Criteria for Chlordane. EPA 440/5-80-027. Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980e. Ambient Water Quality Criteria for DDT. EPA 440/5-80-038. Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980f. Ambient Water Quality Criteria for Dichlorobenzenes. EPA 440/5-80-039. Office of Water Regulations, Criteria Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980g. Ambient Water Quality Criteria for Phalate Esters. EPA 440/5-80-087, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980h. Ambient Water Quality Criteria for Silver. EPA 440/5-80-071, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1984a. Ambient Water Quality Criteria for Arsenic-1984. EPA 440/5-84-033. Office of Water Regulations, Criteria and Standards Division. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1984b. Ambient Water Quality Criteria for Copper. EPA 440/5-84-031. Office of Water Regulations, Criteria and Standards Division. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1984c. Ambient Water Quality Criteria for Hydrogen Cyanide. EPA 440/5-84-028. Office of Water Regulations, Criteria and Standards Division. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985a. Ambient Water Quality Criteria for Cadmium - 1984. EPA 440/5-84-032, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985b. Ambient Water Quality Criteria for Lead - 1984," EPA 440/5-84-027, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1985c. Ambient Water Quality Criteria for Mercury - 1984," EPA 440/5-84-026, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1986. Quality Criteria for Water 1986. EPA 440/5-86-001, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1987a. Ambient Water Quality Criteria for Selenium - 1987. EPA 440/5-87-006. Office of Water Regulations, Criteria and Standards Division. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1987b. Quality Criteria for Zinc-. EPA 440/5-87-003, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1988a. Ambient Water Quality Criteria for Aluminum. EPA 440/5-88-008, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1988b. Ambient Water Quality Criteria for Trichlorethane. EPA 440/5-80-077. Office of Water Regulations, Criteria Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1993a. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume I: Fish Sampling and Analysis. EPA/823/B-93-002. Office of Science and Technology, Office of Water, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1993b. Interim Report on Data and Methods for Assessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Risks to Aquatic Life and Associated Wildlife. EPA-600-R-93-055. Office of Research and Development, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1993c. Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons. EPA 440/5-80-069. Office of Water Regulations, Criteria Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1994a. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume II: Risk Assessment and Fish Consumption Limits. EPA/823/B-94-004. Office of Science and Technology, Office of Water, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1994b. Integrated Risk Information (IRIS) online database. Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1996. Superfund Chemical Data Matrix. On-line database. Washington, D.C.

Gillette, D. M., R. D. Corey, W. G. Helferich, J. M., J. L. Lowenstine, D. E. Moody, B. D. Hammock, and L. R. Shull, 1987. Comparative toxicology of in mink and rats, I. Changes in hepatic enzyme activity and smooth endoplasmic reticulum volume. Fund. Appl. Toxicol. 8:5-14.

Gohlke, R., P. Schmidt, and H. Bahmann, 1977. 1,1,2,2-Tetrachloroethane and heat stress in animal experiment - morphological results. Z. Gesamte Hyg. IHRE Grenzgeb 20:278-282.

Goldsworthy, T. L, and J. A. Popp. Chlorinated hydrocarbon-induced peroxisomal enzyme activity in relation to species and organ carcinogenicity. Toxicol. Appl. Pharmacol. 88: 225-233.

Goyer, R. A ., J. Apgar, and M. Piscator, 1979. Toxicity of Zinc. In: Henkikn, R. I. and Committee (eds): Zinc. University Park Press, Baltimore, pp. 249-268. Cited in Amdur, M. O., J. Doull. and C. D. Klassen. (eds.), 1991. Casarett and Doull's Toxicology: The Basic Science of Poisons. 3rd ed. Macmillan Press. New York, New York.

Hackett, C., 1962. Stimulative Effects of Aluminum in Plant Growth. Nature 195:471-472.

Hayes, W. J., 1982. Pesticides Studied in Man. Williams and Wilkins. Baltimore, Maryland.

Hem, J. D., 1970. Study and Interpretation of the Chemical Characteristics of Natural Water. Geological Water - Supply Paper 1473, U. S. Government Printing Office, Washington, D.C.

Hoffman, P. and M. Klapperstuck, 1990. Effects of carbon disulfide on cardiovascular function after acute and subacute exposure to rats. Biomed. Biochim. Acta 49:115-120.

Howard, P. H., 1993. *Handbook of Environmental Fate and Exposure Data for Organic Chemicals: Volume IV, Solvents*. Lewis Publishers, Boca Raton, Florida.

Hudson, R. H., R. K. Tucker, and M. A. Haegele, 1984. Handbook of Toxicity of Pesticides to Wildlife. U.S. Fish and Wildlife Service. Resource Publication 153. Washington, DC.

Kabata-Pendias, A. and H. Pendias, 1992. Trace Elements in Soils and Plants, 2nd Edition, CRC Press, Inc. Boca Raton, Florida.

Korthals, E. T. and M. R. Winfrey, 1987. Seasonal and spatial variations in mercury methylation and demethylation in an oligotrophic lake. Appl. Environ. Microbiol. 53: 2397-2404.

Lee, C. C, J. C. Bhandari, and J. M. Winston, 1978. Carcinogenicity of vinyl chloride and vinylidene chloride. J. Toxicol. Environ. Health 4:15-30.

Lee, Y. H. and H. Hultberg, 1990. Methyl mercury in some Swedish surface waters. Environ. Toxicol. Chem. 9:833-841.

Maguire, R. J., P. T. S. Wong, and J. S. Rhamey, 1984. Accumulation and metabolism of tri-n butyltin cation by a green alsa, *Ankistrodesmus falcatus*. Can. J. Fish. Aquat. Sci. 41:537-540.

Manahan, 1972.

Masscheleyn, P. H. and W. H. Patrick, Jr., 1993. Biogeochemical processes affecting selenium cycling in wetlands. Environ. Toxicol. and Chem. 12:2235-2243.

Mckee J. R. and H. W. Wolfe, 1963. Water Quality Criteria - 3A, 2nd. Ed., California State Water Resources Control Board, Sacramento, California.

Montgomery, J. H., 1993. *Agrochemicals Desk Reference: Environmental Data*. Lewis Publishers. Boca Raton, Florida.

Murphy, S. D., 1986. Toxic Effects of Pesticides. In Klassen, C. D., M. O. Amdur, and J. Doull, 1986. Casarett and Doull's Toxicology - The Basic Science of Poisons. Macmillan Publishing Company, New York. pp 974.

NAS (National Academy of Science), 1977. Arsenic, Washington, DC.

NAS (National Academy of Science), 1985. Oil in the Sea: Inputs, Fates, and Effects. National Academy Press, Washington, DC.

Nassos, P. A., J. R. Coats, R. L. Metcalf, D. D. Brown, and L. G. Hansen, 1980. "Model ecosystem, toxicity, and uptake evaluation of 75Se-selenite." Bull. Environ. Contam. Toxicol. 24:752-758.

Neff, J. M. and J. W. Anderson, 1981. Response of Marine Animals to Petroleum and Specific Petroleum Hydrocarbons, John Wiley and Sons, New York, New York.

Neff, J. M., 1985. "Polycyclic Aromatic Hydrocarbons." In G. M. Rand and S. R. Petrocelli. eds. Fundamentals of Aquatic Toxicology. Hemisphere Publishing Corp., New York, New York.

Newell, A. J., D. W. Johnson, and L. K. Allen, 1987. Niagara River biota contamination project: fish flesh criteria for piscivorous wildlife. New York State Department of Environmental Conservation. Technical report 87-3. 181 pp.

Nimmo, D. R., 1985. Pesticides. In G. M. Rand and S. R. Petrocelli (eds.). Fundamentals of Aquatic Toxicology. Hemisphere Publishing Corp., New York, New York.

NRC (National Research Council), 1980. Mineral Tolerance of Domestic Animals. National Academy Press, Washington, DC.

Olcott, 1950. As cited in IRIS (Integrated Risk Information System). 1994.

Patton, J. F. and M. P. Drieter, 1980. Effects of petroleum hydrocarbons on hepatic function in the duck. Comprehensive Biochem. Physiol. 65C:33-36.

Pucknat, A. W. (ed.), 1981. "Health impacts of polynuclear aromaic hydrocarbons." Health Review Number 5. Noyes Data Corp., Park Ridge, New Jersey. 271 pp.

Rand, G. M. and S. R. Petrocelli (eds.), 1985. Fundamentals of Aquatic Toxicology. Hemisphere Publishing Corp., New York, New York.

Ringer, R. K., 1983. Toxicity of PCBs in mink and ferrets. In F. M. D'Itri and M. A. Kamrin (eds.). PCBs: Human and Environmental Hazards. Butterworth Publ., Woburn, Massachusetts.

Rodgers, J. S., P. M. Huang, U. T. Hammer and W. K. Liaw, 1984. Dynamics of desorption of mercury adsorbed on poorly crystalline oxides of manganese, iron, aluminum, and silicon. Internationale Vereinigung für Theoretische und Angewandte Limnologie 22:283-288.

Rosomer, G. L., W. A. Dudley, L. J. Machlin, and L. Loveless, 1961. Toxicity of vanadium and chromium for the growing chick. Poultry Sci. 40:1171-1173.

Rudd, J. W. M. and M. A. Turner, 1983. The English-Wabigoon river system: II. suppression of mercury and selenium bioaccumulation by suspended and bottom sediments. Canadian J. of Fisheries and Aquatic Sci. 40:2218-2227.

Shacklette, H. T., J. A. Erdman and T. F. Harms, 1978. Trace Elements in Plant Foodstuffs. In Oehme, ed. Toxicity of Heavy Metals in the Environment, Part I, Marcel Decker, New York, New York.

Sittig, M., 1985. *Handbook of Toxic and Hazardous Chemicals and Carcinogens.* Second Edition. Noves Publications, Park Ridge, New Jersey.

Story, D. L., D. F. Meierhenry, C. A. Tyson, 1986. Differences in rat liver enzyme-altered foci produced by chlorinated aliphatics and phenobarbitol. Toxicol. Ind. Health 2:351-362.

Suter, G. W., 1993. Ecological Risk Assessment, Lewis Publishers, Boca Raton, Florida.

Tepper, L. B., 1972. Beryllium. In CRC Critical Reviews in Toxicology, Vol. 1, p. 235.

Thoresby, P., and Thornton, I., 1979. "Heavy metals and arsenic in soil, pasture herbage and barley in some mineralised areas in Britain." Trace Subst. Environ. Health. 13:93.

USFWS (U.S. Fish and Wildlife Service). 1985. Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 2, Patuxent Wildlife Research Center, Laurel, MD.

USFWS (U.S. Fish and Wildlife Service). 1986a. Polychlorinated Biphenyl Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 7. Patuxent Wildlife Research Center. Laurel, MD.

USFWS (U.S. Fish and Wildlife Service). 1986b. Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 5. Patuxent Wildlife Research Center. Laurel, MD.

USFWS (U.S. Fish and Wildlife Service). 1987a. Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 10, Patuxent Wildlife Research Center, Laurel, MD.

USFWS (U.S. Fish and Wildlife Service). 1987b. Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 11, Patuxent Wildlife Research Center, Laurel, MD.

USFWS (U.S. Fish and Wildlife Service). 1988a. Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 12. Patuxent Wildlife Research Center. Laurel, MD.

USFWS (U.S. Fish and Wildlife Service). 1988b. Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 14, Patuxent Wildlife Research Center, Laurel, MD.

USFWS (U.S. Fish and Wildlife Service). 1989. Tin Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 15, Patuxent Wildlife Research Center, Laurel, MD.

USFWS (U.S. Fish and Wildlife Service). 1990. Chlordane Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 21, Patuxent Wildlife Research Center, Laurel, MD.

Varanasi, U., W. L. Reichert, J. E. Stein, and D. W. Brown, and H. R. Sanborn. 1985. "Bioavailability and biotransformation of aromatic hydrocarbons in benthic organisms exposed to sediment from an urban estuary." Environ. Sci. Techol. 19:836-841.

Venugopal, B. and T. D. Luckey. 1978. Metal Toxicity in Mammals. Volume 2. Chemical Toxicity of Metals and Metalloids, Plenum Press, New York, New York.

Verschueren, K. 1983. Handbook of Environmental Data on Organic Chemicals, Van Nostrand Reinhold. New York, New York.

Wang, X. and R. Bartha. 1990. Effects of Bioremediation on Residues, Activity and Toxicity in Soil Contaminated by Fuel Spills. Soil Biol. Biochem. 22(4):501 - 505.

White, D. H., and M. T. Finely. 1978. Uptake and retention of dietary cadmium in mallard ducks. Environ. Res. 17:53-59.

Winfrey, M. R. and J. W. M. Rudd. 1990. Environmental factors affecting the formation of methylmercury in low pH lakes. Environ. Toxicol. and Chem. 9:853-869.

Zahid, Z. R., Z. S. Al-Hakkak, and A. H. H. Kadhim. 1990. Comparative effects of trivalent and hexavalent chromium on spermatogenesis of the mouse. Toxicol. Environ. Chem. 25:B1-136. In: Agency for Toxic Substances and Disease Registry.

APPENDIX B. PART 4 - EXAMPLE DOSE CALCULATION FOR REPRESENTATIVE RECEPTORS

ESTIMATED CONTAMINANT CONCENTRATIONS IN PREY

RISK ASSESSMENT SPREADSHEET - CONTAMINANT CONCENTRATION IN ANIMAL PRODUCTS

?REY ANIMALS - MAXIMUM SOIL CONCENTRATION

CALCULATE CONTAMINANT CONCENTRATIONS IN PREY:

CHEMICAL	MAXIMUM SOIL CONC. (MG/KG)	SOIL INTAKE (MG/DAY)	Kow	BIOTRANSFER FACTOR (DAY/KG)	TOTAL ANIMAL PRODUCT CONC. (MG/KG)
Aluminum	3.18E+03	3.82E+02		1.50E-03	5.72E-01
Antimony	3.60E+00	4.32E-01		1.00E-03	4.32E-04
Arsenic	1.40E+00	1.68E-01		2.00E-03	3.36E-04
Barium	1.19E+01	1.43E+00		1.50E-04	2.14E-04
Beryllium	1.50E-01	1.80E-02		1.00E-03	1.80E-05
Cadmium	5.90E+00	7.08E-01		5.50E-04	3.89E-04
Chromium	1.49E+01	1.79E+00		5.50E-03	9.83E-03
Cobalt	0.00E+00	0.00E+00		2.00E-02	0.00E+00
Copper	6.63E+01	7.96E+00		1.00E-02	7.96E-02
Cyanide	2.10E+01	2.52E+00	--	1.00E+00	2.52E+00
Lead	6.08E+01	7.30E+00		3.00E-04	2.19E-03
Manganese	1.89E+01	2.27E+00		4.00E-04	2.26E-02
Mercury	1.60E-01	1.92E-02		2.50E-01	4.80E-03
Nickel	2.70E+00	3.24E-01		6.00E-03	1.94E-03
Selenium	0.00E+00	0.00E+00		1.50E-02	0.00E+00
Silver	1.50E+00	1.80E-01		3.00E-03	5.40E-04
Tin	1.12E+01	1.34E+00		8.00E-02	1.08E-01
Vanadium	8.30E+00	9.96E-01		2.50E-03	2.49E-03
Zinc	6.63E+01	7.96E+00		1.00E-01	1.28E+00
4,4'-DDD	0.00E+00	0.00E+00	1.10E+06	2.76E-02	0.00E+00
,4'-DDE	2.95E-02	3.54E-03	5.80E+06	1.46E-01	5.16E-04
4,4'-DDT	3.64E-02	4.37E-03	6.30E+06	1.58E-01	6.91E-04
alpha BHC	0.00E+00	0.00E+00	6.46E+03	1.62E-04	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00	1.40E+07	3.52E-01	0.00E+00
Beta BHC	0.00E+00	0.00E+00	6.31E+03	1.59E-04	0.00E+00
2,4-D	0.00E+00	0.00E+00	6.46E+02	1.62E-05	0.00E+00
2,4,5-T	0.00E+00	0.00E+00	6.46E+02	1.62E-05	0.00E+00
2,4,5-TP (silvex)	0.00E+00	0.00E+00	6.46E+02	1.62E-05	0.00E+00
Endosulfan I	0.00E+00	0.00E+00	1.60E+04	4.02E-04	0.00E+00
Endosulfan II	0.00E+00	0.00E+00	3.30E+04	8.29E-04	0.00E+00
Endrin	0.00E+00	0.00E+00	1.60E+05	4.02E-03	0.00E+00
Heptachlor epoxide	0.00E+00	0.00E+00	8.90E+04	2.24E-03	0.00E+00
Heptachlor	0.00E+00	0.00E+00	2.00E+06	5.02E-02	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	9.55E+05	2.40E-02	0.00E+00
Bis(2-ethylhexyl)phthalate	2.20E-01	2.64E-02	2.50E+05	6.28E-03	1.66E-04
Flouranthene	0.00E+00	0.00E+00	2.14E+05	5.38E-03	0.00E+00
Pyrene	0.00E+00	0.00E+00	1.51E+05	3.79E-03	0.00E+00
1,1,2,2-tetrachloroethene	0.00E+00	0.00E+00	2.45E+02	6.15E-06	0.00E+00
4-methyl-2-pentanone	0.00E+00	0.00E+00	1.23E+01	3.09E-07	0.00E+00
2-butanone	0.00E+00	0.00E+00	1.82E+00	4.57E-08	0.00E+00
Acetone	7.00E-02	8.40E-03	5.80E-01	1.46E-08	1.22E-10
Carbon tetrachloride	3.00E-03	3.60E-04	2.45E+02	6.15E-06	2.22E-09
Cis-1,2-dichloroethene	1.90E-02	2.28E-03	3.02E+01	7.59E-07	1.73E-09
Ethylbenzene	0.00E+00	0.00E+00	1.41E+03	3.54E-05	0.00E+00
Methylene Chloride	6.90E-02	8.28E-03	1.78E+01	4.47E-07	3.70E-09
Toluene	0.00E+00	0.00E+00	4.90E+02	1.23E-05	0.00E+00
Xylene	0.00E+00	0.00E+00	5.89E+02	1.48E-05	0.00E+00

RISK ASSESSMENT SPREADSHEET - CONTAMINANT CONCENTRATION IN ANIMAL PRODUCTS

PREY ANIMALS - MINIMUM SOIL CONCENTRATION

CALCULATE CONTAMINANT CONCENTRATIONS IN PREY:

CHEMICAL	MEAN SOIL CONC. (MG/KG)	SOIL INTAKE (MG/DAY)	Kow	BIOTRANSFER FACTOR (DAY/KG)	TOTAL ANIMAL PRODUCT CONC. (MG/KG)
Aluminum	1.71E+03	2.05E+02		1.50E-03	3.08E-01
Antimony	1.49E+00	1.79E-01		1.00E-03	1.79E-04
Arsenic	4.60E-01	5.52E-02		2.00E-03	1.10E-04
Barium	8.38E+00	1.01E+00		1.50E-04	1.51E-04
Beryllium	7.00E-02	8.40E-03		1.00E-03	8.40E-06
Cadmium	1.58E+00	1.90E-01		5.50E-04	1.04E-04
Chromium	9.38E+00	1.13E+00		5.50E-03	6.19E-03
Cobalt	0.00E+00	0.00E+00		2.00E-02	0.00E+00
Copper	2.27E+01	2.73E+00		1.00E-02	2.73E-02
Cyanide	8.68E+00	1.04E+00		1.00E+00	1.04E+00
Lead	3.04E+01	3.65E+00		3.00E-04	1.09E-03
Manganese	1.34E+01	1.60E+00		4.00E-04	1.24E-02
Mercury	1.00E-01	1.20E-02		2.50E-01	3.00E-03
Nickel	1.37E+00	1.64E-01		6.00E-03	9.86E-04
Selenium	0.00E+00	0.00E+00		1.50E-02	0.00E+00
Silver	7.70E-01	9.24E-02		3.00E-03	2.77E-04
Tin	4.00E+00	4.80E-01		8.00E-02	3.84E-02
Vanadium	2.12E+00	2.54E-01		2.50E-03	6.36E-04
Zinc	3.78E+01	4.53E+00		1.00E-01	7.33E-01
4,4'-DDD	0.00E+00	0.00E+00	1.10E+06	2.76E-02	0.00E+00
4,4'-DDE	1.52E-02	1.82E-03	5.80E+06	1.46E-01	2.66E-04
4,4'-DDT	1.37E-02	1.64E-03	6.30E+06	1.58E-01	2.59E-04
alpha BHC	0.00E+00	0.00E+00	6.46E+03	1.62E-04	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00	1.40E+07	3.52E-01	0.00E+00
Beta BHC	0.00E+00	0.00E+00	6.31E+03	1.59E-04	0.00E+00
2,4-D	0.00E+00	0.00E+00	6.46E+02	1.62E-05	0.00E+00
2,4,5-T	0.00E+00	0.00E+00	6.46E+02	1.62E-05	0.00E+00
2,4,5-TP (silvex)	0.00E+00	0.00E+00	6.46E+02	1.62E-05	0.00E+00
Endosulfan I	0.00E+00	0.00E+00	1.60E+04	4.02E-04	0.00E+00
Endosulfan II	0.00E+00	0.00E+00	3.30E+04	8.29E-04	0.00E+00
Endrin	0.00E+00	0.00E+00	1.60E+05	4.02E-03	0.00E+00
Heptachlor epoxide	0.00E+00	0.00E+00	8.90E+04	2.24E-03	0.00E+00
Heptachlor	0.00E+00	0.00E+00	2.00E+06	5.02E-02	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	9.55E+05	2.40E-02	0.00E+00
Bis(2-ethylhexyl)phthalate	4.54E-01	5.45E-02	2.50E+05	6.28E-03	3.42E-04
Flouranthene	0.00E+00	0.00E+00	2.14E+05	5.38E-03	0.00E+00
Pyrene	0.00E+00	0.00E+00	1.51E+05	3.79E-03	0.00E+00
1,1,2,2-tetrachloroethene	0.00E+00	0.00E+00	2.45E+02	6.15E-06	0.00E+00
4-methyl-2-pentanone	0.00E+00	0.00E+00	1.23E+01	3.09E-07	0.00E+00
2-butanone	0.00E+00	0.00E+00	1.82E+00	4.57E-08	0.00E+00
Acetone	2.70E-02	3.24E-03	5.80E-01	1.46E-08	4.72E-11
Carbon tetrachloride	1.75E-03	2.10E-04	2.45E+02	6.15E-06	1.29E-09
Cis-1,2-dichloroethene	5.76E-03	6.91E-04	3.02E+01	7.59E-07	5.24E-10
Ethylbenzene	0.00E+00	0.00E+00	1.41E+03	3.54E-05	0.00E+00
Methylene Chloride	2.38E-02	2.86E-03	1.78E+01	4.47E-07	1.28E-09
Toluene	0.00E+00	0.00E+00	4.90E+02	1.23E-05	0.00E+00
Xylene	0.00E+00	0.00E+00	5.89E+02	1.48E-05	0.00E+00

LOWER KEYS MARSH RABBIT

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
Aluminum	3.18E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	3.60E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	1.40E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium	1.19E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	1.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	5.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	1.49E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	6.63E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cyanide	2.10E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead	6.08E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	1.89E+01	0.00E+00	0.00E+00	2.47E+01	0.00E+00	0.00E+00
Mercury	1.60E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel	2.70E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver	1.50E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin	1.12E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium	8.30E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc	6.63E+01	0.00E+00	0.00E+00	2.20E+00	0.00E+00	0.00E+00

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
4,4'-DDD	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4,4'-DDE	2.95E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4,4'-DDT	3.64E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Alpha-BHC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor-1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta-BHC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4-D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,5-T	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,5-TP (Silvex)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endosulfan I	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endosulfan II	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptachlor epoxide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptachlor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bis(2-ethylhexyl)phthalate	2.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,1,2,2-tetrachloroethene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-methyl-2-pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-butanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acetone	7.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon Tetrachloride	3.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cis-1,2-dichlorethene	1.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylene chloride	6.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

RISK ASSESSMENT SPREADSHEET - INGESTION OF SOIL

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			**HAZARD QUOTIENT**
Aluminum			6.85E+00
Antimony			1.20E-01
Arsenic			4.62E-02
Barium			9.78E-03
Beryllium			9.45E-04
Cadmium			2.45E-02
Chromium			1.89E-02
Cobalt			0.00E+00
Copper			1.83E-02
Cyanide			1.27E-02
Lead			3.16E-02
Manganese			8.93E-04
Mercury			5.04E-05
Nickel			2.81E-04
Selenium			0.00E+00
Silver			3.45E-04
Tin			9.32E-02
Vanadium			3.03E-03
Zinc			1.72E-03
TOTAL			7.23E+00

RISK ASSESSMENT SPREADSHEET - INGESTION OF SOIL

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
4,4'-DDD			0.00E+00
4,4'-DDE			1.53E-04
4,4'-DDT			1.89E-04
Alpha-BHC			0.00E+00
Aroclor-1260			0.00E+00
Beta-BHC			0.00E+00
2,4-D			0.00E+00
2,4,5-T			0.00E+00
2,4,5-TP (Silvex)			0.00E+00
Endosulfan I			0.00E+00
Endosulfan II			0.00E+00
Endrin			0.00E+00
Heptachlor epoxide			0.00E+00
Heptachlor			0.00E+00
Benzo(a)pyrene			0.00E+00
Bis(2-ethylhexyl)phthalate			5.00E-05
Fluoranthene			0.00E+00
Pyrene			0.00E+00
1,1,2,2-tetrachloroethene			0.00E+00
4-methyl-2-pentanone			0.00E+00
2-butanone			0.00E+00
Acetone			2.91E-06
Carbon Tetrachloride			7.80E-07
Cis-1,2-dichlorethene			1.75E-07
Ethylbenzene			0.00E+00
Methylene chloride			4.91E-05
Toluene			0.00E+00
Xylene			0.00E+00
TOTAL			4.45E-04

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
Aluminum			0.00E+00
Antimony			0.00E+00
Arsenic			0.00E+00
Barium			0.00E+00
Beryllium			0.00E+00
Cadmium			0.00E+00
Chromium			0.00E+00
Cobalt			0.00E+00
Copper			0.00E+00
Cyanide			0.00E+00
Lead			0.00E+00
Manganese			1.74E-02
Mercury			0.00E+00
Nickel			0.00E+00
Selenium			0.00E+00
Silver			0.00E+00
Tin			0.00E+00
Vanadium			0.00E+00
Zinc			8.50E-04
TOTAL			1.82E-02

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: MARSH RABBIT

CHEMICAL			HAZARD QUOTIENT
4,4'-DDD			0.00E+00
4,4'-DDE			0.00E+00
4,4'-DDT			0.00E+00
Alpha-BHC			0.00E+00
Aroclor-1260			0.00E+00
Beta-BHC			0.00E+00
2,4-D			0.00E+00
2,4,5-T			0.00E+00
2,4,5-TP (Silvex)			0.00E+00
Endosulfan I			0.00E+00
Endosulfan II			0.00E+00
Endrin			0.00E+00
Heptachlor epoxide			0.00E+00
Heptachlor			0.00E+00
Benzo(a)pyrene			0.00E+00
Bis(2-ethylhexyl)phthalate			0.00E+00
Fluoranthene			0.00E+00
Pyrene			0.00E+00
1,1,2,2-tetrachloroethene			0.00E+00
4-methyl-2-pentanone			0.00E+00
2-butanone			0.00E+00
Acetone			0.00E+00
Carbon Tetrachloride			0.00E+00
Cis-1,2-dichlorethene			0.00E+00
Ethylbenzene			0.00E+00
Methylene chloride			0.00E+00
Toluene			0.00E+00
Xylene			0.00E+00
TOTAL			0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Aluminum	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	3.18E+03							1.65E+01		1.00E+00	8.00E-01	1.32E+01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Antimony	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	3.60E+00							1.87E-02		1.00E+00	8.00E-01	1.50E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Aluminum	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.18E+03	1.32E+01	1.93E+00	6.85E+00	
Water	0.00E+00	0.00E+00	1.93E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.93E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.93E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.93E+00	0.00E+00	
Total					6.85E+00

Antimony	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.60E+00	1.50E-02	1.25E-01	1.20E-01	
Water	0.00E+00	0.00E+00	1.25E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.25E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E-01	0.00E+00	
Total					1.20E-01

Arsenic	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.40E+00							7.28E-03		1.00E+00	8.00E-01	5.82E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Barium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.19E+01							6.19E-02		1.00E+00	8.00E-01	4.95E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Arsenic	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.40E+00	5.82E-03	1.26E-01	4.62E-02	
Water	0.00E+00	0.00E+00	1.26E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.26E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.26E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.26E-01	0.00E+00	
Total					4.62E-02

Barium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.19E+01	4.95E-02	5.06E+00	9.78E-03	
Water	0.00E+00	0.00E+00	5.06E+00	0.00E+00	
Food	0.00E+00	0.00E+00	5.06E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.06E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.06E+00	0.00E+00	
Total					9.78E-03

Beryllium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.50E-01							7.80E-04		1.00E+00	8.00E-01	6.24E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cadmium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	5.90E+00							3.07E-02		1.00E+00	8.00E-01	2.45E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Beryllium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E-01	6.24E-04	6.60E-01	9.45E-04	
Water	0.00E+00	0.00E+00	6.60E-01	0.00E+00	
Food	0.00E+00	0.00E+00	6.60E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E-01	0.00E+00	
Total					9.45E-04

Cadmium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.90E+00	2.45E-02	1.00E+00	2.45E-02	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					2.45E-02

Dose Calculations for Individual Contaminants - Maximum Concentration

Chromium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.49E+01							7.75E-02		1.00E+00	8.00E-01	6.20E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cobalt	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Chromium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.49E+01	6.20E-02	3.28E+00	1.89E-02	
Water	0.00E+00	0.00E+00	3.28E+00	0.00E+00	
Food	0.00E+00	0.00E+00	3.28E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	3.28E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.28E+00	0.00E+00	
Total					1.89E-02

Cobalt	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Total					0.00E+00

Copper	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	6.63E+01							3.45E-01		1.00E+00	8.00E-01	2.76E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cyanide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	2.10E+01							1.09E-01		1.00E+00	8.00E-01	8.73E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Copper	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.63E+01	2.76E-01	1.51E+01	1.83E-02	
Water	0.00E+00	0.00E+00	1.51E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.51E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.51E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.51E+01	0.00E+00	
Total					1.83E-02

Cyanide	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.10E+01	8.73E-02	6.87E+00	1.27E-02	
Water	0.00E+00	0.00E+00	6.87E+00	0.00E+00	
Food	0.00E+00	0.00E+00	6.87E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.87E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.87E+00	0.00E+00	
Total					1.27E-02

Lead	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	6.08E+01							3.16E-01		1.00E+00	8.00E-01	2.53E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Manganese	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.89E+01							9.83E-02		1.00E+00	8.00E-01	7.86E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.47E+01				1.91E+00					1.00E+00	8.00E-01	1.53E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Lead	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.08E+01	2.53E-01	8.00E+00	3.16E-02	
Water	0.00E+00	0.00E+00	8.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	8.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E+00	0.00E+00	
Total					3.16E-02

Manganese	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.89E+01	7.86E-02	8.80E+01	8.93E-04	
Water	0.00E+00	0.00E+00	8.80E+01	0.00E+00	
Food	2.47E+01	1.53E+00	8.80E+01	1.74E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.80E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.80E+01	0.00E+00	
Total					1.83E-02

Mercury	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.60E-01							8.32E-04		1.00E+00	8.00E-01	6.65E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Nickel	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	2.70E+00							1.40E-02		1.00E+00	8.00E-01	1.12E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Mercury	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.60E-01	6.65E-04	1.32E+01	5.04E-05	
Water	0.00E+00	0.00E+00	1.32E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.32E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.32E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.32E+01	0.00E+00	
Total					5.04E-05

Nickel	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.70E+00	1.12E-02	4.00E+01	2.81E-04	
Water	0.00E+00	0.00E+00	4.00E+01	0.00E+00	
Food	0.00E+00	0.00E+00	4.00E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E+01	0.00E+00	
Total					2.81E-04

Dose Calculations for Individual Contaminants - Maximum Concentration

Selenium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Silver	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.50E+00							7.80E-03		1.00E+00	8.00E-01	6.24E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Selenium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Total					0.00E+00

Silver	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E+00	6.24E-03	1.81E+01	3.45E-04	
Water	0.00E+00	0.00E+00	1.81E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.81E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.81E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.81E+01	0.00E+00	
Total					3.45E-04

Tin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.12E+01							5.82E-02		1.00E+00	8.00E-01	4.66E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Vanadium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	8.30E+00							4.31E-02		1.00E+00	8.00E-01	3.45E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Tin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.12E+01	4.66E-02	5.00E-01	9.32E-02	
Water	0.00E+00	0.00E+00	5.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	5.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-01	0.00E+00	
Total					9.32E-02

Vanadium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.30E+00	3.45E-02	1.14E+01	3.03E-03	
Water	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Total					3.03E-03

Zinc	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	6.63E+01							3.45E-01		1.00E+00	8.00E-01	2.76E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.20E+00				1.70E-01					1.00E+00	8.00E-01	1.36E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentration

Zinc	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.63E+01	2.76E-01	1.60E+02	1.72E-03	
Water	0.00E+00	0.00E+00	1.60E+02	0.00E+00	
Food	2.20E+00	1.36E-01	1.60E+02	8.50E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+02	0.00E+00	
Total					2.57E-03

0.00E+00	Concentration mg/kg	Dose mg/kg-day	NOAEL	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Water	0.00E+00	0.00E+00	0.00E+00	N/A	
Food	0.00E+00	0.00E+00	0.00E+00	N/A	
Inhalation					
Air	0.00E+00	0.00E+00	0.00E+00	N/A	
Dermal					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Total					0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

4,4'-DDD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	2.95E-02							1.53E-04		1.00E+00	8.00E-01	1.23E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

4,4'-DDD	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					0.00E+00

4,4'-DDE	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.95E-02	1.23E-04	8.00E-01	1.53E-04	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					1.53E-04

4,4'-DDT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	3.64E-02							1.89E-04		1.00E+00	8.00E-01	1.51E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Alpha-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

4,4'-DDT	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.64E-02	1.51E-04	8.00E-01	1.89E-04	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					1.89E-04

Alpha-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Food	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Total					0.00E+00

Aroclor-1260	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Beta-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Aroclor-1260	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Total					0.00E+00

Beta-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Food	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Total					0.00E+00

2,4-D	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2,4,5-T	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

2,4-D	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					0.00E+00

2,4,5-T	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Total					0.00E+00

2,4,5-TP (Silvex)	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan I	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

2,4,5-TP (Silvex)	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Water	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Food	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Total					0.00E+00

Endosulfan I	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Total					0.00E+00

Endosulfan II	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Endosulfan II	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Total					0.00E+00

Endrin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Water	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Food	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Total					0.00E+00

Heptachlor epoxide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Heptachlor	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Heptachlor epoxide	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					0.00E+00

Heptachlor	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Benzo(a)pyrene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Bis(2-ethylhexyl)phthalate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	2.20E-01							1.14E-03		1.00E+00	8.00E-01	9.15E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Benzo(a)pyrene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					0.00E+00

Bis(2-ethylhexyl)phthalate	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.20E-01	9.15E-04	1.83E+01	5.00E-05	
Water	0.00E+00	0.00E+00	1.83E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.83E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.83E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.83E+01	0.00E+00	
Total					5.00E-05

Fluoranthene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Pyrene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Fluoranthene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Water	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Food	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Total					0.00E+00

Pyrene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Water	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Food	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Total					0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

1,1,2,2-tetrachloroethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4-methyl-2-pentanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

1,1,2,2-tetrachloroethene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Food	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Total					0.00E+00

4-methyl-2-pentanone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Water	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Food	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Total					0.00E+00

2-butanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Acetone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	7.00E-02							3.64E-04		1.00E+00	8.00E-01	2.91E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2-butanone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Water	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Food	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Total					0.00E+00

Acetone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-02	2.91E-04	1.00E+02	2.91E-06	
Water	0.00E+00	0.00E+00	1.00E+02	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+02	0.00E+00	
Total					2.91E-06

Carbon Tetrachloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	3.00E-03							1.56E-05		1.00E+00	8.00E-01	1.25E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cis-1,2-dichlorethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	1.90E-02							9.88E-05		1.00E+00	8.00E-01	7.90E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Carbon Tetrachloride	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.00E-03	1.25E-05	1.60E+01	7.80E-07	
Water	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Total					7.80E-07

Cis-1,2-dichlorethene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.90E-02	7.90E-05	4.52E+02	1.75E-07	
Water	0.00E+00	0.00E+00	4.52E+02	0.00E+00	
Food	0.00E+00	0.00E+00	4.52E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.52E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.52E+02	0.00E+00	
Total					1.75E-07

Ethylbenzene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Methylene chloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	6.90E-02							3.59E-04		1.00E+00	8.00E-01	2.87E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Ethylbenzene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Water	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Food	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Total					0.00E+00

Methylene chloride	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.90E-02	2.87E-04	5.85E+00	4.91E-05	
Water	0.00E+00	0.00E+00	5.85E+00	0.00E+00	
Food	0.00E+00	0.00E+00	5.85E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.85E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.85E+00	0.00E+00	
Total					4.91E-05

Toluene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Xylene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.22E+00	1.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Dose Calculations for Individual Contaminants - Maximum Concentrations

Toluene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Water	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Food	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Total					0.00E+00

Xylene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Water	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Food	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Total					0.00E+00

COTTON RAT

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
Aluminum	3.18E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	3.60E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	1.40E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium	1.19E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	1.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	5.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	1.49E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	6.63E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cyanide	2.10E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead	6.08E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	1.89E+01	0.00E+00	0.00E+00	2.47E+01	0.00E+00	0.00E+00
Mercury	1.60E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel	2.70E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver	1.50E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin	1.12E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium	8.30E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc	6.63E+01	0.00E+00	0.00E+00	2.20E+00	0.00E+00	0.00E+00

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
4,4'-DDD	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4,4'-DDE	2.95E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4,4'-DDT	3.64E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Alpha-BHC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor-1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta-BHC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4-D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,5-T	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,5-TP (Silvex)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endosulfan I	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endosulfan II	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptachlor epoxide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptachlor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bis(2-ethylhexyl)phthalate	2.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,1,2,2-tetrachloroethene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-methyl-2-pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-butanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acetone	7.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon Tetrachloride	3.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cis-1,2-dichlorethene	1.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylene chloride	6.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

RISK ASSESSMENT SPREADSHEET - INGESTION OF SOIL

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: COTTON RAT

CHEMICAL			HAZARD QUOTIENT
Aluminum			3.03E+00
Antimony			5.30E-02
Arsenic			2.04E-02
Barium			4.33E-03
Beryllium			4.18E-04
Cadmium			1.09E-02
Chromium			8.36E-03
Cobalt			0.00E+00
Copper			8.08E-03
Cyanide			5.62E-03
Lead			1.40E-02
Manganese			3.95E-04
Mercury			2.23E-05
Nickel			1.24E-04
Selenium			0.00E+00
Silver			1.52E-04
Tin			4.12E-02
Vanadium			1.34E-03
Zinc			7.62E-04
TOTAL			3.20E+00

RISK ASSESSMENT SPREADSHEET - INGESTION OF SOIL

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: COTTON RAT

CHEMICAL			HAZARD QUOTIENT
4,4'-DDD			0.00E+00
4,4'-DDE			6.78E-05
4,4'-DDT			8.37E-05
Alpha-BHC			0.00E+00
Aroclor-1260			0.00E+00
Beta-BHC			0.00E+00
2,4-D			0.00E+00
2,4,5-T			0.00E+00
2,4,5-TP (Silvex)			0.00E+00
Endosulfan I			0.00E+00
Endosulfan II			0.00E+00
Endrin			0.00E+00
Heptachlor epoxide			0.00E+00
Heptachlor			0.00E+00
Benzo(a)pyrene			0.00E+00
Bis(2-ethylhexyl)phthalate			2.21E-05
Fluoranthene			0.00E+00
Pyrene			0.00E+00
1,1,2,2-tetrachloroethene			0.00E+00
4-methyl-2-pentanone			0.00E+00
2-butanone			0.00E+00
Acetone			1.29E-06
Carbon Tetrachloride			3.45E-07
Cis-1,2-dichlorethene			7.73E-08
Ethylbenzene			0.00E+00
Methylene chloride			2.17E-05
Toluene			0.00E+00
Xylene			0.00E+00
TOTAL			1.97E-04

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: COTTON RAT

CHEMICAL			HAZARD QUOTIENT
Aluminum			0.00E+00
Antimony			0.00E+00
Arsenic			0.00E+00
Barium			0.00E+00
Beryllium			0.00E+00
Cadmium			0.00E+00
Chromium			0.00E+00
Cobalt			0.00E+00
Copper			0.00E+00
Cyanide			0.00E+00
Lead			0.00E+00
Manganese			1.79E-02
Mercury			0.00E+00
Nickel			0.00E+00
Selenium			0.00E+00
Silver			0.00E+00
Tin			0.00E+00
Vanadium			0.00E+00
Zinc			8.78E-04
TOTAL			1.88E-02

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: COTTON RAT

CHEMICAL			HAZARD QUOTIENT
4,4'-DDD			0.00E+00
4,4'-DDE			0.00E+00
4,4'-DDT			0.00E+00
Alpha-BHC			0.00E+00
Aroclor-1260			0.00E+00
Beta-BHC			0.00E+00
2,4-D			0.00E+00
2,4,5-T			0.00E+00
2,4,5-TP (Silvex)			0.00E+00
Endosulfan I			0.00E+00
Endosulfan II			0.00E+00
Endrin			0.00E+00
Heptachlor epoxide			0.00E+00
Heptachlor			0.00E+00
Benzo(a)pyrene			0.00E+00
Bis(2-ethylhexyl)phthalate			0.00E+00
Fluoranthene			0.00E+00
Pyrene			0.00E+00
1,1,2,2-tetrachloroethene			0.00E+00
4-methyl-2-pentanone			0.00E+00
2-butanone			0.00E+00
Acetone			0.00E+00
Carbon Tetrachloride			0.00E+00
Cis-1,2-dichlorethene			0.00E+00
Ethylbenzene			0.00E+00
Methylene chloride			0.00E+00
Toluene			0.00E+00
Xylene			0.00E+00
TOTAL			0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aluminum	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	3.18E+03							7.31E+00		1.00E+00	8.00E-01	5.85E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Antimony	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	3.60E+00							8.28E-03		1.00E+00	8.00E-01	6.62E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aluminum	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.18E+03	5.85E+00	1.93E+00	3.03E+00	
Water	0.00E+00	0.00E+00	1.93E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.93E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.93E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.93E+00	0.00E+00	
Total					3.03E+00

Antimony	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.60E+00	6.62E-03	1.25E-01	5.30E-02	
Water	0.00E+00	0.00E+00	1.25E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.25E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E-01	0.00E+00	
Total					5.30E-02

Individual Dose Calculations - Maximum Concentrations

Arsenic	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.40E+00							3.22E-03		1.00E+00	8.00E-01	2.57E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Barium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.19E+01							2.74E-02		1.00E+00	8.00E-01	2.19E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Arsenic	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.40E+00	2.57E-03	1.26E-01	2.04E-02	
Water	0.00E+00	0.00E+00	1.26E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.26E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.26E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.26E-01	0.00E+00	
Total					2.04E-02

Barium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.19E+01	2.19E-02	5.06E+00	4.33E-03	
Water	0.00E+00	0.00E+00	5.06E+00	0.00E+00	
Food	0.00E+00	0.00E+00	5.06E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.06E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.06E+00	0.00E+00	
Total					4.33E-03

Individual Dose Calculations - Maximum Concentrations

Beryllium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.50E-01							3.45E-04		1.00E+00	8.00E-01	2.76E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cadmium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	5.90E+00							1.36E-02		1.00E+00	8.00E-01	1.09E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Beryllium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E-01	2.76E-04	6.60E-01	4.18E-04	
Water	0.00E+00	0.00E+00	6.60E-01	0.00E+00	
Food	0.00E+00	0.00E+00	6.60E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E-01	0.00E+00	
Total					4.18E-04

Cadmium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.90E+00	1.09E-02	1.00E+00	1.09E-02	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					1.09E-02

Chromium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.49E+01							3.43E-02		1.00E+00	8.00E-01	2.74E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cobalt	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Chromium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.49E+01	2.74E-02	3.28E+00	8.36E-03	
Water	0.00E+00	0.00E+00	3.28E+00	0.00E+00	
Food	0.00E+00	0.00E+00	3.28E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	3.28E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.28E+00	0.00E+00	
Total					8.36E-03

Cobalt	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.57E+01	0.00E+00	
Total					0.00E+00

Individual Dose Calculations - Maximum Concentrations

Copper	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	6.63E+01							1.52E-01		1.00E+00	8.00E-01	1.22E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cyanide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	2.10E+01							4.83E-02		1.00E+00	8.00E-01	3.86E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Copper	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.63E+01	1.22E-01	1.51E+01	8.08E-03	
Water	0.00E+00	0.00E+00	1.51E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.51E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.51E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.51E+01	0.00E+00	
Total					8.08E-03

Cyanide	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.10E+01	3.86E-02	6.87E+00	5.62E-03	
Water	0.00E+00	0.00E+00	6.87E+00	0.00E+00	
Food	0.00E+00	0.00E+00	6.87E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.87E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.87E+00	0.00E+00	
Total					5.62E-03

Individual Dose Calculations - Maximum Concentrations

Lead	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	6.08E+01							1.40E-01		1.00E+00	8.00E-01	1.12E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Manganese	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.89E+01							4.35E-02		1.00E+00	8.00E-01	3.48E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.47E+01				1.97E+00					1.00E+00	8.00E-01	1.58E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Lead	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.08E+01	1.12E-01	8.00E+00	1.40E-02	
Water	0.00E+00	0.00E+00	8.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	8.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E+00	0.00E+00	
Total					1.40E-02

Manganese	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.89E+01	3.48E-02	8.80E+01	3.95E-04	
Water	0.00E+00	0.00E+00	8.80E+01	0.00E+00	
Food	2.47E+01	1.58E+00	8.80E+01	1.79E-02	
Inhalation					
Air	0.00E+00	0.00E+00	8.80E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.80E+01	0.00E+00	
Total					1.83E-02

Mercury	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.60E-01							3.68E-04		1.00E+00	8.00E-01	2.94E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Nickel	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	2.70E+00							6.21E-03		1.00E+00	8.00E-01	4.97E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Mercury	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.60E-01	2.94E-04	1.32E+01	2.23E-05	
Water	0.00E+00	0.00E+00	1.32E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.32E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.32E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.32E+01	0.00E+00	
Total					2.23E-05

Nickel	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.70E+00	4.97E-03	4.00E+01	1.24E-04	
Water	0.00E+00	0.00E+00	4.00E+01	0.00E+00	
Food	0.00E+00	0.00E+00	4.00E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E+01	0.00E+00	
Total					1.24E-04

Selenium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Silver	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.50E+00							3.45E-03		1.00E+00	8.00E-01	2.76E-03
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Selenium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.00E-01	0.00E+00	
Total					0.00E+00

Silver	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E+00	2.76E-03	1.81E+01	1.52E-04	
Water	0.00E+00	0.00E+00	1.81E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.81E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.81E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.81E+01	0.00E+00	
Total					1.52E-04

Tin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.12E+01							2.57E-02		1.00E+00	8.00E-01	2.06E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Vanadium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	8.30E+00							1.91E-02		1.00E+00	8.00E-01	1.53E-02
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Tin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.12E+01	2.06E-02	5.00E-01	4.12E-02	
Water	0.00E+00	0.00E+00	5.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	5.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.00E-01	0.00E+00	
Total					4.12E-02

Vanadium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.30E+00	1.53E-02	1.14E+01	1.34E-03	
Water	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Total					1.34E-03

Zinc	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	6.63E+01							1.52E-01		1.00E+00	8.00E-01	1.22E-01
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.20E+00				1.76E-01					1.00E+00	8.00E-01	1.40E-01
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Zinc	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.63E+01	1.22E-01	1.60E+02	7.62E-04	
Water	0.00E+00	0.00E+00	1.60E+02	0.00E+00	
Food	2.20E+00	1.40E-01	1.60E+02	8.78E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+02	0.00E+00	
Total					1.64E-03

4,4'-DDD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	2.95E-02							6.78E-05		1.00E+00	8.00E-01	5.43E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

4,4'-DDD	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					0.00E+00

4,4'-DDE	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.95E-02	5.43E-05	8.00E-01	6.78E-05	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					6.78E-05

4,4'-DDT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	3.64E-02							8.37E-05		1.00E+00	8.00E-01	6.69E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Alpha-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDT	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.64E-02	6.69E-05	8.00E-01	8.37E-05	
Water	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	8.00E-01	0.00E+00	
Total					8.37E-05

Alpha-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Food	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Total					0.00E+00

Aroclor-1260	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Beta-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Aroclor-1260	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.35E-01	0.00E+00	
Total					0.00E+00

Beta-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Food	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.37E-02	0.00E+00	
Total					0.00E+00

2,4-D	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2,4,5-T	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

2,4-D	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					0.00E+00

2,4,5-T	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E+00	0.00E+00	
Total					0.00E+00

2,4,5-TP (Silvex)	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan I	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

2,4,5-TP (Silvex)	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Water	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Food	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-01	0.00E+00	
Total					0.00E+00

Endosulfan I	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Total					0.00E+00

Endosulfan II	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan II	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.50E+00	0.00E+00	
Total					0.00E+00

Endrin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Water	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Food	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.20E-02	0.00E+00	
Total					0.00E+00

Heptachlor epoxide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Heptachlor	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Heptachlor epoxide	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					0.00E+00

Heptachlor	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					0.00E+00

Benzo(a)pyrene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Bis(2-ethylhexyl)phthalate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	2.20E-01							5.06E-04		1.00E+00	8.00E-01	4.05E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Benzo(a)pyrene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					0.00E+00

Bis(2-ethylhexyl)phthalate	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.20E-01	4.05E-04	1.83E+01	2.21E-05	
Water	0.00E+00	0.00E+00	1.83E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.83E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.83E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.83E+01	0.00E+00	
Total					2.21E-05

Fluoranthene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Pyrene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Fluoranthene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Water	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Food	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E+02	0.00E+00	
Total					0.00E+00

Pyrene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Water	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Food	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E+01	0.00E+00	
Total					0.00E+00

1,1,2,2-tetrachloroethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4-methyl-2-pentanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

1,1,2,2-tetrachloroethene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Food	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.00E+01	0.00E+00	
Total					0.00E+00

4-methyl-2-pentanone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Water	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Food	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.50E+01	0.00E+00	
Total					0.00E+00

2-butanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Acetone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	7.00E-02							1.61E-04		1.00E+00	8.00E-01	1.29E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

2-butanone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Water	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Food	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.77E+03	0.00E+00	
Total					0.00E+00

Acetone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-02	1.29E-04	1.00E+02	1.29E-06	
Water	0.00E+00	0.00E+00	1.00E+02	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+02	0.00E+00	
Total					1.29E-06

Carbon Tetrachloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	3.00E-03							6.90E-06		1.00E+00	8.00E-01	5.52E-06
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cis-1,2-dichlorethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	1.90E-02							4.37E-05		1.00E+00	8.00E-01	3.49E-05
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Carbon Tetrachloride	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.00E-03	5.52E-06	1.60E+01	3.45E-07	
Water	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+01	0.00E+00	
Total					3.45E-07

Cis-1,2-dichlorethene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.90E-02	3.49E-05	4.52E+02	7.73E-08	
Water	0.00E+00	0.00E+00	4.52E+02	0.00E+00	
Food	0.00E+00	0.00E+00	4.52E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.52E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.52E+02	0.00E+00	
Total					7.73E-08

Ethylbenzene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Methylene chloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	6.90E-02							1.59E-04		1.00E+00	8.00E-01	1.27E-04
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Ethylbenzene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Water	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Food	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.08E+01	0.00E+00	
Total					0.00E+00

Methylene chloride	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.90E-02	1.27E-04	5.85E+00	2.17E-05	
Water	0.00E+00	0.00E+00	5.85E+00	0.00E+00	
Food	0.00E+00	0.00E+00	5.85E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.85E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.85E+00	0.00E+00	
Total					2.17E-05

Toluene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Xylene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.03E-01	8.49E+03									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Toluene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Water	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Food	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.60E+01	0.00E+00	
Total					0.00E+00

Xylene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Water	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Food	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.06E+00	0.00E+00	
Total					0.00E+00

AMERICAN KESTREL

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
Aluminum	3.18E+03	0.00E+00	5.72E-01	0.00E+00	0.00E+00	0.00E+00
Antimony	3.60E+00	0.00E+00	4.32E-04	0.00E+00	0.00E+00	0.00E+00
Arsenic	1.40E+00	0.00E+00	3.36E-04	0.00E+00	0.00E+00	0.00E+00
Barium	1.19E+01	0.00E+00	2.14E-04	0.00E+00	0.00E+00	0.00E+00
Beryllium	1.50E-01	0.00E+00	1.80E-05	0.00E+00	0.00E+00	0.00E+00
Cadmium	5.90E+00	0.00E+00	3.89E-04	0.00E+00	0.00E+00	0.00E+00
Chromium	1.49E+01	0.00E+00	9.83E-03	0.00E+00	0.00E+00	0.00E+00
Cobalt	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	6.63E+01	0.00E+00	7.96E-02	0.00E+00	0.00E+00	0.00E+00
Cyanide	2.10E+01	0.00E+00	2.52E+00	0.00E+00	0.00E+00	0.00E+00
Lead	6.08E+01	0.00E+00	2.19E-03	0.00E+00	0.00E+00	0.00E+00
Manganese	1.89E+01	0.00E+00	2.26E-02	0.00E+00	0.00E+00	0.00E+00
Mercury	1.60E-01	0.00E+00	4.80E-03	0.00E+00	0.00E+00	0.00E+00
Nickel	2.70E+00	0.00E+00	1.94E-03	0.00E+00	0.00E+00	0.00E+00
Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver	1.50E+00	0.00E+00	5.40E-04	0.00E+00	0.00E+00	0.00E+00
Tin	1.12E+01	0.00E+00	1.08E-01	0.00E+00	0.00E+00	0.00E+00
Vanadium	8.30E+00	0.00E+00	2.49E-03	0.00E+00	0.00E+00	0.00E+00
Zinc	6.63E+01	0.00E+00	1.28E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
4,4'-DDD	0.00E+00	0.00E+00	0.00E+00	3.12E+01	0.00E+00	0.00E+00
4,4'-DDE	2.95E-02	0.00E+00	5.16E-04	4.34E-01	0.00E+00	0.00E+00
4,4'-DDT	3.64E-02	0.00E+00	6.91E-04	1.32E-01	0.00E+00	0.00E+00
Alpha-BHC	0.00E+00	0.00E+00	0.00E+00	1.49E+01	0.00E+00	0.00E+00
Aroclor-1260	0.00E+00	0.00E+00	0.00E+00	2.00E-03	0.00E+00	0.00E+00
Beta-BHC	0.00E+00	0.00E+00	0.00E+00	6.16E+00	0.00E+00	0.00E+00
2,4-D	0.00E+00	0.00E+00	0.00E+00	1.38E+00	0.00E+00	0.00E+00
2,4,5-T	0.00E+00	0.00E+00	0.00E+00	9.20E-02	0.00E+00	0.00E+00
2,4,5-TP (Silvex)	0.00E+00	0.00E+00	0.00E+00	1.63E+02	0.00E+00	0.00E+00
Endosulfan I	0.00E+00	0.00E+00	0.00E+00	3.33E+01	0.00E+00	0.00E+00
Endosulfan II	0.00E+00	0.00E+00	0.00E+00	1.17E+02	0.00E+00	0.00E+00
Endrin	0.00E+00	0.00E+00	0.00E+00	5.58E+00	0.00E+00	0.00E+00
Heptachlor epoxide	0.00E+00	0.00E+00	0.00E+00	3.01E+00	0.00E+00	0.00E+00
Heptachlor	0.00E+00	0.00E+00	0.00E+00	1.53E-02	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	3.04E+00	0.00E+00	0.00E+00
Bis(2-ethylhexyl)phthalate	2.20E-01	0.00E+00	1.66E-04	3.87E-01	0.00E+00	0.00E+00
Fluoranthene	0.00E+00	0.00E+00	0.00E+00	6.93E-02	0.00E+00	0.00E+00
Pyrene	0.00E+00	0.00E+00	0.00E+00	1.43E+03	0.00E+00	0.00E+00
1,1,2,2-tetrachloroethene	0.00E+00	0.00E+00	0.00E+00	1.54E-01	0.00E+00	0.00E+00
4-methyl-2-pentanone	0.00E+00	0.00E+00	0.00E+00	6.45E-02	0.00E+00	0.00E+00
2-butanone	0.00E+00	0.00E+00	0.00E+00	2.13E-02	0.00E+00	0.00E+00
Acetone	7.00E-02	0.00E+00	1.22E-10	6.22E-02	0.00E+00	0.00E+00
Carbon Tetrachloride	3.00E-03	0.00E+00	2.22E-09	3.32E+00	0.00E+00	0.00E+00
Cis-1,2-dichlorethene	1.90E-02	0.00E+00	1.73E-09	5.48E-03	0.00E+00	0.00E+00
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	1.36E-02	0.00E+00	0.00E+00
Methylene chloride	6.90E-02	0.00E+00	3.70E-09	9.34E-02	0.00E+00	0.00E+00
Toluene	0.00E+00	0.00E+00	0.00E+00	2.14E-02	0.00E+00	0.00E+00
Xylene	0.00E+00	0.00E+00	0.00E+00	7.94E-05	0.00E+00	0.00E+00

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: KESTREL

CHEMICAL			HAZARD QUOTIENT
4,4'-DDD			0.00E+00
4,4'-DDE			4.27E-02
4,4'-DDT			5.72E-02
Alpha-BHC			0.00E+00
Aroclor-1260			0.00E+00
Beta-BHC			0.00E+00
2,4-D			0.00E+00
2,4,5-T			0.00E+00
2,4,5-TP (Silvex)			0.00E+00
Endosulfan I			0.00E+00
Endosulfan II			0.00E+00
Endrin			0.00E+00
Heptachlor epoxide			0.00E+00
Heptachlor			0.00E+00
Benzo(a)pyrene			0.00E+00
Bis(2-ethylhexyl)phthalate			3.49E-06
Fluoranthene			0.00E+00
Pyrene			0.00E+00
1,1,2,2-tetrachloroethene			0.00E+00
4-methyl-2-pentanone			0.00E+00
2-butanone			0.00E+00
Acetone			2.84E-12
Carbon Tetrachloride			3.21E-10
Cis-1,2-dichlorethene			8.87E-12
Ethylbenzene			0.00E+00
Methylene chloride			1.47E-09
Toluene			0.00E+00
Xylene			0.00E+00
TOTAL			1.00E-01

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: KESTREL

CHEMICAL			HAZARD QUOTIENT
Aluminum			1.21E-03
Antimony			8.01E-03
Arsenic			6.18E-03
Barium			9.82E-05
Beryllium			6.32E-05
Cadmium			6.23E-05
Chromium			2.28E-03
Cobalt			0.00E+00
Copper			3.93E-04
Cyanide			8.51E-01
Lead			1.32E-04
Manganese			5.37E-06
Mercury			2.47E-03
Nickel			1.13E-04
Selenium			0.00E+00
Silver			6.92E-05
Tin			3.67E-03
Vanadium			5.06E-05
Zinc			2.05E-02
TOTAL			8.96E-01

Aluminum	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	3.18E+03							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	5.72E-01			1.66E-01						1.00E+00	8.00E-01	1.33E-01
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Antimony	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	3.60E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	4.32E-04			1.25E-04						1.00E+00	8.00E-01	1.00E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aluminum	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.18E+03	0.00E+00	1.10E+02	0.00E+00	
Water	0.00E+00	0.00E+00	1.10E+02	0.00E+00	
Food	5.72E-01	1.33E-01	1.10E+02	1.21E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.10E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.10E+02	0.00E+00	
Total					1.21E-03

Antimony	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.60E+00	0.00E+00	1.25E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.25E-02	0.00E+00	
Food	4.32E-04	1.00E-04	1.25E-02	8.01E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E-02	0.00E+00	
Total					8.01E-03

Arsenic	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.40E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	3.36E-04			9.74E-05						1.00E+00	8.00E-01	7.79E-05
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Barium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.19E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.14E-04			6.21E-05						1.00E+00	8.00E-01	4.97E-05
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Arsenic	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.40E+00	0.00E+00	1.26E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Food	3.36E-04	7.79E-05	1.26E-02	6.18E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Total					6.18E-03

Barium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.19E+01	0.00E+00	5.06E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.06E-01	0.00E+00	
Food	2.14E-04	4.97E-05	5.06E-01	9.82E-05	
Inhalation					
Air	0.00E+00	0.00E+00	5.06E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.06E-01	0.00E+00	
Total					9.82E-05

Beryllium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.50E-01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.80E-05			5.22E-06						1.00E+00	8.00E-01	4.17E-06
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cadmium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	5.90E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	3.89E-04			1.13E-04						1.00E+00	8.00E-01	9.03E-05
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Beryllium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E-01	0.00E+00	6.60E-02	0.00E+00	
Water	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Food	1.80E-05	4.17E-06	6.60E-02	6.32E-05	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Total					6.32E-05

Cadmium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.90E+00	0.00E+00	1.45E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.45E+00	0.00E+00	
Food	3.89E-04	9.03E-05	1.45E+00	6.23E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.45E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.45E+00	0.00E+00	
Total					6.23E-05

Chromium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.49E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	9.83E-03			2.85E-03						1.00E+00	8.00E-01	2.28E-03
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cobalt	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Chromium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.49E+01	0.00E+00	1.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	9.83E-03	2.28E-03	1.00E+00	2.28E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					2.28E-03

Cobalt	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Total					0.00E+00

Individual Dose Calculations - Maximum Concentrations

Copper	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	6.63E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	7.96E-02			2.31E-02						1.00E+00	8.00E-01	1.84E-02
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cyanide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	2.10E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.52E+00			7.30E-01						1.00E+00	8.00E-01	5.84E-01
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Copper	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.63E+01	0.00E+00	4.70E+01	0.00E+00	
Water	0.00E+00	0.00E+00	4.70E+01	0.00E+00	
Food	7.96E-02	1.84E-02	4.70E+01	3.93E-04	
Inhalation					
Air	0.00E+00	0.00E+00	4.70E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.70E+01	0.00E+00	
Total					3.93E-04

Cyanide	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.10E+01	0.00E+00	6.87E-01	0.00E+00	
Water	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Food	2.52E+00	5.84E-01	6.87E-01	8.51E-01	
Inhalation					
Air	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Total					8.51E-01

Lead	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	6.08E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.19E-03			6.34E-04						1.00E+00	8.00E-01	5.08E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Manganese	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.89E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.26E-02			6.56E-03						1.00E+00	8.00E-01	5.25E-03
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Lead	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.08E+01	0.00E+00	3.85E+00	0.00E+00	
Water	0.00E+00	0.00E+00	3.85E+00	0.00E+00	
Food	2.19E-03	5.08E-04	3.85E+00	1.32E-04	
Inhalation					
Air	0.00E+00	0.00E+00	3.85E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.85E+00	0.00E+00	
Total					1.32E-04

Manganese	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.89E+01	0.00E+00	9.77E+02	0.00E+00	
Water	0.00E+00	0.00E+00	9.77E+02	0.00E+00	
Food	2.26E-02	5.25E-03	9.77E+02	5.37E-06	
Inhalation					
Air	0.00E+00	0.00E+00	9.77E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.77E+02	0.00E+00	
Total					5.37E-06

Mercury	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.60E-01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	4.80E-03			1.39E-03						1.00E+00	8.00E-01	1.11E-03
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Nickel	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	2.70E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.94E-03			5.63E-04						1.00E+00	8.00E-01	4.51E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Mercury	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.60E-01	0.00E+00	4.50E-01	0.00E+00	
Water	0.00E+00	0.00E+00	4.50E-01	0.00E+00	
Food	4.80E-03	1.11E-03	4.50E-01	2.47E-03	
Inhalation					
Air	0.00E+00	0.00E+00	4.50E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.50E-01	0.00E+00	
Total					2.47E-03

Nickel	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.70E+00	0.00E+00	4.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Food	1.94E-03	4.51E-04	4.00E+00	1.13E-04	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Total					1.13E-04

Selenium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Silver	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.50E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	5.40E-04			1.57E-04						1.00E+00	8.00E-01	1.25E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Selenium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Total					0.00E+00

Silver	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E+00	0.00E+00	1.81E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.81E+00	0.00E+00	
Food	5.40E-04	1.25E-04	1.81E+00	6.92E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.81E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.81E+00	0.00E+00	
Total					6.92E-05

Individual Dose Calculations - Maximum Concentrations

Tin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.12E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.08E-01			3.12E-02						1.00E+00	8.00E-01	2.49E-02
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Vanadium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	8.30E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.49E-03			7.22E-04						1.00E+00	8.00E-01	5.77E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Tin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.12E+01	0.00E+00	6.80E+00	0.00E+00	
Water	0.00E+00	0.00E+00	6.80E+00	0.00E+00	
Food	1.08E-01	2.49E-02	6.80E+00	3.67E-03	
Inhalation					
Air	0.00E+00	0.00E+00	6.80E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.80E+00	0.00E+00	
Total					3.67E-03

Vanadium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.30E+00	0.00E+00	1.14E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Food	2.49E-03	5.77E-04	1.14E+01	5.06E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Total					5.06E-05

Zinc	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	6.63E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.28E+00			3.71E-01						1.00E+00	8.00E-01	2.97E-01
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Zinc	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.63E+01	0.00E+00	1.45E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.45E+01	0.00E+00	
Food	1.28E+00	2.97E-01	1.45E+01	2.05E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.45E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.45E+01	0.00E+00	
Total					2.05E-02

Individual Dose Calculations - Maximum Concentrations

4,4'-DDD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.12E+01				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	2.95E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	5.16E-04			1.49E-04						1.00E+00	8.00E-01	1.20E-04
Food-veg.	4.34E-01				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

4,4'-DDD	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Water	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Food	3.12E+01	0.00E+00	2.80E-03	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Total					0.00E+00

4,4'-DDE	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.95E-02	0.00E+00	2.80E-03	0.00E+00	
Water	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Food	4.35E-01	1.20E-04	2.80E-03	4.27E-02	
Inhalation					
Air	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Total					4.27E-02

4,4'-DDT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	3.64E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	6.91E-04			2.00E-04						1.00E+00	8.00E-01	1.60E-04
Food-veg.	1.32E-01				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Alpha-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.49E+01				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

4,4'-DDT	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.64E-02	0.00E+00	2.80E-03	0.00E+00	
Water	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Food	1.33E-01	1.60E-04	2.80E-03	5.72E-02	
Inhalation					
Air	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Total					5.72E-02

Alpha-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Food	1.49E+01	0.00E+00	5.60E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Total					0.00E+00

Aroclor-1260	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.00E-03				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Beta-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.16E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aroclor-1260	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Food	2.00E-03	0.00E+00	1.80E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Total					0.00E+00

Beta-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Food	6.16E+00	0.00E+00	5.60E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Total					0.00E+00

2,4-D	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.38E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2,4,5-T	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	9.20E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

2,4-D	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	1.38E+00	0.00E+00	1.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					0.00E+00

2,4,5-T	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Food	9.20E-02	0.00E+00	3.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Total					0.00E+00

2,4,5-TP (Silvex)	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.63E+02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan I	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.33E+01				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2,4,5-TP (Silvex)	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Water	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Food	1.63E+02	0.00E+00	7.50E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Total					0.00E+00

Endosulfan I	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	3.33E+01	0.00E+00	1.00E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					0.00E+00

Endosulfan II	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.17E+02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	5.58E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Endosulfan II	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	1.17E+02	0.00E+00	1.00E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					0.00E+00

Endrin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Food	5.58E+00	0.00E+00	3.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Total					0.00E+00

Individual Dose Calculations - Maximum Concentrations

Heptachlor epoxide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.01E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Heptachlor.	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.53E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Heptachlor epoxide	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Food	3.01E+00	0.00E+00	1.00E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Total					0.00E+00

Heptachlor	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Food	1.53E-02	0.00E+00	1.00E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Total					0.00E+00

Benzo(a)pyrene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	3.04E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Bis(2-ethylhexyl)phthalate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	2.20E-01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.66E-04			4.81E-05						1.00E+00	8.00E-01	3.84E-05
Food-veg.	3.87E-01				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Benzo(a)pyrene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	3.04E+00	0.00E+00	1.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					0.00E+00

Bis(2-ethylhexyl)phthalate	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.20E-01	0.00E+00	1.10E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.10E+01	0.00E+00	
Food	3.87E-01	3.84E-05	1.10E+01	3.49E-06	
Inhalation					
Air	0.00E+00	0.00E+00	1.10E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.10E+01	0.00E+00	
Total					3.49E-06

Fluoranthene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.93E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Pyrene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.43E+03				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Fluoranthene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Food	6.93E-02	0.00E+00	1.25E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Total					0.00E+00

Pyrene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.50E+00	0.00E+00	
Water	0.00E+00	0.00E+00	7.50E+00	0.00E+00	
Food	1.43E+03	0.00E+00	7.50E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E+00	0.00E+00	
Total					0.00E+00

Individual Dose Calculations - Maximum Concentrations

1,1,2,2-tetrachloroethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.54E-01				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4-methyl-2-pentanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	6.45E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

1,1,2,2-tetrachloroethene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Food	1.54E-01	0.00E+00	2.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Total					0.00E+00

4-methyl-2-pentanone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Water	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Food	6.45E-02	0.00E+00	2.50E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Total					0.00E+00

2-butanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.13E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Acetone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	7.00E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.22E-10			3.55E-11						1.00E+00	8.00E-01	2.84E-11
Food-veg.	6.22E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

2-butanone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Water	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Food	2.13E-02	0.00E+00	1.77E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Total					0.00E+00

Acetone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-02	0.00E+00	1.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	6.22E-02	2.84E-11	1.00E+01	2.84E-12	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					2.84E-12

Carbon Tetrachloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	3.00E-03							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.22E-09			6.42E-10						1.00E+00	8.00E-01	5.14E-10
Food-veg.	3.32E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cis-1,2-dichlorethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	1.90E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.73E-09			5.01E-10						1.00E+00	8.00E-01	4.01E-10
Food-veg.	5.48E-03				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Carbon Tetrachloride	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.00E-03	0.00E+00	1.60E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.60E+00	0.00E+00	
Food	3.32E+00	5.14E-10	1.60E+00	3.21E-10	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+00	0.00E+00	
Total					3.21E-10

Cis-1,2-dichlorethene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.90E-02	0.00E+00	4.52E+01	0.00E+00	
Water	0.00E+00	0.00E+00	4.52E+01	0.00E+00	
Food	5.48E-03	4.01E-10	4.52E+01	8.87E-12	
Inhalation					
Air	0.00E+00	0.00E+00	4.52E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.52E+01	0.00E+00	
Total					8.87E-12

Individual Dose Calculations - Maximum Concentrations

Ethylbenzene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	1.36E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Methylene chloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	6.90E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	3.70E-09			1.07E-09						1.00E+00	8.00E-01	8.58E-10
Food-veg.	9.34E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Ethylbenzene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Water	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Food	1.36E-02	0.00E+00	4.08E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Total					0.00E+00

Methylene chloride	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.90E-02	0.00E+00	5.85E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.85E-01	0.00E+00	
Food	9.34E-02	8.58E-10	5.85E-01	1.47E-09	
Inhalation					
Air	0.00E+00	0.00E+00	5.85E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.85E-01	0.00E+00	
Total					1.47E-09

Toluene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	2.14E-02				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Xylene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		1.38E-01	4.00E+04									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	7.94E-05				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Toluene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Water	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Food	2.14E-02	0.00E+00	2.60E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Total					0.00E+00

Xylene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Water	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Food	7.94E-05	0.00E+00	2.06E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Total					0.00E+00

GREAT BLUE HERON

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
Aluminum	3.18E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	3.60E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	1.40E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium	1.19E+01	0.00E+00	2.20E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	1.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	5.90E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	1.49E+01	0.00E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	6.63E+01	0.00E+00	3.83E+01	0.00E+00	0.00E+00	0.00E+00
Cyanide	2.10E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead	6.08E+01	0.00E+00	2.90E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	1.89E+01	0.00E+00	5.50E+00	0.00E+00	0.00E+00	0.00E+00
Mercury	1.60E-01	0.00E+00	1.00E-01	0.00E+00	0.00E+00	0.00E+00
Nickel	2.70E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver	1.50E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin	1.12E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium	8.30E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc	6.63E+01	0.00E+00	1.09E+02	0.00E+00	0.00E+00	0.00E+00

Predicted Chemical Concentration by Media (mg/kg except air, which is ng/m3)						
Chemical	Ingestion				Inhalation	Dermal
	Soil	Water	Food-Animal	Food-Veget.	Air	Soil
4,4'-DDD	0.00E+00	0.00E+00	2.40E-03	0.00E+00	0.00E+00	0.00E+00
4,4'-DDE	2.95E-02	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
4,4'-DDT	3.64E-02	0.00E+00	2.40E-02	0.00E+00	0.00E+00	0.00E+00
Alpha-BHC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor-1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beta-BHC	0.00E+00	0.00E+00	3.00E-03	0.00E+00	0.00E+00	0.00E+00
2,4-D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,5-T	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,5-TP (Silvex)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endosulfan I	0.00E+00	0.00E+00	1.20E-02	0.00E+00	0.00E+00	0.00E+00
Endosulfan II	0.00E+00	0.00E+00	2.70E-03	0.00E+00	0.00E+00	0.00E+00
Endrin	0.00E+00	0.00E+00	1.10E-03	0.00E+00	0.00E+00	0.00E+00
Heptachlor epoxide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptachlor	0.00E+00	0.00E+00	4.40E-03	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bis(2-ethylhexyl)phthalate	2.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene	0.00E+00	0.00E+00	4.30E-01	0.00E+00	0.00E+00	0.00E+00
1,1,2,2-tetrachloroethene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-methyl-2-pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-butanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acetone	7.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon Tetrachloride	3.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cis-1,2-dichlorethene	1.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylene chloride	6.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aldrin	0.00E+00	0.00E+00	2.70E-03	0.00E+00	0.00E+00	0.00E+00
gamma-BHC	0.00E+00	0.00E+00	6.60E-04	0.00E+00	0.00E+00	0.00E+00
delta-BHC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chlorobenzilate	0.00E+00	0.00E+00	1.70E-03	0.00E+00	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00	2.80E-03	0.00E+00	0.00E+00	0.00E+00
Endosulfan Sulfate	0.00E+00	0.00E+00	7.60E-02	0.00E+00	0.00E+00	0.00E+00
Endrin Aldehyde	0.00E+00	0.00E+00	2.60E-02	0.00E+00	0.00E+00	0.00E+00
Isodrin	0.00E+00	0.00E+00	6.20E-03	0.00E+00	0.00E+00	0.00E+00
Methoxychlor	0.00E+00	0.00E+00	2.70E-02	0.00E+00	0.00E+00	0.00E+00
Phenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: GREAT BLUE HERON

CHEMICAL			HAZARD QUOTIENT
Aluminum			0.00E+00
Antimony			0.00E+00
Arsenic			0.00E+00
Barium			6.26E-01
Beryllium			0.00E+00
Cadmium			0.00E+00
Chromium			1.58E-01
Cobalt			0.00E+00
Copper			1.17E-01
Cyanide			0.00E+00
Lead			1.08E-01
Manganese			8.10E-04
Mercury			3.20E-02
Nickel			0.00E+00
Selenium			0.00E+00
Silver			0.00E+00
Tin			0.00E+00
Vanadium			0.00E+00
Zinc			1.08E+00
TOTAL			2.12E+00

RISK ASSESSMENT SPREADSHEET - INGESTION OF FOOD

EXPOSURE SCENARIO: THIS ASSUMES 80% ABSORPTION OF EACH CHEMICAL
RECEPTOR: GREAT BLUE HERON

CHEMICAL			HAZARD QUOTIENT
4,4'-DDD			1.23E-01
4,4'-DDE			2.57E-01
4,4'-DDT			1.23E+00
Alpha-BHC			0.00E+00
Aroclor-1260			0.00E+00
Beta-BHC			7.71E-04
2,4-D			0.00E+00
2,4,5-T			0.00E+00
2,4,5-TP (Silvex)			0.00E+00
Endosulfan I			1.73E-04
Endosulfan II			3.88E-05
Endrin			5.27E-04
Heptachlor epoxide			0.00E+00
Heptachlor			6.33E-02
Benzo(a)pyrene			0.00E+00
Bis(2-ethylhexyl)phthalate			0.00E+00
Fluoranthene			0.00E+00
Pyrene			8.25E-03
1,1,2,2-tetrachloroethene			0.00E+00
4-methyl-2-pentanone			0.00E+00
2-butanone			0.00E+00
Acetone			0.00E+00
Carbon Tetrachloride			0.00E+00
Cis-1,2-dichlorethene			0.00E+00
Ethylbenzene			0.00E+00
Methylene chloride			0.00E+00
Toluene			0.00E+00
Xylene			0.00E+00
Aldrin			1.94E-02
gamma-BHC			1.70E-04
delta-BHC			0.00E+00
Dieldrin			5.23E-03
Endosulfan Sulfate			1.09E-03
Endrin Aldehyde			1.25E-02
Methoxychlor			9.71E-03
TOTAL			1.73E+00

Aluminum	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	3.18E+03							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Antimony	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	3.60E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aluminum	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.18E+03	0.00E+00	1.10E+02	0.00E+00	
Water	0.00E+00	0.00E+00	1.10E+02	0.00E+00	
Food	0.00E+00	0.00E+00	1.10E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.10E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.10E+02	0.00E+00	
Total					0.00E+00

Antimony	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.60E+00	0.00E+00	1.25E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.25E-02	0.00E+00	
Food	0.00E+00	0.00E+00	1.25E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E-02	0.00E+00	
Total					0.00E+00

Arsenic	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.40E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Barium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.19E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.20E+00			3.96E-01						1.00E+00	8.00E-01	3.17E-01
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Arsenic	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.40E+00	0.00E+00	1.26E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Food	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.26E-02	0.00E+00	
Total					0.00E+00

Barium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.19E+01	0.00E+00	5.06E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.06E-01	0.00E+00	
Food	2.20E+00	3.17E-01	5.06E-01	6.26E-01	
Inhalation					
Air	0.00E+00	0.00E+00	5.06E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.06E-01	0.00E+00	
Total					6.26E-01

Individual Dose Calculations - Maximum Concentrations

Beryllium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.50E-01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cadmium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	5.90E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Beryllium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E-01	0.00E+00	6.60E-02	0.00E+00	
Water	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Food	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.60E-02	0.00E+00	
Total					0.00E+00

Cadmium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	5.90E+00	0.00E+00	1.45E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.45E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.45E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.45E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.45E+00	0.00E+00	
Total					0.00E+00

Chromium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.49E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.10E+00			1.98E-01						1.00E+00	8.00E-01	1.58E-01
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cobalt	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Chromium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.49E+01	0.00E+00	1.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Food	1.10E+00	1.58E-01	1.00E+00	1.58E-01	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+00	0.00E+00	
Total					1.58E-01

Cobalt	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.57E+00	0.00E+00	
Total					0.00E+00

Copper	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	6.63E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	3.83E+01			6.89E+00						1.00E+00	8.00E-01	5.51E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cyanide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	2.10E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Copper	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.63E+01	0.00E+00	4.70E+01	0.00E+00	
Water	0.00E+00	0.00E+00	4.70E+01	0.00E+00	
Food	3.83E+01	5.51E+00	4.70E+01	1.17E-01	
Inhalation					
Air	0.00E+00	0.00E+00	4.70E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.70E+01	0.00E+00	
Total					1.17E-01

Cyanide	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.10E+01	0.00E+00	6.87E-01	0.00E+00	
Water	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Food	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.87E-01	0.00E+00	
Total					0.00E+00

Lead	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	6.08E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.90E+00			5.22E-01						1.00E+00	8.00E-01	4.17E-01
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Manganese	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.89E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	5.50E+00			9.89E-01						1.00E+00	8.00E-01	7.92E-01
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Lead	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.08E+01	0.00E+00	3.85E+00	0.00E+00	
Water	0.00E+00	0.00E+00	3.85E+00	0.00E+00	
Food	2.90E+00	4.17E-01	3.85E+00	1.08E-01	
Inhalation					
Air	0.00E+00	0.00E+00	3.85E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.85E+00	0.00E+00	
Total					1.08E-01

Manganese	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.89E+01	0.00E+00	9.77E+02	0.00E+00	
Water	0.00E+00	0.00E+00	9.77E+02	0.00E+00	
Food	5.50E+00	7.92E-01	9.77E+02	8.10E-04	
Inhalation					
Air	0.00E+00	0.00E+00	9.77E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	9.77E+02	0.00E+00	
Total					8.10E-04

Individual Dose Calculations - Maximum Concentrations

Mercury	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.60E-01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.00E-01			1.80E-02						1.00E+00	8.00E-01	1.44E-02
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Nickel	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	2.70E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Mercury	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.60E-01	0.00E+00	4.50E-01	0.00E+00	
Water	0.00E+00	0.00E+00	4.50E-01	0.00E+00	
Food	1.00E-01	1.44E-02	4.50E-01	3.20E-02	
Inhalation					
Air	0.00E+00	0.00E+00	4.50E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.50E-01	0.00E+00	
Total					3.20E-02

Nickel	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.70E+00	0.00E+00	4.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E+00	0.00E+00	
Total					0.00E+00

Selenium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Silver	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.50E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Selenium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.80E+00	0.00E+00	
Total					0.00E+00

Silver	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.50E+00	0.00E+00	1.81E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.81E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.81E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.81E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.81E+00	0.00E+00	
Total					0.00E+00

Tin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.12E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Vanadium	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	8.30E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Tin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.12E+01	0.00E+00	6.80E+00	0.00E+00	
Water	0.00E+00	0.00E+00	6.80E+00	0.00E+00	
Food	0.00E+00	0.00E+00	6.80E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	6.80E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	6.80E+00	0.00E+00	
Total					0.00E+00

Vanadium	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	8.30E+00	0.00E+00	1.14E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.14E+01	0.00E+00	
Total					0.00E+00

Zinc	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	6.63E+01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.09E+02			1.96E+01						1.00E+00	8.00E-01	1.57E+01
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Zinc	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.63E+01	0.00E+00	1.45E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.45E+01	0.00E+00	
Food	1.09E+02	1.57E+01	1.45E+01	1.08E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.45E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.45E+01	0.00E+00	
Total					1.08E+00

4,4'-DDD	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.40E-03			4.32E-04						1.00E+00	8.00E-01	3.45E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4,4'-DDE	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	2.95E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	5.00E-03			8.99E-04						1.00E+00	8.00E-01	7.19E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

4,4'-DDD	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Water	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Food	2.40E-03	3.45E-04	2.80E-03	1.23E-01	
Inhalation					
Air	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Total					1.23E-01

4,4'-DDE	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.95E-02	0.00E+00	2.80E-03	0.00E+00	
Water	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Food	5.00E-03	7.19E-04	2.80E-03	2.57E-01	
Inhalation					
Air	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Total					2.57E-01

4,4'-DDT	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	3.64E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.40E-02			4.32E-03						1.00E+00	8.00E-01	3.45E-03
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Alpha-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

4,4'-DDT	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.64E-02	0.00E+00	2.80E-03	0.00E+00	
Water	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Food	2.40E-02	3.45E-03	2.80E-03	1.23E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.80E-03	0.00E+00	
Total					1.23E+00

Alpha-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Food	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Total					0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aroclor-1260	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Beta-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	3.00E-03			5.39E-04						1.00E+00	8.00E-01	4.32E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aroclor-1260	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.80E-01	0.00E+00	
Total					0.00E+00

Beta-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Food	3.00E-03	4.32E-04	5.60E-01	7.71E-04	
Inhalation					
Air	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Total					7.71E-04

2,4-D	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2,4,5-T	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

2,4-D	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					0.00E+00

2,4,5-T	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Total					0.00E+00

2,4,5-TP (Silvex)	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan I	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.20E-02			2.16E-03						1.00E+00	8.00E-01	1.73E-03
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

2,4,5-TP (Silvex)	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Water	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Food	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E-02	0.00E+00	
Total					0.00E+00

Endosulfan I	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	1.20E-02	1.73E-03	1.00E+01	1.73E-04	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					1.73E-04

Endosulfan II	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.70E-03			4.86E-04						1.00E+00	8.00E-01	3.88E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.10E-03			1.98E-04						1.00E+00	8.00E-01	1.58E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan II	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	2.70E-03	3.88E-04	1.00E+01	3.88E-05	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					3.88E-05

Endrin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Food	1.10E-03	1.58E-04	3.00E-01	5.27E-04	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Total					5.27E-04

Heptachlor epoxide	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Heptachlor	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Uptake from Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	4.40E-03			7.91E-04						1.00E+00	8.00E-01	6.33E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Heptachlor epoxide	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Total					0.00E+00

Heptachlor	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Food	4.40E-03	6.33E-04	1.00E-02	6.33E-02	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-02	0.00E+00	
Total					6.33E-02

Benzo(a)pyrene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Bis(2-ethylhexyl)phthalate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	2.20E-01							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Benzo(a)pyrene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E-01	0.00E+00	
Total					0.00E+00

Bis(2-ethylhexyl)phthalate	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	2.20E-01	0.00E+00	1.10E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.10E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.10E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.10E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.10E+01	0.00E+00	
Total					0.00E+00

Fluoranthene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Pyrene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	4.30E-01			7.73E-02						1.00E+00	8.00E-01	6.19E-02
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Fluoranthene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.25E+00	0.00E+00	
Total					0.00E+00

Pyrene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.50E+00	0.00E+00	
Water	0.00E+00	0.00E+00	7.50E+00	0.00E+00	
Food	4.30E-01	6.19E-02	7.50E+00	8.25E-03	
Inhalation					
Air	0.00E+00	0.00E+00	7.50E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.50E+00	0.00E+00	
Total					8.25E-03

1,1,2,2-tetrachloroethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

4-methyl-2-pentanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

1,1,2,2-tetrachloroethene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Water	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Food	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.00E+00	0.00E+00	
Total					0.00E+00

4-methyl-2-pentanone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Water	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Food	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.50E+00	0.00E+00	
Total					0.00E+00

2-butanone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Acetone	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	7.00E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

2-butanone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Water	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Food	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.77E+02	0.00E+00	
Total					0.00E+00

Acetone	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	7.00E-02	0.00E+00	1.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					0.00E+00

Carbon Tetrachloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	3.00E-03							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Cis-1,2-dichlorethene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	1.90E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Carbon Tetrachloride	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	3.00E-03	0.00E+00	1.60E+00	0.00E+00	
Water	0.00E+00	0.00E+00	1.60E+00	0.00E+00	
Food	0.00E+00	0.00E+00	1.60E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	1.60E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.60E+00	0.00E+00	
Total					0.00E+00

Cis-1,2-dichlorethene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	1.90E-02	0.00E+00	4.52E+01	0.00E+00	
Water	0.00E+00	0.00E+00	4.52E+01	0.00E+00	
Food	0.00E+00	0.00E+00	4.52E+01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.52E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.52E+01	0.00E+00	
Total					0.00E+00

Individual Dose Calculations - Maximum Concentrations

Ethylbenzene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Methylene chloride	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	6.90E-02							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Ethylbenzene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Water	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Food	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.08E+00	0.00E+00	
Total					0.00E+00

Methylene chloride	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	6.90E-02	0.00E+00	5.85E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.85E-01	0.00E+00	
Food	0.00E+00	0.00E+00	5.85E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.85E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.85E-01	0.00E+00	
Total					0.00E+00

Individual Dose Calculations - Maximum Concentrations

Toluene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Xylene	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Toluene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Water	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Food	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.60E+00	0.00E+00	
Total					0.00E+00

Xylene	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Water	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Food	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.06E-01	0.00E+00	
Total					0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aldrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.70E-03			4.86E-04						1.00E+00	8.00E-01	3.88E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

gamma-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	6.60E-04			1.19E-04						1.00E+00	8.00E-01	9.49E-05
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Aldrin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Water	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Food	2.70E-03	3.88E-04	2.00E-02	1.94E-02	
Inhalation					
Air	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	2.00E-02	0.00E+00	
Total					1.94E-02

gamma-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Food	6.60E-04	9.49E-05	5.60E-01	1.70E-04	
Inhalation					
Air	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Total					1.70E-04

delta-BHC	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Chlorobenzilate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	1.70E-03			3.06E-04						1.00E+00	8.00E-01	2.45E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

delta-BHC	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Water	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Food	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Inhalation					
Air	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	5.60E-01	0.00E+00	
Total					0.00E+00

Chlorobenzilate	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Water	0.00E+00	0.00E+00	0.00E+00	N/A	
Food	1.70E-03	2.45E-04	0.00E+00	N/A	
Inhalation					
Air	0.00E+00	0.00E+00	0.00E+00	N/A	
Dermal					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Total					0.00E+00

Dieldrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.80E-03			5.03E-04						1.00E+00	8.00E-01	4.03E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endosulfan Sulfate	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	7.60E-02			1.37E-02						1.00E+00	8.00E-01	1.09E-02
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Dieldrin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	7.70E-02	0.00E+00	
Water	0.00E+00	0.00E+00	7.70E-02	0.00E+00	
Food	2.80E-03	4.03E-04	7.70E-02	5.23E-03	
Inhalation					
Air	0.00E+00	0.00E+00	7.70E-02	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	7.70E-02	0.00E+00	
Total					5.23E-03

Endosulfan Sulfate	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Water	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Food	7.60E-02	1.09E-02	1.00E+01	1.09E-03	
Inhalation					
Air	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	1.00E+01	0.00E+00	
Total					1.09E-03

Endrin Aldehyde	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.60E-02			4.68E-03						1.00E+00	8.00E-01	3.74E-03
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Isodrin	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	6.20E-03			1.11E-03						1.00E+00	8.00E-01	8.92E-04
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Endrin Aldehyde	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Food	2.60E-02	3.74E-03	3.00E-01	1.25E-02	
Inhalation					
Air	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	3.00E-01	0.00E+00	
Total					1.25E-02

Isodrin	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Water	0.00E+00	0.00E+00	0.00E+00	N/A	
Food	6.20E-03	8.92E-04	0.00E+00	N/A	
Inhalation					
Air	0.00E+00	0.00E+00	0.00E+00	N/A	
Dermal					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Total					0.00E+00

Methoxychlor	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	2.70E-02			4.86E-03						1.00E+00	8.00E-01	3.88E-03
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Phenol	Predicted Concent.	Weight kg	From Food mg/day	Intake from Meat mg/kg/day	Intake from Vegetation mg/kg/day	Intake from Water mg/kg/day	Dermal Uptake from Soil mg/kg/day	Dietary Intake Soil mg/kg/day	Air mg/kg/day	Fractional Intake	Absorption Fraction	Predicted Dose mg/kg-day
Ingestion		2.23E+00	4.01E+05									
Soil	0.00E+00							0.00E+00		1.00E+00	8.00E-01	0.00E+00
Water	0.00E+00					0.00E+00				1.00E+00	8.00E-01	0.00E+00
Food-an.	0.00E+00			0.00E+00						1.00E+00	8.00E-01	0.00E+00
Food-veg.	0.00E+00				0.00E+00					1.00E+00	8.00E-01	0.00E+00
Inhalation												
Air	0.00E+00								0.00E+00	1.00E+00	8.00E-01	0.00E+00
Dermal												
Soil	0.00E+00						0.00E+00			1.00E+00	8.00E-01	0.00E+00

Individual Dose Calculations - Maximum Concentrations

Methoxychlor	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Water	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Food	2.70E-02	3.88E-03	4.00E-01	9.71E-03	
Inhalation					
Air	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Dermal					
Soil	0.00E+00	0.00E+00	4.00E-01	0.00E+00	
Total					9.71E-03

Phenol	Concentration mg/kg	Dose mg/kg-day	TRV	Hazard Quotient	Hazard Index
Ingestion					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Water	0.00E+00	0.00E+00	0.00E+00	N/A	
Food	0.00E+00	0.00E+00	0.00E+00	N/A	
Inhalation					
Air	0.00E+00	0.00E+00	0.00E+00	N/A	
Dermal					
Soil	0.00E+00	0.00E+00	0.00E+00	N/A	
Total					0.00E+00

APPENDIX C

INVESTIGATION PROCEDURES

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1.0 FIELD PROCEDURES

This section discusses the general sampling operations and procedures used during the Supplemental Resource Conservation and Recovery Act (RCRA) Field Investigation (RFI) and Remedial Investigation (RI) performed August to October 1996. Details of the procedures referenced herein can be found in the Supplemental RFI/RI Sampling and Analysis Plan (SAP) (ABB, 1995).

Environmental samples including surface and subsurface soils, surface water, sediment, groundwater and biota were collected. The sample collection procedures presented in the following section cover the range of activities performed during the field investigation at NAS Key West. These procedures are consistent with the requirements of the Florida Department of Environmental Protection (FDEP) and the U.S. Environmental Protection Agency (EPA) Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (1991d).

1.1 SURFACE INVESTIGATION

1.1.1 <u>Surface Soil Sampling</u>

Surface debris and vegetation were removed from the ground surface before sample collection. Surface soil samples were collected from the ground surface to a maximum depth of 12 inches. A stainless steel trowel was used to collect samples. If the sample was unconsolidated, it was scraped directly into the sample bottle. If the sample material was consolidated, the sample was collected in a stainless steel bowl, homogenized, then transferred to the sample bottle. Volatile organic compound (VOC) samples were directly transferred to the sample bottle to avoid loss of volatiles.

1.1.2 <u>Surface-Water and Sediment Sampling</u>

Surface-water grab samples were collected from surface-water bodies, including borrow pits, drainage ditches, ocean inlets, and lagoons. Surface-water samples were collected by lowering the sample bottle beneath the surface until water began to flow into it. Unpreserved bottles were filled prior to preserved bottles. The bottle was then slowly turned upright, keeping the lip just below the surface as it filled. Surface-water samples were not filtered prior to sample collection and analysis; therefore, any metals analyses were for total metals.

Temperature, pH, specific conductivity, color, salinity, dissolved oxygen (DO), and turbidity were noted on the Sample Log Form for each surface-water sample.

Sediment samples were collected using a variety of sampling equipment including stainless steel trowels, bowls, or dredges, as required by the sample location and conditions. The sample was usually collected in finer-grained sediments that had the greatest potential for adsorbed contaminants. Depth of sample collection and sediment description were recorded on a Sample Log Form for each sediment sample.

In addition, the following procedures were applied during surface-water and sediment sampling: samples were collected first at downstream locations, and surface-water samples were collected before sediment samples.

1.2 SUBSURFACE INVESTIGATIONS

This section describes the procedures followed by field operations personnel during subsurface soil sampling and drilling.

1.2.1 Drilling Methods

Subsurface soil sampling was performed by hollow-stem auger (HSA) drilling. Investigation-derived waste (IDW) was containerized, and disposal was handled by NAS Key West personnel following receipt of analytical results.

1.2.1.1 General Drilling Requirements

The drilling protocol was approved by the State of Florida as a part of the 1993 IT Corporation Workplan. The items listed below were part of the standard operating procedure during drilling and well construction:

- Water was the only fluid used during drilling, as necessary.

- Boring logs (Appendix E of the Supplemental RFI/RI Report) were completed for all borings drilled. This was done through visual analysis of driller cuttings or periodic split-spoon samples which were taken during well installation.

- All data related to well construction were documented on a Well Construction Form (Appendix G of the Supplemental RFI/RI Report).

- Each well was constructed by a driller and drilling company certified by the State of Florida.

- A geologist from B&R Environmental logged all holes and oversaw all drilling operations.
- Well locations were approved by NAS Key West before installation.
- Casing material conformed to American Society for Testing and Materials (ASTM) Standard F-480.88A or National Sanitation Foundation Standard 14.
- A notch was cut into the top of the casing to be used as a reference point for the elevation survey and for the measuring of water levels.

1.3 GROUNDWATER INVESTIGATIONS

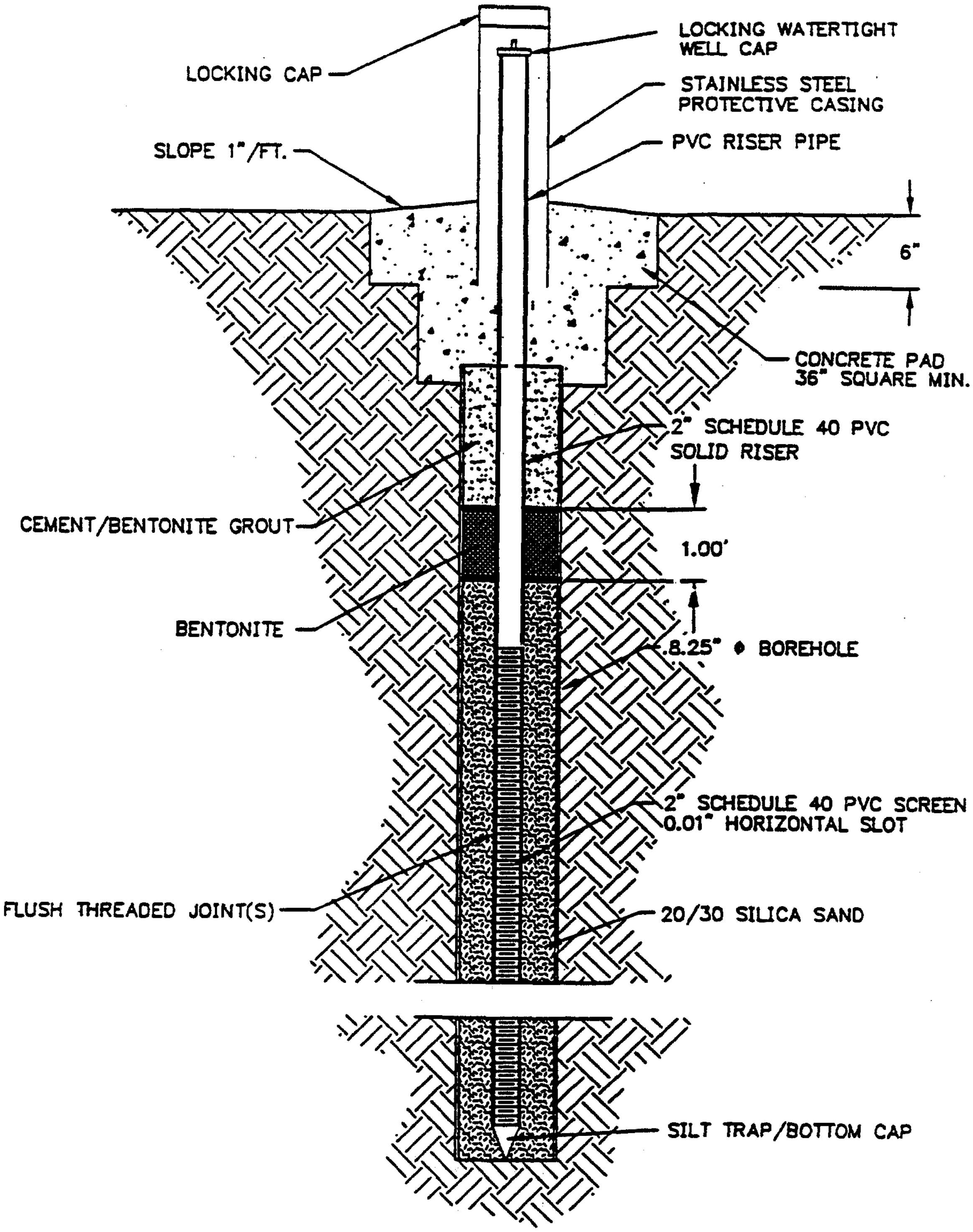
Sixteen permanent groundwater monitoring wells were installed during the field investigation. These wells were used to determine groundwater levels, to collect samples for analysis, and to investigate aquifer parameters.

During the construction of all monitoring wells, the on-site geologist recorded a complete and detailed log of all materials and their placement on a Well Completion Form (Appendix G of the Supplemental RFI/RI Report) that became part of the permanent project file.

1.3.1 Monitoring Well Installation

After boring to a sufficient depth in the target zone of groundwater saturation, monitoring wells were installed in the borehole. An 8.25-inch outer diameter HSA was used, providing more than 3 inches of filter pack annulus once the well was installed (a minimum 2-inch filter pack annulus is required). Shallow wells were installed to depths of approximately 13 feet below land surface (bls). Flush mount wells were installed where necessitated by vehicular traffic or the mowing of grass. Figures C.1-1 and C.1-2 show typical above- and below-ground completions.

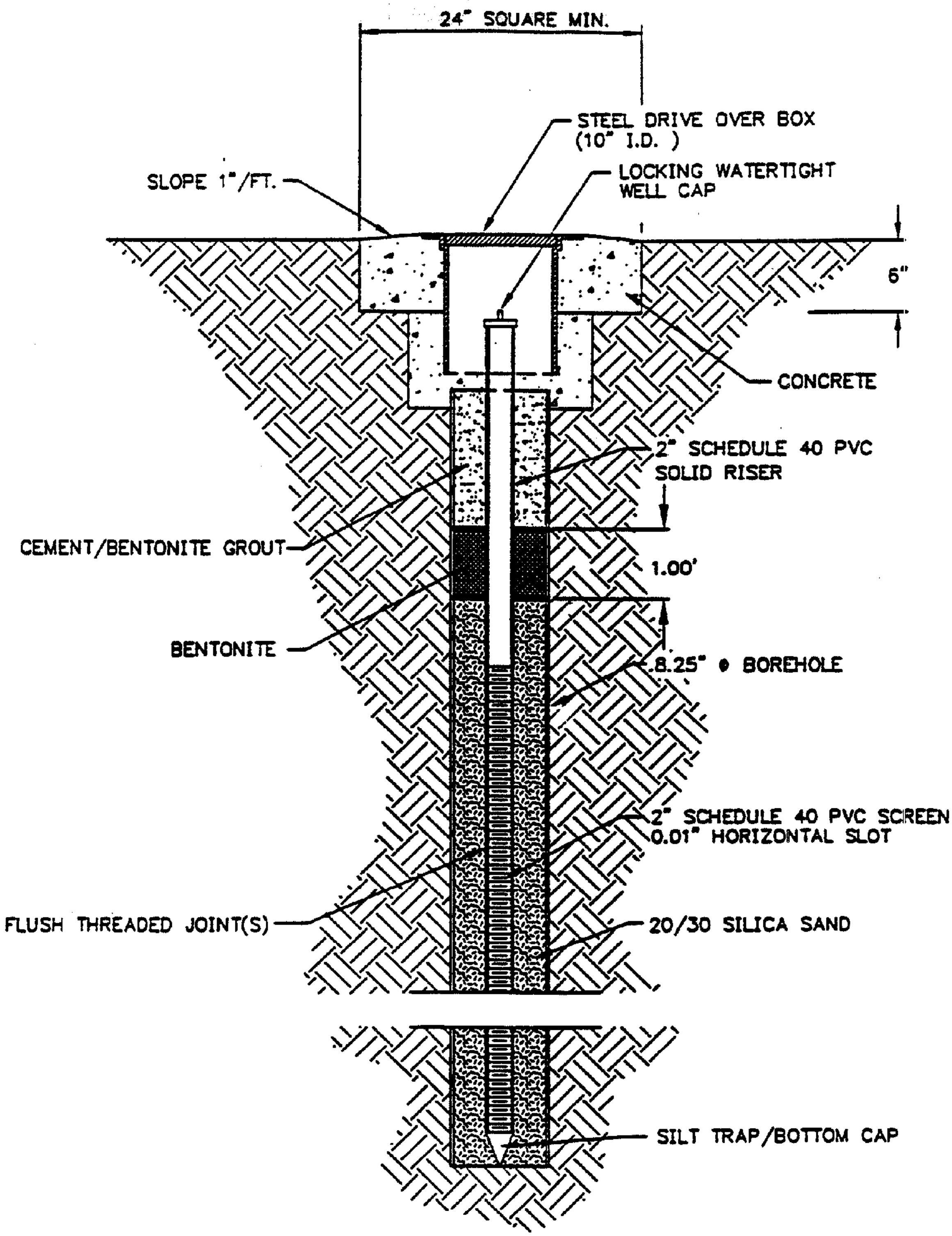
Ideally the screen should intersect the water table at all times, and water table fluctuations should be accounted for during installation. However, the water table was at 2 feet bls or less in most locations at NAS Key West, so the top of the screen was placed at approximately 2 to 3 feet bls to allow for a minimum of 1 foot sand pack above the top of screen, at least 1 foot of bentonite seal, and approximately 6 inches of concrete cap. The original IT Corporation Workplan (1993) called for 2 feet of bentonite seal, which was reduced to place the top of the screen at the highest possible elevation.



MONITORING WELL DETAIL

(ABOVE GROUND COMPLETION)

SITE MANAGER: RD	CHECKED BY: KW	Brown & Root Environmental	FIGURE C.1-1
DRAWN BY: TCB	DRAWING DATE: 7/24/96		MONITORING WELL DETAIL (ABOVE GROUND COMPLETION)
SURVEYED BY:	SURVEY DATE:		NAVAL AIR STATION BOCA CHICA KEY, FLORIDA
SCALE: N.T.S.			
CAD DWG. NO.: HK7046-D	PROJ. NO.: HK7046		



MONITORING WELL DETAIL
(BELOW GROUND COMPLETION)

SITE MANAGER: RD	CHECKED BY: KW	Brown & Root Environmental	FIGURE C.1-2 MONITORING WELL DETAIL (BELOW GROUND COMPLETION) NAVAL AIR STATION BOCA CHICA KEY, FLORIDA
DRAWN BY: TCB	DRAWING DATE: 7/27/96		
SURVEYED BY:	SURVEY DATE:		
SCALE: N.T.S.			
CAD DWG. NO.: HK7046-D	PROJ. NO.: HK7046		

Fully penetrating 10-foot screens were used, and the borehole was typically drilled 1 foot below the desired screened interval to accommodate a silt trap. The annulus around the silt trap was then backfilled with the filter pack material.

The filter pack used for the wells was silica sand certified as clean by the manufacturer. It was placed from the bottom of the hole to at least 1 foot above the top of the well screen. When shallow wells were installed through HSAs, the augers were used as a tremmie pipe. The augers were lifted at the approximate rate that the sand was emplaced. Potable water that had been determined to be clean through the use of field blank samples was used to emplace the filter pack, when necessary. All the monitoring wells were completed in the indigenous oolitic limestone. A 20/30 sieve-size filter pack was selected because it was readily available and promoted interstitial drainage of the filter material. This procedure simplified and standardized the well construction process and facilitated meeting the requirements to obtain consistent readings of temperature, pH, conductivity, and turbidity (i.e., the parameters monitored to determine when a well was developed or sufficiently purged). The very fine-grained filter pack required to match the standard water well design specifications described below [which were considered inappropriate for monitoring wells in nonaquifer formations (Gass, 1988 and 1989)] was not used. The use of very fine-grained filter materials slows the well development and purging process because these materials have a high specific retention and lower conductivity (compared to a 20/30-size sand). Over time they may also be more susceptible to invasion and clogging by formation fines and encrustation by microbes and chemical precipitation. A screen slot size of 0.01 inch was used with the 20/30-size filter pack.

The wells were constructed with 2-inch diameter machine-slotted, 10-foot long, Schedule 40 polyvinyl/chloride (PVC) screens and silt traps. Above each screen section was a 2-inch, threaded, Schedule 40 PVC riser topped with a well cap. The top of the sand pack was sounded during placement to verify its depth. If after surging the well the sand level subsided, additional sand was placed into the annulus to return the top of the sand to at least 1 foot above the top of the screen.

One foot of 100 percent sodium bentonite pellets or powder was placed into the annulus on top of the filter pack. The bentonite was hydrated with potable water and allowed to cure for over 24 hours, producing a seal to prevent downward migration of the overlying grout or percolation of surface water into the filter pack. A grout mixture was placed from the top of the bentonite seal to the ground surface. The grout was mixed at the following proportions: 20 pounds of neat Type 1 Portland or American Petroleum Institute Class A cement to not more than 1 pound of 100 percent sodium bentonite powder with not more than 2 gallons of water.

1.3.2 Well Surface Completion

The monitoring wells were constructed using above ground or flush completion methods. Wells constructed above ground had steel protector casing with a normal diameter at least 6 inches greater than the diameter of the well riser. Each aboveground completion had a 3-foot by 3-foot by 6-inch steel-reinforced concrete pad sloping at 1-inch/foot away from the steel casing. The bottom of the pad was set 2 inches bls. A well identification information tag was permanently affixed to the protective casing.

Surface completions were flush with the ground where above ground construction was not feasible. The well riser was cut approximately 3 inches bls. A freely draining valve box (or equivalent) with a bolt-down cover was placed over the well head. The top of the well riser was approximately 1 foot above the bottom of the box. The lid was centered in a 2-foot by 2-foot, 6-inch thick concrete pad sloping at 1-inch per foot away from the box. Well identification was permanently marked on the box lid and well cap (where possible).

1.3.3 Well Development

Monitoring wells were developed to remove fine-grained sediments and to break down the filter cake or smearing along the borehole wall. The preferred method of development was surging alternating with peristaltic pumping. All development equipment was decontaminated before placement in the well. Throughout the development procedure, discharge water color and volume were documented. Wells were developed until the criteria below were achieved:

- Turbidity remained within a 10-nephelometric unit range.
- The following parameters stabilized:
  - Temperature plus or minus 1° centigrade
  - pH plus or minus 1 unit
  - Electrical conductivity plus or minus 5 percent
- Accumulated sediment was removed from the well

At most locations the well screen was placed in the oolitic limestone. The primary function of these wells was to provide representative, sediment-free samples of the formation water. The wells were not intended for sustained water production. Large hydraulic gradients that might induce piping of fines through the filter pack and into the well were avoided through the use of low-energy well development and well purging techniques and through minimization of drawdown. The objective of monitoring well development was to flush the well screen and well casing and to compact and stabilize the filter pack around the well screen

(Gass, 1989). Development in this case proceeded with gentle (low-energy) surging alternated with low-flow-rate pumping. The action continued until the stabilization parameters had been reached or until five borehole volumes had been extracted, whichever was first. This criterion was based on the FDEP standard operation procedures (SOPs) for well purging.

In general, the well development process considered the items below.

- Development began no sooner than 24 hours after well installation.
- Wells were free of suspended sediments or fines.
- No detergents, bleaches, soaps, or other such agents were used to develop a well.

1.3.4 Groundwater Sampling

Groundwater samples were collected from monitoring wells after they had been properly developed and purged and not before the water level had recovered to 80 percent of its static level. No samples were collected within 24 hours of the well development. The purging procedure was designed to remove stagnant water from the well casing and the filter pack around the casing, ensuring that fresh formation water was sampled. The calculation of the purge volume required that the following two variables be known: height of the water column in the well and diameter of the well casing.

The casing volume was calculated using the formula below.

$$V = (\pi r^2 h)\ 7.48$$

where

V	=	volume of well casing and borehole, in gallons (gal)
π	=	3.14
r	=	radius of well casing, in feet (ft)
h	=	height of water column in well, in ft
7.48	=	gal/ft^3

Before purging, the air in the breathing zone was checked with a Sensodyne (or Portable FID at SWMU-1) flame ionization detector (FID), as prescribed in the Health and Safety Plan.

Wells were purged with a peristaltic pump constructed of stainless steel and Teflon®. Purging took place at a "low-flow" rate [approximately 300 milliliters per minute(m/min)] to prevent agitation of sediments in the well. The dedicated pump tubing was lowered into the well in a slow, controlled manner.

The temperature, pH, DO, electrical conductivity (EC), salinity, and turbidity were measured and recorded after removal of each gallon during purging. Purging was considered complete after a minimum of three casing volumes had been removed, time-consecutive readings were within 5 percent, and turbidity was below 5 nephelometric turbidity units (NTUs), if possible. If such stabilization of parameters could not be attained, then a maximum of five casing volumes was removed.

The Peristaltic Teflon® dedicated to each monitoring well was used to collect the groundwater samples for all analyses but VOCs after field parameter stabilization. Samples for VOC analysis were collected with precleaned Teflon® bailers. After well purging was complete, the portion of the sample for metal analysis was collected first, if required. The portion of the sample for VOC analysis was then collected. VOC sample vials were filled completely to the top by slowly pouring the water along the side of the vial. The vials were checked for air bubbles after filling. If bubbles were present in a vial, the vial was discarded and another was filled for laboratory analysis. The containers for the other analyses were then filled with the bailer, as required. Groundwater samples were not filtered prior to collection and analysis; therefore, any metals analyses were for total metals.

1.3.5 Well Abandonment

No wells were abandoned during this field investigation.

1.4 BIOLOGICAL INVESTIGATIONS

Based on the results of the RFI/RI screening-level ecological risk assessment (IT Corporation, 1994), and in consultation with FDEP and EPA, B&R Environmental conducted biological sampling at solid waste management units (SWMUs) 4, 5, and 7; IRs 1, 7, and 8; and Area of Concern (AOC)-B. The biological sampling sought to determine whether site-related contaminants may be accumulating in ecological receptors. The sections below describe biological investigations performed as part of the Supplemental RFI/RI investigation.

1.4.1 Ecology

B&R Environmental biologists visited the sites in June, August, September, and October, 1996. Site-specific features and habitat descriptions in this report are based on these site visits and on other sources

(IT Corporation, 1994; FNAI, 1994). Biologists identified dominant vegetation types and potential aquatic, semi-aquatic, and terrestrial ecological receptors at each site during the June 1996 visit. This information was used to determine the receptors that may be at risk from site-related contaminants and the species to be collected for tissue analysis. Biologists based conclusions regarding the presence or potential occurrence of endangered and threatened species at NAS Key West on B&R Environmental site visits, the FNAI (1994) report, discussions with the NAS Key West Natural Resources Manager, and discussions with Florida Game and Fresh Water Fish Commission (FGFWFC) and U.S. Fish and Wildlife Service (FWS) biologists.

Section 1.4.8 of the RFI/RI report describes the general ecological setting at NAS Key West and Chapters 2 through 9 of the RFI/RI report provide an ecological description of each RCRA/Comprehensive Environmental Recovery and Compensation Liability Act (CERCLA) site.

1.4.2 Tissue Analysis

Although elevated concentrations of several contaminants were detected in various media during earlier investigations at the eight RCRA/CERCLA sites, no biological samples were previously collected to determine whether ecological receptors were accumulating site-related contaminants. Hence, B&R Environmental collected biological samples for chemical tissue analysis during the current investigation. Aquatic and terrestrial habitats exist at all sites except IR 3. This site consists of a small area of turf grass surrounded by urban development. Contaminated surface soil was removed during interim remediation activities, and no aquatic habitat exists on or near the site. Thus, biological sampling was unnecessary and inappropriate at IR 3. Table C.1-1 lists species collected at each RCRA/CERCLA site. Table 7-1 of Appendix F lists species collected at background sites.

1.4.2.1 Aquatic Biota

With the exception of IR 3, aquatic habitat exists at each site. However, aquatic habitat at SWMU 7 was minimal; therefore, aquatic sampling was not conducted there. Aquatic habitat at the remaining six sites consists either of water bodies with little or no connection to marine waters (inland sites), and sites that are adjacent to the Gulf of Mexico or the Atlantic Ocean (shoreline sites). The type of species targeted for collection at each site depended on which of these two conditions existed at the site. SWMU 4, SWMU 5, and AOC B are inland sites, while IRs 1, 7, and 8 are shoreline sites. Fish were collected at SWMU 4, SWMU 5, and AOC B. Crabs were also collected from AOC B but were absent from SWMU 4 and SWMU 5. Fish were not collected from the shoreline sites (IRs 1, 7, and 8). Since these sites are

TABLE C.1-1

**NUMBER OF PLANT AND ANIMAL SAMPLES COLLECTED FOR CHEMICAL ANALYSES
NAS KEY WEST**

Species	SWMU4	SWMU5	SWMU7	IR 1	IR 7	IR 8	AOC B
Spiny lobster *(Panulirus argus)*				12	10	4	
Stone crab *(Menippe mercenaria)*					2	1	
Spiny spider crab *(Mithrax spinosissimus)*					2	4	
Red hermit crab *(Petrochirus diogenes)*				2			
Blue crab (*Callinectes sapidus)*							8
Mud crab (*Panopeus herbstii)*							3
Milk conch *(Strombus costatus)*						16	
Caribbean vase conch *(Vasum muricatum)*				10			
True tulip snail *(Fasciolaria tulipa)*						4	
Sheepshead minnow *(Cyprinodon variegatus)*	13	18					
Killifish *(Fundulus spp)*	6	4					
Goldspotted killifish *(Floridicthys carpio)*		1					
Sailfin molly *(Poecilia latipinna)*	2	2					6
Crested goby *(Lophogobius cyprinoides)*							18
Tarpon (*Megalops atlanticus)*							2
Turtle grass *(Thalassia testudinum)*				4	9	4	
Sea oxeye daisy *(Borrichia frutescens)*		2	2				
Seashore dropseed *(Sporobolus virginicus and S. soartinae)*		2	2				
Red mangrove *(Rhizophora mangle)*	3						
Total Number of Samples Analyzed	24	29	4	28	23	33	37

adjacent to open marine waters, it was assumed that fish are transient in these areas, and potential tissue residues may not be attributable to site-related conditions. Aquatic organisms collected at the shoreline sites consisted of mollusks, crabs, lobsters, and turtle grass. Although crabs and lobsters are not immobile, they are (in general) less mobile than fish, particularly during much of the year. Additionally, crabs and lobsters are commercially important in the Key West economy, and they were collected, in part, for their use in the human health risk assessment.

1.4.2.1.1 Fish

Several small, minnow-like fish species are found in the Key West area. The most common minnows found at the inland sites described above include the sheepshead minnow (*Cyprinodon variegatus*), sailfin molly (*Poecilia latipinna*), killifish (*Fundulus* sp.), and crested goby (*Lophogobius cyprinoides*). The sailfin molly feeds mostly on algae and vascular plants but will eat mosquito larvae when available. Killifish and sheepshead minnow are omnivorous, feeding on algae, insect larvae, small crustaceans, and annelid worms. Gobies feed on small crustaceans and insect larvae. All of these species are relatively short lived, less than 2 years in most instances.

Larger-bodied predators, such as tarpon (*Megalops atlanticus*), are also found in NAS Key West coastal waters, ponds, and lagoons. Tarpon feed on crabs and small fish. Tarpon reach sexual maturity at 6 or 7 years of age and may live as long as 15 to 20 years.

1.4.2.1.2 Mollusks

Mollusks collected for tissue analyses consisted of three species of gastropods: milk conch (*Strombus costatus*), Caribbean vase conch (*Vasum muricatum*), and true tulip snails (*Fasciolaria tulipa*). These mollusks inhabit sea grass beds and sand flats. The milk conch and vase conch are herbivorous and feed primarily on algae and algal detritus. True tulips are carnivorous; they attack their prey by inserting the proboscis into the aperture of other snails and rasping away at the operculum, eventually reaching the soft tissues (Kaplan, 1988). Mollusks were collected due to their relatively immobile nature, which would be expected to result in maximal exposure to potential site-related contaminants.

Queen conchs (*Strombus gigas*) were numerous at the shoreline sites (IRs 1, 7, and 8) but were not collected because the sampling permit issued by FDEP prohibited the collection of this species. Queen conch populations have been drastically reduced by over-harvesting.

1.4.2.1.3 Crabs

Several species of crabs live in the Key West area. Species collected for tissue analyses consisted of the blue crab (*Callinectes sapidus*), stone crab (*Menippe mercenaria*), mud crab (*Panopeus herbstii*), spiny spider crab (*Mithrax spinosissimus*), and red hermit crab (*Petrochirus diogenes*). Blue crabs and stone crabs are important commercial species in South Florida. Crabs have a varied diet, preying primarily on larvae, small crustaceans, worms, etc. A variety of large fish and other aquatic organisms prey upon crabs. Although some crab species migrate over long distances, the lack of a connection between the canal (where specimens were collected) and marine waters restricts mud crabs and blue crabs collected at AOC B to the site. Stone crabs, which have relatively small home ranges, inhabit burrows and crevices.

1.4.2.1.4 Lobsters

The Florida spiny lobster (*Panulirus argus*) supports major commercial fisheries in south Florida. It is a mid-level predator in the foodchain and feeds on a variety of slow-moving animals including gastropod and bivalve mollusks, crustaceans, and echinoderms. Octopii, crabs, and fish feed on larval and juvenile lobsters. Large predators such as groupers, jewfish, sharks, and sea turtles prey on juvenile and adult lobsters. Lobsters spawn in late spring in offshore waters along the fringes of reefs and then return to shallow waters after larvae are released. Adults remain in shallow waters until fall, when water temperatures drop and fall storms arrive, at which time they migrate to deeper waters. Lobsters forage at night and return to the same or nearby dens each day (Marx and Herrnkind, 1986). Although the seasonal migration of some lobsters could expose them to non-site related contaminants, biologists collected lobsters for this investigation during August to October. Collection during this time period (several months after spring migration and immediately prior to fall migration) maximized the possibility of exposure to potential site-related contaminants.

1.4.2.1.5 Turtle Grass

Seagrass communities are among the most productive of all coastal ecosystems, and several species of seagrasses are found in the Florida Keys. Turtle grass (*Thalassia testudinum*) was collected for tissue analyses in this study. Green sea turtles, manatees, parrot fish, and urchins consume seagrasses. Numerous fish species consume seagrass epiphytes. Because sea grasses are immobile and are known to accumulate contaminants, they were collected in this study. The growing season is year-round in the semi-tropical conditions of Key West, but seagrass reaches a peak biomass in August (Fourqueen, 1996). Seagrass samples were collected in September; thus, analytical results should be indicative of conditions during the time period most likely to result in maximum tissue accumulation.

1.4.2.2 Terrestrial Biota

Terrestrial vegetation was collected for tissue analyses at sites where the endangered Lower Keys marsh rabbit is known to occur (or could potentially occur). Marsh rabbits are known to occur (at least occasionally) in the area immediately adjacent to SWMU 4 and SWMU 7 and have been observed approximately 500 feet northwest of SWMU 5. Seashore dropseed (*Sporobolus virginicus* and *Sporobolus spartinae*) comprises the majority of the rabbit's diet, while white and red mangrove and sea oxeye daisy are also common food items (FWS, 1994). Foliage of seashore dropseed, red mangrove, and sea oxeye daisy were collected from SWMUs 4, 5, and 7. Habitat for the marsh rabbit does not exist at the other five RCRA/CERCLA sites.

1.4.2.3 Sample Collection and Analysis

Minnow-sized fish were collected in baited minnow traps, and tarpon were collected in gill nets. Crabs and lobsters were collected by hand nets and baited traps. Mollusks and vegetation samples were collected by hand.

Individual lengths and weights of crabs, lobsters, mollusks, and gill-netted fish were measured. Individual lengths and weights of minnow-sized fish were not determined. Instead, lengths of the smallest and largest fish in each minnow sample were measured, and minnows were pooled by species to create samples of at least 30 grams each. Vegetation samples consisted of approximately 150 grams of foliage. Table C.1-2 provides lengths (or widths) and weights of crabs, lobsters, mollusks, and gill-netted fish.

Chemical analyses were performed on whole-body samples of fish and crabs. Analyses were performed on soft tissue (muscle and viscera) of lobsters and conchs. The soft tissues were removed from these organisms at the testing laboratory. Chapters 2 through 9 of the RFI/RI summarize concentrations of all chemicals detected in tissue samples at each RCRA/CERCLA site and at background sites by type (crab, lobster, fish, conch, aquatic vegetation, and terrestrial vegetation). Appendix H contains individual sample results.

TABLE C.1-2

MEASUREMENTS OF CONCH, LOBSTER, CRAB, AND FISH[1]
COLLECTED AT NAS KEY WEST
PAGE 1 OF 4

Site	Sample ID	Species	Length or Width (mm)[2]	Weight (g)	Notes
IR1	I1CH-1	Vase Conch	85	160	
	I1CH-2	Vase Conch	91	183	
	I1CH-3	Vase Conch	99	232	
	I1C-4	Red Hermit Crab	140	103	
	I1L-5	Lobster	138	642	
	I1L-6	Lobster	120	427	
	I1L-7	Lobster	118	309	
	I1L-8	Lobster	106	263	
	I1L-9	Lobster	106	277	
	I1L-10	Lobster	104	231	
	I1L-11	Lobster	108	259	
	I1L-12	Lobster	105	278	
	I1L-13	Lobster	134	369	
	I1L-14	Lobster	98	225	
	I1L-15	Lobster	112	319	
	I1L-16	Lobster	126	448	
	I1CH-17	Vase Conch	88	202	
	I1CH-18	Vase Conch	79	144	
	I1CH-19	Vase Conch	78	163	
	I1CH-20	Vase Conch	90	215	
	I1CH-21	Vase Conch	82	168	
	I1CH-22	Vase Conch	82	184	
	I1CH-23	Vase Conch	85	200	
	I1C-27	Red Hermit Crab	116	82	
IR 7	I7L-1	Lobster	114	302	
	I7L-2	Lobster	128	339	
	I7L-3	Lobster	124	317	
	I7L-6	Lobster	72	61	
	I7L-7	Lobster	69 65	52 55	n = 2
	I7C-8	Stone Crab	91	274	
	I7L-9	Lobster	106	242	
	I7L-10	Lobster	60 56	33 41	n = 2
	I7C-11	Spiny Spider Crab	66	122	
	I7L-12	Lobster	110	310	
	I7C-15	Stone Crab	110	323	
	I7C-16	Spiny Spider Crab	64	113	
	I7L-22	Lobster	125	472	
	I7L-23	Lobster	135	524	

TABLE C.1-2

MEASUREMENTS OF CONCH, LOBSTER, CRAB, AND FISH[1] COLLECTED AT NAS KEY WEST
PAGE 2 OF 4

Site	Sample ID	Species	Length or Width (mm)[2]	Weight (g)	Notes
IR8	I8C-1	Stone Crab	77	166	
	I8C-2	Spiny Spider Crab	83	209	
	I8C-3	Spiny Spider Crab	98	384	
	I8C-4	Spiny Spider Crab	116	660	
	I8T-5	True Tulip	167	276	
	I8T-6	True Tulip	182	337	
	I8CH-7	Milk Conch	145	372	
	I8CH-8	Milk Conch	158	605	
	I8CH-9	Milk Conch	140	443	
	I8CH-10	Milk Conch	141	441	
	I8CH-11	Milk Conch	152	513	
	I8CH-12	Milk Conch	166	587	
	I8CH-13	Milk Conch	179	883	
	I8CH-14	Milk Conch	184	828	
	I8CH-15	Milk Conch	198	1,004	
	I8L-16	Lobster	87	126	
	I8L-17	Lobster	92	162	
	I8L-18	Lobster	71 75	58 84	n = 2
	I8T-19	True Tulip	94	62	
	I8T-20	True Tulip	134	163	
	I8CH-21	Milk Conch	156	587	
	I8C-22	Spiny Spider Crab	103	422	
	I8CH-23	Milk Conch	140	424	
	I8CH-24	Milk Conch	139	527	
	I8CH-25	Milk Conch	146	512	
	I8CH-26	Milk Conch	153	485	
	I8CH-27	Milk Conch	158	565	
	I8CH-28	Milk Conch	174	1,000	
	I8L-29	Lobster	85 80	138 102	n = 2
AOC B	AC-1	Blue Crab	15 16	198 173	n = 2
	AC-2	Blue Crab	155 154	178 190	n = 2
	AC-3	Blue Crab	148 154	153 155	n = 2
	AC-4	Blue Crab	145 166	204 223	n = 2

TABLE C.1-2

**MEASUREMENTS OF CONCH, LOBSTER, CRAB, AND FISH[1]
COLLECTED AT NAS KEY WEST
PAGE 3 OF 4**

Site	Sample ID	Species	Length or Width (mm)[2]	Weight (g)	Notes
AOC-8 (continued)	AC-5	Blue Crab	156 165	162 243	n = 2
	AC-6	Blue Crab	155 158	312 272	n = 2
	AF-7	Tarpon	496	946	
	AC-8	Mud Crab	15-30	29 (total)	n = 5
	AC-9	Blue Crab	169 161	224 201	n = 2
	AC-27	Mud Crab	29-32	38 (total)	n = 4
	AC-28	Mud Crab	14-32	31 (total)	n = 7
	AF-29	Tarpon	526	828	
	AC-30	Blue Crab	146	191	
Background 4	B4C-1	Stone Crab	91	232	
	B4C-2	Stone Crab	114	575	
	B4C-3	Stone Crab	114	605	
	B4C-4	Stone Crab	103	341	
	B4C-5	Stone Crab	102	376	
	B4C-6	Stone Crab	95	307	
	B4C-7	Stone Crab	95)	340	
	B4L-8	Lobster	120	370	
	B4C-9	Stone Crab	96	315	
	B4C-10	Stone Crab	102	301	
	B4C-11	Stone Crab	106	502	
	B4C-12	Spiny Spider Crab	81	258	
	B4CH-16	Vase Conch	82	136	
	B4CH-COMP 1	Vase Conch	79 82	102 124	n = 2
	B4CH-COMP 2	Vase Conch	71 75 85	81 85 144	n = 3
	B4CH-22	Vase Conch	71	89	
	B4CH-23	Vase Conch	65 64	70 65	n = 2
	B4CH-24	Milk Conch	161	591	
Background 5	B5L-10	Lobster	90	160	
	B5L-11	Lobster	92	183	
	B5L-12	Lobster	116	365	
	B5L-13	Lobster	123	407	
	B5L-14	Lobster	97	198	
	B5L-15	Lobster	130	490	
	B5L-16	Lobster	92	176	
	B5L-17	Lobster	98	213	

TABLE C.1-2

**MEASUREMENTS OF CONCH, LOBSTER, CRAB, AND FISH[1]
COLLECTED AT NAS KEY WEST
PAGE 4 OF 4**

Site	Sample ID	Species	Length or Width (mm)[2]	Weight (g)	Notes
Background 5 (continued)	B5L-18	Lobster	94	180	
	B5L-19	Lobster	97	168	
	B5L-20	Lobster	106	222	
	B5L-21	Lobster	113	284	
	B5L-22	Lobster	82	121	
	B5L-23	Lobster	89	145	
	B5L-24	Lobster	123	375	
	B5L-25	Lobster	133	479	
	B5C-27	Spiny Spider Crab	73	164	
	B5C-28	Spiny Spider Crab	58	100	
	B5CH-29	Milk Conch	152	587	
	B5CH-30	Florida Horse Conch	285	1,112	
Background 8	B8L-1	Lobster	82	145	
	B8C-2	Spiny Spider Crab	98	475	
	B8T-3	True Tulip	161	319	
	B8T-4	True Tulip	124	163	
	B8T-5	True Tulip	126	128	
	B8CH-6	Florida Horse Conch	372	1,978	
	B8C-7	Red Hermit Crab	180	150	
	B8L-8	Lobster	61	33	
	B8T-9	True Tulip	155	237	

1 Minnows were composited into samples of approximately 30 to 60 grams each and are not included here.

2 Fish: Total length.
Mollusk (conch and true tulip): Tip of shell spire to bottom of aperture.
Crab: Carapace width at widest extent.
Lobster: Length from anterior of carapace to posterior of tail.

All tissue samples were analyzed for metals, pesticides, and PCBs. No volatile compounds were detected in 116 fish and oyster samples collected in a previous RFI/RI investigation conducted at NAS Key West by B&R Environmental, and semivolatile compounds were rarely detected in the same samples. For these reasons (and with the concurrence of FDEP and EPA), tissue samples collected in the present study were not analyzed for volatile and semivolatile compounds. However, as a conservative measure, a limited number of fish samples collected from SWMU 4 and SWMU 5 were analyzed for semivolatile compounds, since semivolatile compounds were identified in a biotic media at those sites during previous investigations.

B&R Environmental biologists performed sample preservation, packaging, and shipping as described in Section 4.0 of the Sampling and Analysis Plan (ABB, 1995). They completed chain-of-custody forms in the field and transported those forms with the samples. Data recorded in the field included the date and time that samples were collected, sample location, sample identification number, and miscellaneous notes relating to physical abnormalities, weather, etc.

Water quality measurements were taken concurrently with the aquatic biota sampling. Table C.1-3 lists water quality data for the RCRA/CERCLA sites. Table 5-1 of Appendix F provides background site water quality measurements. Water quality data are important because aquatic habitat quality is determined by water quality conditions (e.g., dissolved oxygen, pH, temperature) as well as existing levels of contaminants. Abundance and diversity of aquatic organisms may be low if an aquatic environment is subject to extreme fluctuations in temperature and oxygen levels regardless of the presence of contaminants in aquatic media. Conversely, abundance and diversity may be high in waters that are contaminated (particularly if contaminants are in a form that is not bioavailable) but offer cover, a variety of micro-habitats, high levels of dissolved oxygen, and abundant food sources.

1.5 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) STATUS

The following sections describe the various QA/QC samples taken and the respective frequencies of collection for each type of sample. Section 1.6.2 presents the QA/QC sample identification procedure.

1.5.1 <u>Trip Blanks</u>

Trip blanks are required for assessing the potential for VOC contamination of samples during sampling or in transit. Trip blanks were VOC sample bottles filled in the laboratory with volatile-organic-free water, transported to the site, handled in a manner similar to that of environmental samples, and returned to the

TABLE C.1-3

WATER QUALITY DATA SUMMARY
NAS KEY WEST, FLORIDA

Location	Date	Time	Temp. (°C)	Salinity (PPT)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
SWMU 4	8/25/96	0945	27.5	3.9	7.84	7.29	3.46	10
	8/26/96	1107	28.6	3.8	7.48	7.06	4.59	1
	9/15/96	1010	29.6	2.9	8.14	5.54	5.02	5
	9/15/96	1040	29.5	2.8	8.01	5.48	4.01	2
	9/15/96	1100	29.7	2.8	7.81	5.51	3.40	1
	9/27/96	1430	31.2	3.0	8.13	5.70	8.08	7
SWMU 5	8/25/96	0920	28.5	NA	7.89	14.5	3.10	10
	8/25/96	1620	33.5	NA	8.16	14.8	4.50	0
	8/26/96	1055	29.9	31.9	7.51	49.4	3.04	1
	9/17/96	1145	30.5	NA	7.74	15.6	3.00	10
	9/18/96	1310	37.2	26.4	7.51	39.2	3.43	13
	9/18/96	1340	36.9	32.6	7.74	46.8	3.08	2
	9/18/96	NA	38.6	32.8	7.80	50.1	2.41	3
	9/27/96	1445	34.5	33.2	7.81	50.4	3.75	5
SWMU 7	10/01/96	1340	28.2	2.0	7.05	3.93	0.57	26
	10/01/96	1345	28.0	1.9	7.43	4.10	0.76	6
	10/01/96	1400	29.2	1.8	7.50	3.63	1.35	2
	10/01/96	1405	28.3	1.7	7.82	3.52	2.72	15
	10/01/96	1540	29.5	1.9	7.85	4.24	5.03	4
IR 1	09/12/96	1730	31.9	33.1	7.88	50.4	6.07	5
	09/29/96	0830	28.0	32.4	7.72	49.4	6.10	35
IR 7 (east)	08/29/96	0755	28.3	37.1	7.78	55.8	5.17	1
(west)	09/18/96	0925	30.8	NA	7.98	15.1	5.81	1
(west)	09/28/96	0945	28.7	34.8	7.61	52.8	4.99	0
(east)	09/29/96	1400	31.0	32.4	8.31	49.5	12.39	4
IR 8	08/29/96	0910	28.7	36.8	7.80	5.62	5.56	2
	09/26/96	NA	29.8	35.2	7.75	53.3	5.32	1
	09/26/96	NA	30.3	35.2	7.95	53.2	7.41	1
AOC B	08/24/96	1500	28.7	NA	8.07	12.5	5.01	7
	08/25/96	1230	29.6	NA	8.07	12.8	3.50	1
	08/26/96	1002	29.2	27.3	7.54	42.2	3.74	0
	10/02/96	1600	30.0	31.2	7.90	47.7	3.94	NA
	10/02/96	1650	30.0	31.3	7.93	47.7	4.39	NA

NA = Not available.

laboratory for VOC analysis. Trip blanks were not opened in the field. At least one trip blank accompanied each shipping container (cooler) used to store or transport VOC samples.

1.5.2 Equipment Rinsate Blanks

Rinsate blanks were used to assess the adequacy of decontamination procedures and to trace potential cross contamination. Rinsate blanks were prepared on site by pouring analyte-free water over or through freshly decontaminated field equipment. One equipment rinsate blank was collected for every 20 samples collected of like media and like sample method. These blanks were tested for the same analytes as were the environmental samples collected by the sampling team on the same day.

1.5.3 Field Duplicates

Field duplicate samples are two or more samples collected simultaneously into separate containers from the same source under identical conditions. Field duplicates of water samples were collected independently of other water samples, but at the same time and location as the other samples. Soil and sediment field duplicates consisted of a single sample collected at a given location and then divided into two samples (one as the primary sample and the other as the duplicate). Subsurface soil duplicates were obtained from the same interval as the original sample. The entire interval was composited and divided equally between the sample and sample duplicate containers. Soil, sediment, and water field duplicates were prepared and analyzed at a rate of 10 percent for all water and soil samples collected. Water and soil duplicates were labeled in such a manner that the laboratory could not determine which samples were duplicates.

1.5.4 Field Blanks

Field blanks were obtained by sampling each water source used in decontamination during the field investigation. The blanks were used to confirm that neither the analyte-free water nor the potable water source was contributing to sample contamination. Field blanks were collected for each type of water used for decontamination and were submitted at a frequency of one sample per water source per sampling event. Four water sources were used during the course of this investigation: two lots of de-ionized (DI) water, potable water from Truman Annex-Building 112, and potable water from the fuel farm adjacent to Taxiway A.

1.6 SAMPLE MANAGEMENT

Each sample was placed directly into the laboratory-supplied pre-preserved sample containers, labeled, and placed on ice in a cooler. Each sample was assigned a unique sample number for tracking. Pertinent field data (e.g., color, odor, texture, pH, conductivity, turbidity, temperature, DO, salinity) for each sample were recorded on a sampling form specific to the type and matrix of the sample collected. Each sample collected was also recorded in the field log book and tracked by chain-of-custody throughout its transport from the field to the laboratory. The details of these activities are discussed in the following sections.

1.6.1 Sample Bottle and Container Preparation

The laboratory provided the field sampling team with clean sample bottles containing the proper preservatives for collection of soil, sediment, and water samples. A certificate of cleanliness was included with each shipment. The types of sample containers were determined by the various analyses to be performed. If preservatives were required, sample containers were shipped from the laboratory in a pre-preserved state so that no preservatives had to be added while in the field. When sample bottles were ready to be shipped to the field, the shipping clerk placed the sample bottles in the ice chest. When requested, custody seals, temperature blanks and trip blanks were also included. The ice chests were sealed with custody tape to guard against tampering, and the seals were applied in such a way that they would break when the chest was opened.

The laboratory included a sample bottle checksheet, which documented the preparation of each set of bottles. Documentation included the type and number of bottles; analysis type for each bottle; date of preparation; special cleaning procedures; preservative, if any; and initials of the shipping clerk. Labels were then placed on all prepared bottles indicating the preservative used and the date of preparation.

1.6.2 Sample Identification

B&R Environmental used two methods of sample identification during the course of the field investigation at NAS Key West. One system of labeling was used strictly for environmental samples, while a second identification system was applied to samples such as trip blanks and method blanks, which were used for QA/QC purposes.

1.6.2.1 Environmental Sample Identification

Each environmental sample was assigned a unique alphanumeric code (number) to track the sample from collection through laboratory analysis and into the final reports. Each number consists of three subparts that indicate the sample site, the sample matrix, and the sample location, respectively, as shown in the example below.

S1	SS	- 01
(Sample Site)	**(Sample Matrix)**	**(Sample Location)**

The first two or three characters indicate the abbreviation for the SWMU or background site. For example, SWMU 2 was abbreviated S2 or background 4 as B4.

Following the site code is the two-character sample matrix code. These codes indicate the specific type of environmental sample collected. The specific matrix abbreviations are shown below.

- GW - Groundwater
- SS - Sediment
- SD - Sediment
- SB - Surface Soil
- SW - Surface Water

The last portion of the sample number is a two-character sample location identifier. It denotes the specific physical or geographic location of the sample's origin.

1.6.2.2 QA/QC Sample Identification

Each QA/QC sample is assigned a unique alphanumeric code (number) similar to the environmental samples' identification. The QA/QC sample type is also designated.

For example, a surface soil duplicate sample from SWMU-7 is designated S7SBDP. For trip blanks, field banks, and rinsate blanks, two characters representing the type of QA sample are followed by a two-digit number and the date. For example, TB01-091596 is the identification code for a trip blank collected on September 15, 1996; FB02-090396 is the appropriate identification for a field blank collected on September 3, 1996; and RB01-091496 is the designation for a rinsate blank collected on September 14, 1996.

This sample identification system is used to ensure that the QA/QC samples can be tracked from collection through laboratory analysis and into the final reports while the analytical laboratory is "blind" to the true identity of the samples.

1.6.3 Packaging and Shipping Procedures

Soil, sediment, water, and biota samples collected were considered low-concentration environmental samples (low in pollutant concentration) and were collected from naturally occurring media such as estuaries, lagoons, ditches, soils, and groundwater. Soil, sediment, water and biota samples were packaged and shipped as described below. These shipping procedures comply with U.S. Department of Transportation (DOT) regulations (40 Code of Federal Regulations 171-179).

- Each sample bottle was placed in a plastic bag and the bag was sealed.
- The ice chest was lined with a large plastic bag.
- The large plastic bag lining the ice chest was filled one-quarter full of inert, absorbent packing material (such as vermiculite).
- Environmental samples, a temperature blank, and a trip blank (if appropriate) were placed in the ice chest.
- Several plastic bags were filled with ice chips and placed between the samples.
- Additional ice-filled bags were placed on top of samples before the large plastic bag was sealed.
- The large plastic bag lining the ice chest was filled with inert packing material and closed and sealed with tape.
- The required paperwork, including chain-of-custody records, was sealed inside a plastic bag and taped to the inside of the ice chest lid.
- The ice chest was closed and sealed with strapping tape, and at least one custody seal was placed over the edges in such a way that they would break when the ice chest was opened.

- The ice chest was delivered, using a standard airbill, to Federal Express (or other overnight carrier) within 48 hours (typically within 24 hours) of sample collection.

Tissue samples were typically wrapped in foil and placed in clean, unused Ziploc™ plastic bags and frozen. Large tissue samples that could not fit into Ziplocs were placed in garbage bags and frozen. Minnow samples were not wrapped in foil. After freezing, tissue samples were placed in ice chests lined with a plastic bag. Dry ice was placed in brown paper bags and packed around the sealed liner bag. The paperwork was then completed, and the ice chest was sealed and shipped as described above.

1.6.4 Sample Custody

The possession of samples was traceable from the time the samples were collected until the analytical results were submitted by the laboratory. This information was available as a result of the use of Chain-of-Custody Forms. These forms accompanied the samples and were shipped in the appropriate shipping container (cooler). Copies of the completed Chain-of-Custody Forms were included in the analytical data packages. Field custody began when materials were placed in clean sample containers obtained from the laboratory and ended when the collected samples were relinquished to the laboratory for testing. This sequence of custody was reflected by the appropriate entries on the Chain-of-Custody Forms.

A sample was considered to be under field custody when: it was in the field investigator's physical possession; it was in the field investigator's view, after being in his physical possession; and it was placed in a designated secure area.

To simplify the chain-of-custody record, as few people as possible handled the samples. For this reason, one individual from the field sampling team was designated as the individual responsible for all sample transfer activities. This field investigator was personally responsible for the care and custody of the samples collected until they were properly transferred to another person or facility.

Field documentation of each sample was made on a Sample Logsheet and in the Site Logbook. This documentation was made in ink and consisted of a notation of the sample identification number, the sample location, and the time/date of collection. All samples were accompanied by a chain-of-custody record. This record documented the transfer of custody of samples from the field investigator to another person, to the laboratory, or to another organizational element, and each change of possession was accompanied by two signatures, one indicating relinquishment and the other receipt of the samples. Completed Chain-of-Custody Forms were enclosed in a plastic cover and placed inside the shipping container used for sample transport from the field to the laboratory.

When samples were relinquished to a shipping company for transport, the tracking number from the shipping bill/receipt was recorded on the Chain-of-Custody Form.

Custody seals were used on the shipping containers when samples were shipped to the fixed-base laboratory to ensure that no sample tampering occurred during transport. At least one custody seal was placed on each shipping container on the front. Each was signed and dated by the B&R Environmental employee who packed the container.

1.7 EQUIPMENT DECONTAMINATION

Sampling equipment decontamination was performed in accordance with procedures presented in Appendix B of the EPA Region IV Environmental Compliance Branch Standard Operating Procedure and Quality Assurance Manual (EPA, 1991d).

Decontamination of major equipment (e.g., drilling rigs) and sampling equipment was necessary to eliminate the spread of contamination to clean zones, to reduce exposure of personnel, and to reduce cross-contamination of samples when equipment was used at more than one sampling location.

Major equipment was decontaminated using the procedures specified in Section 1.7.3. Sampling equipment was decontaminated in tubs or drainage pans so that solvents could be collected and properly disposed. Rinsate samples were collected, as required, from the decontaminated sampling equipment by rinsing the clean equipment with analyte-free water. The sampling equipment was then wrapped in aluminum foil and stored in a clean area until used. Clean sampling equipment was not allowed to come into contact with the ground or any potentially contaminated surfaces before and during use at the sampling location.

1.7.1 Soil Sampling Equipment

All stainless steel spoons, bowls, trowels, dredges and other soil sampling equipment were decontaminated after each use. The following decontamination procedure was used:

- Wash and scrub the equipment with a solution of Alconox (or equivalent) and potable water.
- Rinse with potable water.
- Rinse with deionized free water.
- Rinse with isopropanol.
- Air dry (if possible).

- Rinse with deionized water, if it is necessary to use equipment before air drying is complete.
- Wrap in oil-free foil (if appropriate).

1.7.2 Groundwater Sampling Equipment

Peristaltic pumps were used to purge and collect groundwater samples. Dedicated discharge lines were used for each sampling location.

1.7.3 Major Equipment

Between use at each site, all major equipment such as drill rigs was decontaminated. The drill rig was steam cleaned and, if necessary, surfaces were scrubbed until all visible soil and possible contaminants had been removed. The casing, drill rods, and auger flights were decontaminated by a rinse with potable water, followed by an Alconox wash and steam cleaning.

1.8 INVESTIGATION-DERIVED WASTE MANAGEMENT

During field operations, several types of solid and liquid wastes were generated, including disposable equipment and supplies as well as decontamination and well development/purging fluids. The ultimate disposal of these wastes was dependent upon the degree of environmental contamination present at the site and the likelihood that the investigation wastes would be similarly contaminated. The discussion that follows outlines the strategy for waste management at NAS Key West.

All soil boring cuttings were drummed, transported, and stored temporarily at each investigation site (as practical) until analytical results from each soil boring were evaluated by the NAS Key West RCRA Coordinator.

All fluids from decontamination of major equipment were containerized. If containerization of the fluid was required, it was collected and stored in drums. These drums were handled in a manner similar to that used with the soil cuttings.

Upon removal from the monitoring wells, well development/purge water was containerized in labeled drums for proper disposal. NAS Key West disposed of these fluids.

Miscellaneous solid wastes such as disposable gloves, disposable protective clothing, and paper towels were placed in trash bags and disposed of as municipal waste.

1.9 SURVEYING

A certified B&R Environmental land surveyor measured all groundwater sample locations and elevations. The surveyor measured each point from a reference location that was tied to the state plane system. An X-Z coordinate system was used to identify locations. The X coordinate describes the east-west axis location (Easting), the Y coordinate describes the north-south axis location (Northing), and the Z coordinate was the vertical elevation above the National Geodetic Vertical Datum. The accuracy of the coordinates and elevations of all survey points was closely scrutinized by B&R Environmental. The locations were compared to field notes and drawings, and elevations were compared to finished floor elevations derived from engineering drawings and aerial photographs of the base which were supplied by the Navy. In some instances, locations were cross-checked using Global Positioning System (GPS) equipment. When discrepancies were noted, the root cause was investigated, and in many instances the surveyor was required to verify the data.

All surveyed locations were reported using the Florida State Plane Coordinate System-Eastern Zone. Existing installation benchmarks served as the horizontal and vertical data for the survey. Elevations and horizontal locations were recorded to the nearest hundredth of a foot. The elevations of all monitoring wells were surveyed at the water-level measuring notch on the riser pipe and on the undisturbed ground surface adjacent to the pad, as well as on the pad itself.

1.10 WATER-LEVEL MEASUREMENTS

Water-level measurements were taken at each monitoring well where groundwater samples were obtained during the Supplemental RFI/RI sampling. Measurements were made at least 24 hours after well development with an electrical water-level indicator using the top of the well casing as the reference point for determining depths to water. Water-Level measurements were recorded to the nearest 0.01 foot in the appropriate field logbook or Water-Level Survey Form. Static water-levels were measured in each well before any fluid was withdrawn. If floating hydrocarbon was detected in monitoring wells, the thickness of the free product was measured with an electronic interface probe.

1.11 RECORDKEEPING

The project and field logbooks are considered to be the primary sources of field documentation. Field data (Appendixes E and G of the Supplemental RFI/RI Report) were recorded on various field forms that included, but were not limited to, those listed below.

- Sample Logsheets
- Calibration Sheets
- Chain-of-Custody Forms
- Sample Collection Forms
- Boring Logs
- Water-Level Measurement Logs
- Well Construction Forms
- Well Development Forms

These documents, once completed by the field team, were reviewed by the Field Operations Leader (FOL) for completeness and accuracy before being incorporated into the project files.

Project files are maintained in file cabinets located in an area designated for file storage. Each project file contains a project file index that specifies the types and location of all project records to allow for easy access and retrieval. Whenever a record is removed from the project file, it is replaced with a record withdrawal card that indicates the date the record was removed, the name of the individual removing the record, and a description of the record taken.

All project records will be maintained for the period specified by the contract (no longer than 3 years), after which time the client will be contacted for final record disposition. All documents, including voided entries, will be maintained within the project files located at the Brown & Root Environmental office in Aiken, SC.

1.11.1 <u>Logbooks</u>

The field logbooks are considered the primary sources of field documentation. These logbooks are hard-covered, bound logbooks with sequentially numbered pages. The fronts of the logbooks were labeled with the project name and the dates of use, and they were numbered sequentially as they were completed. Entries in the logbooks were made in real time and included all significant site activities, such as:

- Times of specific events
- Weather conditions
- Site observations (e.g., sample activities, construction progress)
- Specific problems encountered and their solutions (e.g., equipment malfunctions, construction delays)
- Reference to sample custody records
- Personnel on site (names of visitors and times of visits)
- References to equipment calibration records (if appropriate)

The field investigator signed each day's logbook. Entries made after the fact were made below this signature and also signed and dated by the individual making the additional entry.

1.11.2 Boring Logs

During the drilling to collect subsurface soil samples or to install monitoring wells, the on-site geologist recorded a complete and detailed log of the drilling conditions and formations encountered. The information was recorded on a Boring Log that became part of the permanent project file. A list of the primary information recorded is shown below.

- Boring or well identification
- Purpose of the boring
- Location in relation to an easily identifiable landmark
- Names of drilling contractor and logger
- Start and finish dates and times
- Drilling method
- Weather conditions
- Lithologic descriptions
    - Predominant particle size
    - Particle size estimate
    - Mineral characteristics
    - Lithologic structure
- Depths of lithologic boundaries
- Analytical samples
- Sampling interval depths and blow counts, where appropriate

1.11.3 Well Construction Forms

The site geologist completed the Well Construction Forms during installation of all permanent wells. Information on the logs included the following:

- Well name and date of installation
- Name of drilling contractor, driller, and geologist
- Total depth of borehole and well
- Depth intervals of screen, sand pack, bentonite seal
- Materials used

1.11.4 Well Development Forms

Following installation, all monitoring wells were developed under the site geologist's supervision. At 5 or 10 minute intervals, the temperature, pH, conductivity, color, turbidity, and total volume of purge water flowing from the well were recorded. Additional information, also noted on the Well Development Form, included the following:

- Well name and date of installation
- Well stickup, total depth, and inside diameter
- Static level before purging
- One casing volume
- Date and time of development
- Method of development
- Name of individual performing development
- Casing volume(s) removed
- Time completed

1.11.5 Chain of Custody

All samples collected in the field were accompanied to the laboratory by a Chain-of-Custody Form. Information recorded on the form included the following:

- Names(s) of the sampler(s)
- Site name from which the sample was collected
- Sample name, date, and time of collection

- Analytical parameters to be tested
- Number of containers per sample
- Date, time, and signature for relinquishing samples

Chain-of-custody records originated on self-duplicating forms. A copy of each completed chain-of-custody record was retained in the field by the sample team. Two copies were shipped with the samples to the laboratory. After the form was signed and the custody of the samples was accepted by the laboratory, one copy of the Chain-of-Custody Form was retained by the laboratory and one was sent to B&R Environmental with the analytical data sheets.

2.0 DATA QUALITY ASSESSMENT

An SAP (ABB, 1995), consisting of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP) (IT Corporation, 1993), was prepared for the Supplemental RFI/RI at the NAS Key West. The contents of these documents meet the requirements of the State of Florida's hazardous waste regulations and are consistent with the requirements of EPA's RFI guidance.

The SAP defines the project activities necessary to ensure that field activities performed and analytical data generated during the RFI/RI sampling and monitoring well installation activities at NAS Key West were technically valid and adequate to support any remedial alternatives. The SAP specifies field sampling, analytical, and QA/QC requirements. These requirements are briefly summarized in the following sections.

2.1 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The goal of QA is to assure that project activities are planned and performed according to accepted standards and practices and that the resulting data are valid and retrievable. QC is an integral part of the overall QA function and is comprised of all those actions necessary to control and verify that project activities and resulting data meet established requirements.

Data Quality Objectives (DQOs) for measurement data are expressed by EPA in terms of precision, accuracy, representativeness, completeness, and comparability. DQOs provided the mechanism for ongoing control and evaluation of measurement data quality throughout the project and were used to define data quality for the various measurement parameters. The QA/QC effort focused on controlling measurement error within the established limits and provided a database for estimating the actual uncertainty in the measurement data.

2.1.1 <u>Precision</u>

Precision is a measure of the amount of variability and bias inherent in a data set. This parameter also describes the reproducibility or degree of agreement among replicate measurements of a single analyte. The closer the numerical values of the replicate measurements are to each other, the more precise the measurement. Analytical precision for a single analyte is expressed as the relative percent difference (RPD) between results of MS/MSDs for organic analyses or between laboratory duplicate results of unspiked sample aliquots for inorganic analyses. Field duplicate precision is expressed as the RPD between results of field duplicate samples.

The range and RPD were calculated as shown below.

$$\text{Range} = D_1 - D_2$$

$$\text{RPD (\%)} = \left((D_1 - D_2) \Big/ \left(\frac{D_1 + D_2}{2} \right) \right) \times 100$$

where:

RPD = relative percent difference

D_1 = first sample value

D_2 = second sample value (duplicate)

Laboratory-derived control limits for precision, typically set at plus or minus three times the standard deviation of a series of RPD or range values, were used for evaluation of MS/MSD and laboratory duplicate RPDs. Control limits of 30 percent (for aqueous samples) and 50 percent (for solid samples) were used for evaluation of field duplicate RPDs.

2.1.2 Accuracy

Accuracy refers to the degree of difference between measured or calculated values and the true value. The closer the numerical value of the measurement is to the true value, or actual concentration, the more accurate the measurement. Analytical accuracy may be expressed as the percent recovery of an analyte that has been added to the environmental sample at a known concentration before analysis. For example, accuracy can be determined from the results of MS, surrogate, and LCS analyses.

Accuracy (standard recovery) as percent recovery (P) was calculated as shown below.

$$P = ((\Theta - X) \times 100) \ / \ T$$

where:

P = percent recovery

Θ = measured value of analyte (concentration in the sample after spike was added)

X = measured value of analyte (concentration in the sample before spike was added)

T = value of spike

Laboratory-derived upper and lower control limits for accuracy were typically set at the mean plus or minus three times the standard deviation of a series of percent recovery values.

The accuracy of simple, yet fundamental, field analyses is difficult to assess quantitatively. Sampling accuracy can be maximized, however, by the adoption of and adherence to a strict QA program. For the analytical work performed at NAS Key West, all procedures were documented as standard protocol, and all equipment and instrumentation were properly calibrated and well maintained. In addition to equipment operation procedures and SOPs, a high level of accuracy was maintained by thorough and frequent review of field procedures. In this manner any deficiencies could be quickly documented and corrected. Trip blanks (volatiles only), field (water source) blanks, and equipment rinsate blanks were also collected during field sampling events to assess the potential for any contamination that might have occurred. Trip blanks were submitted at a frequency of one per shipment of samples scheduled for volatile analysis. Field blanks were collected from each water source at the beginning and at the completion of the field investigation. Equipment rinsate blanks were collected at a frequency of one per day or one per decontamination event.

2.1.3 Representativeness

Representativeness is defined by the degree to which the data accurately and precisely represent

- A characteristic of a population
- Parameter variations at a sampling point
- A process condition
- An environmental condition

Representativeness is ensured by collecting sufficient samples of an environmental medium, properly chosen with respect to place and time. The SAP describes the methods and protocols used to select samples that are representative of a particular sampling site.

2.1.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data originally intended to be obtained. Under ideal conditions, the completeness objective would be 100 percent; however, samples can be rendered unusable during shipment, preparation (e.g., bottles broken or extracts accidentally destroyed), or analysis (e.g., loss of instrument sensitivity, strong matrix effects). Therefore, the overall DQO for completeness during this investigation was 95 percent. Typical completeness values for these types of investigations fall between 90 and 100 percent.

Samples for which critical data points were determined invalid and unusable via data validation were reanalyzed (provided adequate sample volume was available and holding times could be met) or resampled (with the approval and direction of the Project Manager).

Completeness was calculated as shown below.

$$C = (V / T) \times 100$$

where:

C = completeness of analytical effort, in percent

V = number of valid sample analyses

T = total number of samples

A completeness calculation was performed on the analytical results obtained during the Supplemental RFI/RI from surface-water, soil, sediment, groundwater, and tissue samples. A total of 1,536 analytical results were rejected during the data validation process out of a total of 25,108 data points, which produces a completeness of 94 percent. While this completeness value is slightly below the goal for this supplemental RFI/RI, it is recommended that additional sampling and analysis not be performed at the eight NAS Key West sites. The benefit derived from replacing rejected data points is off-set by the cost required to perform the additional sampling and analysis.

2.1.5 Comparability

Comparability is defined by the confidence with which one data set can be compared to another. Comparability was achieved by using standardized sampling and analysis methods and standardized data reporting formats (including use of consistent units of measure and reporting of solid matrix sample results on a dry-weight basis).

2.2 FIELD INSTRUMENT CALIBRATION PROCEDURES

While in the field, all field instruments and equipment were calibrated daily using manufacturer's recommended procedures to verify the usability and general accuracy of instruments. Calibration checks were documented in the field logbook and included the following information:

- Date of calibration check
- Identification number(s) of the instruments
- Initials of person(s) performing the calibration
- Instrument readings
- Standard used (as applicable)

Section 2.2 of the Field Sampling Plan (IT Corporation, 1993) contains a more detailed presentation of the field instrument calibration procedures that were used.

2.3 ANALYTICAL PROCEDURES

This section addresses the identification of analytical methods that were used in sample analysis, the determination of instrument detection and quantitation limits, and calibration procedures that were used in association with sample analysis.

2.3.1 <u>Identification of Methods</u>

Methods of analysis for samples were taken principally from Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) (EPA, 1986c) and EPA Contract Laboratory Program Statement of Work for Inorganics Analysis (ILM03.0 with all revisions). Sample analyses were performed in conformance with the EPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual, as specified in the SAP.

2.3.2 <u>Detection and Quantitation Limits</u>

Instrument Detection Limits (IDLs) or Method Detection Limits (MDLs) are determined through the performance of detection limit studies. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The IDL is defined as the minimum concentration of substance that can be reliably detected above background noise for a particular instrument. IDLs or MDLs are statistically derived, depending on the parameter of interest. For metals, the procedure is defined in the EPA Contract Laboratory Program Statement of Work (CLP SOW) for Inorganics Analysis, Multi-Media, Multi-Concentration, Document No. ILM03.0 (including Revision 1). For all other parameters, the appropriate procedure is defined in 40 CFR 136, Appendix B.

Practical quantitation limits (PQLs) are derived by considering the effects of the sample matrix on the IDL or MDL. PQLs are defined in SW-846 (EPA, 1986c) with allowances made for differing types of sample matrices (e.g., groundwater, soil). Contract Required Detection Limits (CRDLs), which are applicable to metals and cyanide analyses for this project, are specified in the CLP SOW ILM03.0.

2.3.3 Method Calibration

Calibration procedures, including frequency of calibration, were performed as specified in the applicable analytical methods.

2.4 DATA MANAGEMENT, REDUCTION AND VALIDATION

Data management, reduction, and validation considerations are addressed in this section.

2.4.1 Data Management

Proper data management is an integral part of the reporting process and provides a basis for ensuring the validity, correctness, and completeness of reported data. The laboratory will archive all raw data/data packages associated with the analysis of project samples for a minimum of 7 years after project completion. These packages include QA/QC standards, chromatograms, data notebooks, injection logs, instrument calibration and performance data, and any associated workbooks and calculations. In addition, all field data, including log sheets, notebooks, photographs, etc., will be retained by the contractor in project files. Upon completion of the contract, all pertinent files will be relinquished to the custody of the United States Navy.

2.4.2 Data Reduction

Field instruments used by B&R Environmental were direct-reading, making field calculations and subsequent data reduction unnecessary. Field data were recorded in project logbooks or on field data logsheets. If data entries required correction, the change did not obscure the original entry and the correction or the change was initialed and dated at the time it was made.

Most of the data produced in the laboratory were generated through the use of instrumentation with microcomputer interfaces. The computer received the original signal from the instrument and transformed the raw data into a quantitative value, which was reviewed by an experienced analyst for validity and correct identification.

Other laboratory instrumentation did not interface with computers. The signal from these instruments was recorded as a strip chart trace, numerical output on a printer strip, or direct reading from a digital or analog dial. In these instances, the analyst reduced the data to a reportable format. The original signal was multiplied by a calibration factor or compared with a standard curve. The aliquot result was then divided by the mass or volume of the sample to produce a concentration-based final data result. Hand-held calculators were used to calculate the data results. The analyst recorded all data in a dedicated bench book.

2.4.3 Data Validation

Since some data was acquired directly in the field and other data were obtained through the laboratory analysis of samples, two types of data validation were necessary. Field data validation considerations, as well as laboratory data validation considerations, are discussed below.

2.4.3.1 Field Data Validation

All field data were reviewed by the FOL or another individual responsible for the collection and verification of data while in the field. Data were initially accepted or rejected by this individual before leaving the sampling site. Extreme readings (i.e., readings that appeared significantly different from other readings at the same site) were accepted only after the instrument had been checked for malfunction and the readings had been verified by retesting (with an alternate instrument, if possible). Field data validation entailed review and evaluation of field records for the parameters discussed below:

- Field Record Completeness: This examination ensured that established procedures had been followed, all work had been performed in accordance with the Supplemental RFI SAP (ABB, 1995) and sample integrity had been maintained.

- Sample Identification: Field forms and logbooks were checked for accuracy of information.

- Anomalous Field Test Data: When necessary, field records were examined for anomalous data.

Precision and Accuracy: When applicable, the precision and accuracy of field test data were evaluated.

Discrepancies found during examination and evaluation of field records were documented, and their effects on the project are discussed in this report.

2.4.3.2 Laboratory Data Validation

Formal laboratory data validation performs three basic functions. First, it serves as an independent QA check of the veracity of laboratory results. Second, it is a means of evaluating laboratory performance and determining the impact of noncompliance to the data. Finally, through the use of data qualifiers, it lends interpretive guidance as to the proper usage and limitations of the data. Laboratory data validation is essential to the overall defensibility of the data and also provides a secure platform from which to make risk assessment decisions.

Laboratory data validation is a systematic review and evaluation of the data conducted according to the following EPA national protocols (modified as necessary for SW-846 methods): *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (EPA, 1994f) and *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1994b).

Analysts performed a full data validation on 10 percent of the analytical data obtained for NAS Key West. In accordance with these protocols, organic data were evaluated based on the following parameters:

- Data completeness
- Laboratory blank analyses
- Holding times

- Surrogate spike recoveries
- Gas chromatograph/mass specrometer (GC/MS) tuning and mass calibration
- MS/MSD analyses
- Initial and continuing calibration
- Detection limits
- Internal standards performance.
- Sample quantitation

Inorganic data were evaluated based on the following parameters:

- Data completeness
- Laboratory control sample (LCS) results
- Holding times
- Furnace atomic absorption (AA) results
- Initial and continuing calibration verification
- Serial dilution analysis
- Laboratory blank analyses
- Detection limits
- MS and duplicate analyses
- Sample quantitation
- Interference check sample results

Results from field QC analyses (i.e., field blanks and field duplicates) were also evaluated according to these protocols.

A data review (i.e., the performance of a subset of the data validation steps) was performed on the remaining ninety percent of the analytical data to eliminate false positives and false negatives. This data review included several considerations for organic and inorganic data: evaluation of holding times, gas chromatography/mass spectroscopy (GC/MS) tuning and mass calibration (as applicable), initial and continuing calibration, and laboratory and field blank analyses. The benefit of performing the data review is that most of the problems typically associated with analytical results can be identified during the data review, but at a much lower cost than data validation.

Results and conclusions drawn from the laboratory validation and review were submitted as an internal correspondence memo addressed to the B&R Environmental Task Order Manager. This memo explained the findings of the data evaluation process, provided interpretations of actions taken on the data, and included a summary of the data qualifiers assigned. Qualified laboratory results and supporting documentation consisting of photocopied pages depicting the noncompliances are kept on file in the B&R Environmental Chemistry Department. A copy of the memo is included in Appendix J of this report.

2.5 QUALITY CONTROL FOR FIELD AND LABORATORY OPERATIONS

The principal functions of a sampling and analysis program are to obtain reliable and representative environmental samples and to document data quality. To accomplish this task, a program to assess field and laboratory data was planned. This program established the types and frequency of QC checks for field sampling and laboratory activities.

2.5.1 Field Quality Control Checks

The types of field QC samples collected include field duplicate samples, trip blanks, equipment rinsate blanks, and field water blanks. Section 1.5 discusses these samples and the frequency at which they were collected in the field procedures.

2.5.2 Laboratory Quality Control

Laboratory QC checks included several procedures to assess laboratory accuracy and precision. Analytical instrument performance was determined by routinely conducting calibration verification as specified in the applicable analytical methods.

The primary types of laboratory QC samples used during the present study were method blanks, internal standards, surrogates, spikes, matrix spike/matrix spike duplicates (MS/MSDs) and laboratory control samples (LCSs).

2.5.2.1 Method Blanks

Method blanks consisted of laboratory-grade water that was carried through the same analytical process as the environmental samples. Method blanks measured contamination associated with laboratory preparation or instrumentation. For most parameters, a method blank was analyzed with each batch of samples or at a frequency of 1 per 20 samples if more than 20 samples were run in a given batch.

2.5.2.2 Internal Standards

Internal standards were measured amounts of certain compounds added after preparation or extraction of each sample for GC/MS volatile or semivolatile analysis. Internal standards were used to monitor sensitivity and response for GC/MS analyses.

2.5.2.3 Surrogates

Surrogates were measured amounts of certain compounds added before preparation or extraction of a sample. The recovery of a surrogate was measured to determine systematic extraction, analysis problems, or sample matrix problems. Surrogates were added to all samples analyzed using chromatographic organic methods (volatiles, semivolatiles, and pesticides/polychlorinated biphenyls (PCBs) by GC or GC/MS).

2.5.2.4 Spikes

Spikes were aliquots of samples for inorganic analysis to which known amounts of analyte had been added. They were subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for spiking were purchased or prepared independently of calibration standards. The spike recovery measured the effects of interferences in the sample matrix and reflected the accuracy of the determination.

Additional sample volume was collected for samples requiring spike analyses, and spikes were prepared and analyzed at a frequency of at least 1 per 20 project samples for inorganic analyses.

2.5.2.5 MS/MSDs

MS/MSDs were duplicate aliquots of samples for organic analysis to which known amounts of the target analytes had been added. MS/MSDs were subjected to the same preparation and analytical procedures as the original samples. The MS/MSD percent recoveries measured the effects of interferences in the sample matrix and reflected the accuracy of the determination, while the RPD between the MS and the MSD measured the precision of a given analysis.

Additional sample volume was collected for samples requiring MS/MSD analyses, and MS/MSDs were prepared and analyzed at a frequency of at least 1 per every 20 project samples of similar matrix undergoing organic analysis. A matrix was defined in terms of sample type (e.g., soil/sediment or aqueous) and concentration (e.g., low-level, medium-level).

2.5.2.6 LCSs

LCSs were aliquots of organic-free or deionized water to which known amounts of analyte had been added for aqueous matrices. Other reference materials were sometimes used for nonaqueous matrices. LCSs were subjected to the same sample preparation or extraction and analysis procedures as the environmental samples. The stock solutions used for LCSs were purchased or prepared independently of calibration standards. The LCS recovery tested the function of analytical methods and equipment. LCSs were prepared and analyzed with each analytical batch.

2.6 PERFORMANCE AND SYSTEMS AUDITS

The B&R Environmental Quality Assurance Manager performed an audit of field activities during the second week of the field investigation at the NAS Key West. B&R Environmental performed the audit to confirm that work was being completed in compliance with the requirements of the SAP. The audit entailed review and evaluation of facilities and equipment, sampling and sample handling procedures, and data handling and documentation procedures. In addition, the FOL or designee performed daily reviews of field procedures and records.

Laboratories performing sample analysis for NAS Key West were approved as part of the U.S. Navy's laboratory contracting program. The U.S. Navy audit program specifies that the Navy perform laboratory audits for each contracted laboratory on an 18-month schedule.

3.0 DATA INTERPRETATION AND PRESENTATION

This section presents an overview of how the analytical data were used in interpreting and presenting the nature and extent of contaminants at the SWMUs as well as in assessing the human health and ecological risks associated with those contaminants. Section 3.1 discusses how the analytical data were evaluated in conjunction with each site's history and waste generation activities, physical setting, and geology and hydrogeology to construct a link between the analytical data and the nature and extent of impacts to environmental media at the site. Many of the data manipulation and presentation techniques, especially for tabular and graphical displays, are explained to provide the reader with an understanding of the investigation results presented in Chapters 2 through 9 of the Supplemental RFI/RI Report.

Sections 3.2 and 3.3 focus on the methodologies, standards, scenarios, and techniques used in assessing the potential human health and ecological risks resulting from the chemicals that were detected at each SWMU. These sections are based on the *Supplemental Resource Conservation and Recovery Act Facility Investigation and Remedial Investigation Workplan* for NAS Key West, Volume I and the *Supplemental Resource Conservation and Recovery Act Facility Investigation and Remedial Investigation Sampling and Analysis Plan* for NAS Key West, Volume II, which were approved by EPA Region IV and the FDEP. Sections 3.2 and 3.3 explain the systematic methodology for evaluating detection of each contaminant at each site, the qualitative process for selecting Chemicals of Potential Concern (COPCs), and the quantitative determination of contaminants of concern that may cause acute or chronic risks under the existing or future land use scenarios.

3.1 INVESTIGATION RESULTS

Chapters 2 through 9 of the Supplemental RFI/RI Report present the results of the RFI/RI. Each of these chapters includes a discussion of each SWMU and presents the contaminants that were detected at the site as well as the spatial. If applicable, each presents the temporal extent to which all environmental media have been impacted and interprets how the findings are related to activities that occur during base operations.

3.1.1 <u>Site Characterization</u>

Each site-specific chapter (Chapters 2 through 9) begins with a brief historical account of the site's uses and activities as well as its geographic and physical features, a description of previous investigations, and the rationale and scope of the RFI/RI. These report subsections are intended to establish a basis for the suspected and/or documented releases of contaminants to the environment. Site-specific details and exceptions to the typical environmental setting are discussed in each site-specific chapter of the Supplemental RFI/RI Report. The general information presented in Chapter 1 of the Supplemental RFI/RI Report is not repeated in each site's discussion.

3.1.2 Determination of Background Levels

A representative background data set was assembled for use as a tool in characterizing the nature and extent of contamination and in performing ecological and human health risk assessments at the eight sites under investigation in this Supplemental RFI/RI report. Background levels were calculated based on chemical-analytical data from background samples collected in the vicinity of NAS Key West, Florida. Descriptive statistics were calculated for each parameter detected in the background soil, sediment, surface-water, groundwater, and biota data sets. Generally, average concentrations were calculated for each analyte detected in a given media. For inorganic compounds, twice the average values were used as potential screening criteria in the Supplemental RFI/RI Report. For pesticides, average background concentrations were used as potential screening criteria. Appendix F provides a more complete discussion of the background sampling methodology and results.

The background characterization considered historical data collected at NAS Key West by previous contractors, as well as samples collected in 1996 by B&R Environmental. The historical data consisted of groundwater, surface-water, sediment, and soil analyses. B&R Environmental data were collected during two sampling events that coincided with the two supplemental field investigations conducted by B&R Environmental at NAS Key West. In January 1996, background data from Boca Chica Key were collected in order to establish a representative background data set for use with the four high-priority Boca Chica Key RCRA sites that were under investigation at the time. Appendix J of the *Supplemental RFI/RI Report for NAS Key West High Priority Sites, Boca Chica Key, Florida* (B&R Environmental, 1997) contains a detailed analysis and discussion of that smaller, more geographically specific data set. Since the eight additional CERCLA and RCRA sites being addressed in this report are more geographically widespread, additional background samples were collected to expand the geographical extent of the background data and create a background data set representative of general NAS Key West background conditions, rather than those specific to Boca Chica Key. Data from both B&R Environmental investigations were incorporated into the Comprehensive Background Data Set (Appendix F of the Supplemental RFI/RI for Eight Sites). Appendix H contains the full data set printout.

In order to construct a truly representative background data set, the location of all potential background samples was evaluated to determine whether site operations might have impacted the sample.

Additionally, all potential background samples were analyzed for statistical outliers. Both of these criteria were used to eliminate samples from the background data set. Chapter 2 of Appendix F of this Supplemental RFI/RI discusses this process in more detail.

The background data set for Boca Chica Key appears to be sufficient for accurately characterizing background conditions. Although some of the results are inconclusive (i.e., toxicity tests), there is currently sufficient background information available for supporting the NAS Key West RFI/RI at Boca Chica Key.

In general, the comprehensive background data set appears to provide an adequate characterization of background conditions in the vicinity of NAS Key West. For soil, sediment, surface water, and groundwater, the pesticide and inorganic data are considered representative of widespread soil background conditions in the vicinity of NAS Key West. This is due both to the high frequency of detection for these compounds, as well as their ubiquitous nature (in the case of inorganics) and history of widespread use (in the case of pesticides). Inorganic and pesticide background concentrations were therefore considered as potential screening criteria in evaluating the RCRA and CERCLA sites. While volatile and semivolatile contamination may be a consequence of widespread fuel and solvent use in our industrialized society, the organics that were detected also include common laboratory and rinsate contaminants. Volatile and semivolatile background concentrations in sediment, surface water, soil, and groundwater were therefore not used as screening values in characterizing the nature and extent of contamination or in performing the risk assessments at the RCRA and CERCLA sites.

3.1.3 Site Data Set

The following sections discuss the development of the site data set and detail the modifications that were necessary in order to construct a representative data set for site characterization.

3.1.3.1 Data Set Development

Data from both the Supplemental RFI/RI and previous investigations were used in data set development and site characterization. The data from the Supplemental RFI/RI underwent data validation, and the validated results were incorporated in the data set.

Data from previous investigations were obtained from several sources. Where possible, historical data was obtained electronically. In most cases, lab datasheets were available to support the electronic data, and the electronic results were verified and modified as necessary. In a few cases, electronic data was available for historical samples for which there were no corresponding lab datasheets. In these cases, electronic values were verified against those cited in the corresponding investigation's final report, where possible, and were otherwise accepted at face value. In a few cases, neither datasheets nor electronic data were available to support IT Corporation RFI/RI results, although results for a few detected parameters were cited in the report. These values were included in the database, and it was assumed that since they were the only values addressed in the report for the samples in question, they were probably the most significant results. Electronic data were not available for the 1986 Verification Study samples, 1990 RI samples, and some 1995-1996 Confirmation samples. These sample results were entered into the site database directly from lab datasheets.

3.1.3.2 Data Set Modifications

In general, the electronic data set developed for site characterization and analysis directly reflects the information presented in the hard-copy supporting documentation (lab datasheets, validation records for the Supplemental RFI/RI data, etc.). A few modifications and exclusions were necessary, as follows:

- Historical data with inadequate or conflicting documentation were excluded. For example, in several instances, lab datasheets were not correlated to a particular sample location and did not appear to have been used for site characterization during the previous investigation.

- Soil and sediment samples collected prior to an excavation, in an area that was later excavated, were excluded.

- Upgradient samples that were located in the vicinity of a site, but were used in background characterization, were excluded from the site data set (see Section 3.1.2 or Appendix F of the Supplemental RFI/RI for Eight Sites for a further discussion of background samples).

- Essential macronutrients (i.e. calcium, magnesium, sodium, potassium) were excluded, as per the Sampling and Analysis Plan (ABB, 1995).

- Data from field duplicate samples were averaged in order to obtain a single set of results for each sample location within a given investigation. The individual duplicate results were maintained in the electronic database for completeness, but only the calculated averages were used in site characterization and analysis.

- Historical samples which underwent dilutions or reextractions/reanalyses were evaluated conservatively in order to select a single result for each constituent associated with a given sample.

- All data were reviewed and modified as necessary to make the units in which results were reported consistent throughout a given analytical fraction (e.g. VOCs, inorganics, etc.) in a given medium (e.g. soil, surface water, etc.).

- Essential macronutrients (i.e. calcium, magnesium, sodium, potassium) were excluded.

- In some cases, historical sample names were altered slightly in order to make their origin more clear, and eliminate situations where samples from different investigations had identical sample names.

- A standardized set of parameter names was used throughout the data set, and the assignment of parameters to analytical fractions was also standardized.

3.1.4 Nature and Extent of Contamination

The site-specific chapters (Sections 2.0 through 9.0) of the Supplemental RFI/RI Report evaluate the nature and extent of contamination for each site. The detected chemicals at each site are discussed by medium (i.e., soil) and by analytical fraction (i.e., VOCs versus inorganics) within each media. All of the analytes were compared to screening values for each media, and the analytes determined to exceed the selected screening values are the primary focus of the nature and extent discussion. The compounds which exceeded the screening values are shown on maps within the site-specific discussion of contamination nature and extent. For reference, all detected parameters are presented in data tables which accompany the discussion.

3.1.4.1 Screening Values

The screening values used in the nature and extent discussion include criteria used both in the human health risk assessment and the ecological risk assessment process. The goal of the nature and extent discussion is to provide a broad overview of parameters that may be significant in the risk assessment process. Since a number of different ARARs and SALs were considered in the nature and extent screening process, the nature and extent data set generally contains a wider range of contaminants than that identified as being potentially significant in either risk assessment. The nature and extent screening process is completely separate from that used in either risk assessment. The risk assessments are conducted independently, although parameters that exceed nature and extent screening values should include most chemicals considered as COPCs in the risk assessments and should present an overview of contamination that can be used as a preface to the risk assessments.

A situation could occur where a screening value does not exist for a parameter within one or both of the risk assessments, but for which a nature and extent screening value was established from another source. In this case, a parameter may be considered as a COPC in the risk assessments if it exceeds background levels, but still be below the nature and extent screening levels. Additionally, as explained in Section 3.2.2.1, the human health risk assessment applies a safety factor of 0.1 to human health screening values for noncarcinogenic compounds. This safety factor was not applied to the risk-based concentrations (RBCs) when they were considered as potential nature and extent screening values. Instead, the RBCs were used directly, as published by EPA. In any instance where a COPC in one of the risk assessments does not exceed the nature and extent screening level, it will still be addressed in the nature and extent discussion, in order to present a complete picture.

ARARs and SALs were obtained from various state agencies, Federal agencies, and research institutions. These values were all considered as potential screening criteria in evaluating the nature and extent of contamination at each site. Twice the average background concentration (as determined in the Comprehensive Background Report, Appendix F of the Supplemental RFI/RI for Eight Sites) was used as an additional screen for inorganics. The average background concentration was used in screening pesticides. All potential screening values considered for soil, sediment, surface water, and groundwater are presented in Tables C.3-1 through C.3-4. The last columns of each table identify the value selected for use in screening the parameters detected in each media.

A two-step process was used to select the appropriate set of screening values. For a given compound, all ARAR and SAL concentrations were compared and the most restrictive value was selected. For inorganic and pesticide/PCB parameters, these restrictive concentrations were then compared to twice the average background concentration of the analyte. If the restrictive ARAR/SAL concentration was greater than twice the average background concentration, then the ARAR/SAL value was selected as the screening criteria for that compound. Since background values represent ubiquitous concentrations for inorganic compounds, it was considered appropriate to select twice the average background concentration as a screening value where the restrictive ARAR or SAL was less than that value. Likewise, for pesticides, the average background concentration was selected as the screening value when the most restrictive ARAR or SAL was less than that value. As discussed in Appendix F and Section C.3-1, VOC and SVOC background concentrations are not considered representative of widespread background concentrations so were not considered in the selection of screening values.

TABLE C.3-1
POTENTIAL SOIL SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

PAGE 1 OF 3

Detected Parameters	Potential Screening Values							Screening Value	Source
	ORNL BTVs[1]	Reg III BTAGs[2]	Proposed RCRA ALs[3]	FDEP Res. Goals[4]	FDEP Indust. Goals[5]	Res Soil RBCs[6]	BG[7]		
INORGANICS (mg/kg)									
Aluminum	600	1	NA	75,000	1,000,000	78,000	3,800	3,800	2×BG
Antimony	NA	0.48	30	26	220	31	0.79	0.79	2×BG
Arsenic	60	328	80	0.8	3.7	0.43	2.6	2.6	2×BG
Barium	3,000	440	4,000	5,200	84,000	5,500	21	440	Reg III BTAGs
Beryllium	NA	NA	0.2	0.2	1	0.15	0.09	0.15	Res Soil RBCs
Cadmium	20	2.5	40	37	600	39	0.30	2.5	Reg III BTAGs
Chromium	0.4	0.0075	400	290	430	390	12	12	2×BG
Cobalt	1,000	200	NA	4,700	110,000	4,700	0.59	200	Reg III BTAGs
Copper	50	15	NA	NA	NA	3,100	11	15	Reg III BTAGs
Cyanide	NA	0.005	2,000	1,600	40,000	1,600	NA	0.005	Reg III BTAGs
Iron	200	3,260	NA	NA	NA	23,000	2,300	2,300	2×BG
Lead	500	0.01	NA	500	1,000	NA	31	31	2×BG
Manganese	100	330	NA	370	5,500	1,800	35	100	ORNL BTVS
Mercury	0.1	0.058	20	23	480	23	0.06	0.06	2×BG
Nickel	200	2	2,000	1,500	26,000	1,600	3.4	3.4	2×BG
Selenium	70	1.8	NA	390	9,900	390	1.3	1.8	Reg III BTAGs
Silver	50	0.0000098	200	390	9,000	390	NA	0.0000098	Reg III BTAGs
Sulfide	NA	NA	NA	NA	NA	NA	98	98	2×BG
Thallium	NA	0.001	NA	NA	NA	NA	NA	0.001	Reg III BTAGs
Tin	2,000	0.89	NA	44,000	670,000	47,000	3.9	3.9	2×BG
Vanadium	20	0.5	NA	490	4,800	550	7.9	7.9	2×BG
Zinc	200	10	NA	23,000	560,000	23,000	30	30	2×BG
PESTICIDES/PCBs (µg/kg)									
2,4,5-T	NA	NA	800	760	15,000	NA	NA	760	FDEP Res Goals
2,4,5-TP (silvex)	NA	NA	NA	610	13,000	NA	NA	610	FDEP Res Goals
2,4-D	NA	NA	800	110	800	780,000	NA	110	FDEP Res Goals
4,4'-DDD	NA	100	3,000	4,500	17,000	2,700	22.5	100	Reg III BTAGs
4,4'-DDE	NA	100	2,000	3,000	11,000	1,900	63.2	100	Reg III BTAGs
4,4'-DDT	NA	100	2,000	3,100	12,000	1,900	46.7	100	Reg III BTAGs
Aldrin	NA	100	40	60	200	NA	NA	40	Proposed RCRA ALs

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alpha-BHC	NA	100,000	100	200	600	100	NA	100	Proposed RCRA ALs
Aroclor-1242	NA	100	90	900	3,500	320	NA	90	Proposed RCRA ALs
Aroclor-1254	NA	100	90	900	3,500	320	NA	90	Proposed RCRA ALs
Aroclor-1260	NA	100	90	900	3,500	320	43.2	96	2×BG
beta-BHC	NA	NA	4,000	600	2,300	350	NA	350	Res Soil RBCs
Dieldrin	NA	100	40	70	300	40	NA	40	Proposed RCRA ALs
Endosulfan I	NA	NA	NA	NA	NA	470,000	6	470,000	Res Soil RBCs
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	100	20,000	23,000	470,000	23,000	11.5	100	Reg III BTAGs
Endrin aldehyde	NA	NA	NA	23,000	480,000	NA	NA	23,000	FDEP Res Goals
Heptachlor	NA	NA	200	200	500	140	NA	140	Res Soil RBCs
Heptachlor epoxide	NA	100	80	100	300	70	NA	70	Res Soil RBCs
Methoxychlor	NA	100	NA	380,000	7,800,000	NA	58	100	Reg III BTAGs
SEMIVOLATILE ORGANIC COMPOUNDS (μg/kg)									
1,2-dichlorobenzene	20,000	100	NA	820,000	6,000,000	7,000,000	NA	100	Reg III BTAGs
1,3-dichlorobenzene	20,000	NA	NA	1,700,000	13,000,000	7,000,000	NA	20,000	ORNL BTVs
1,4-dichlorobenzene	20,000	100	NA	7,500	1,100	27,000	NA	100	Reg III BTAGs
2-methylnaphthalene	NA	NA	NA	960,000	8,800,000	NA	NA	960,000	FDEP Res Goals
Acenaphthene	NA	100	NA	2,800,000	30,000,000	4,700,000	NA	100	Reg III BTAGs
Anthracene	NA	100	NA	20,000,000	300,000,000	23,000,000	NA	100	Reg III BTAGs
Benzo(a)anthracene	NA	100	NA	1,400	4900	880	NA	100	Reg III BTAGs
Benzo(a)pyrene	NA	100	NA	100	500	88	NA	88	Res Soil RBCs
Benzo(b)fluoranthene	NA	100	NA	1,400	5,000	880	NA	100	Reg III BTAGs
Benzo(g,h,i)perylene	NA	100	NA	14,000	50,000	NA	NA	100	Reg III BTAGs
Benzo(k)fluoranthene	NA	100	NA	14,000	48,000	8,800	NA	100	Reg III BTAGs
Benzoic acid	NA	NA	NA	130,000,000	1,000,000,000	310,000,000	NA	130,000,000	FDEP Res Goals
Bis(2-ethylhexyl)phthalate	NA	NA	50,000	48,000	110,000	46,000	NA	46,000	Res Soil RBCs
Chrysene	NA	100	NA	140,000	500,000	88,000	NA	100	Reg III BTAGs
Dib3enzo(a,h)anthracene	NA	100	NA	100	500	88	NA	88	Res Soil RBCs
Dibenzofuran	NA	NA	NA	240,000	3,500,000	310,000	NA	240,000	FDEP Res Goals
Di-n-butyl phthalate	NA	NA	8,000,000	7,300,000	140,000,000	7,800,000	NA	7,300,000	FDEP Res Goals

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Fluoranthene	NA	100	NA	2,900,000	48,000,000	3,100,000	NA	100	Reg III BTAGs
Fluorene	30,000	100	NA	2,400,000	30,000,000	3,100,000	NA	100	Reg III BTAGs
Indeno(1,2,3-cd)pyrene	NA	100	NA	1,400	5,000	880	NA	100	Reg III BTAGs
Naphthalene	NA	100	NA	1,300,000	12,000,000	3,100,000	NA	100	Reg III BTAGs
Phenanthrene	100	100	NA	1,700,000	21,000,000	NA	NA	100	Reg III BTAGs
Pyrene	NA	100	NA	2,200,000	41,000,000	2,300,000	NA	100	Reg III BTAGs
VOLATILE ORGANIC COMPOUNDS (µg/kg)									
1,1,2-trichloroethane	NA	300	100,000	2,000	3,000	2,700,000	NA	300	Reg III BTAGs
1,2-dichloroethene	NA	300	NA	26,000	180,000	700,000	NA	300	Reg III BTAGs
2-butanone	NA	NA	NA	2,200,000	15,000,000	47,000,000	NA	2,200,000	FDEP Res Goals
2-chloro-1,3-butadiene	NA	NA	NA	NA	NA	1,600,000	NA	1,600,000	Res Soil RBCs
4-methyl-2-pentanone	NA	100,000	4,000,000	520,000	3,700,000	6,300,000	NA	100,000	Reg III BTAGs
Acetone	NA	NA	8,000,000	260,000	1,800,000	7,800,000	NA	260,000	FDEP Res Goals
Carbon disulfide	NA	NA	8,000,000	5,200	34,000	7,800,000	NA	5,200	FDEP Res Goals
Carbon tetrachloride	1,000,000	300	5,000	600	800	4,900	NA	300	Reg III BTAGs
Chlorobenzene	40,000	100	2,000,000	44,000	300,000	1,600,000	NA	100	Reg III BTAGs
Cis-1,2-dichloroethene	NA	300	NA	26,000	180,000	780,000	NA	300	Reg III BTAGs
Ethylbenzene	NA	100	8,000,000	1,400,000	10,000,000	7,800,000	NA	100	Reg III BTAGs
Methylene chloride	NA	300	90,000	16,000	23,000	85,000	NA	300	Reg III BTAGs
Tetrachloroethene	NA	300	10,000	12,000	28,000	12,000	NA	300	Reg III BTAGs
Toluene	NA	100	20,000,000	520,000	3,500,000	16,000,000	NA	100	Reg III BTAGs
Vinyl acetate	NA	NA	NA	180,000	1,200,000	78,000,000	NA	180,000	FDEP Res Goals
Xylenes, total	NA	100	200,000,000	13,000,000	92,000,000	160,000,000	NA	100	Reg III BTAGs

1 Oak Ridge National Laboratory Benchmark Toxicity Values (Will and Suter 1995a).
2 EPA Region III BTAG Screening Levels for Soil (EPA 1995f).
3 40 CFR Part 264 Proposed RCRA Action Levels.
4 Florida Residential Soil Cleanup Goals (FDEP 1995b and 1996a).
5 Florida Industrial Soil Cleanup Goals (FDEP 1995b and 1996a).
6 Residential Soil Risk-Based Concentrations (EPA 1997).
7 Twice the Average Background Concentration (Appendix F of the Supplemental RFI/RI for Eight Sites) for inorganics; the average background concentration (Appendix F of the Supplemental RFI/RI for Eight Sites) for pesticides.

TABLE C.3-2
POTENTIAL SEDIMENT SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

Detected Parameters	Potential Screening Values												Screening Value	Source
	FDEP Criteria[1]	Reg IV Values[2]	USEPA SQC Fresh[3]	USEPA SQC Marine[4]	ER-L[5]	ER-M[6]	USEPA SQB[7]	Other	Proposed RCRA ALs[11]	Reg III BTAGs[12]	Soil RBCs[13]	BG[14]		
INORGANICS (mg/kg)														
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	78,000	2,700	78,000	Res Soil RBCs
Antimony	NA	12	NA	NA	NA	NA	NA	NA	30	150	31	NA	12	Region IV Values
Arsenic	7.24	7.24	NA	NA	8.2	70	NA	NA	80	8.2	0.43	5.3	5.3	2×BG
Barium	NA	NA	NA	NA	NA	NA	NA	40[8]	4,000	NA	5,500	18	40	Other
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	0.2	NA	0.15	0.11	0.15	Res Soil RBCs
Cadmium	0.676	1	NA	NA	1.2	9.6	NA	NA	40	1.2	39	0.44	0.676	FDEP Criteria
Chromium	52.3	52.3	NA	NA	81	370	NA	NA	400	81	390	10	52.3	FDEP Criteria
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,700	0.94	4,700	Res Soil RBCs
Copper	18.7	18.7	NA	NA	34	270	NA	NA	NA	34	3,100	18	18.7	FDEP Criteria
Cyanide	NA	NA	NA	NA	NA	NA	NA	0.1[9]	2,000	NA	1,600	NA	0.1	Other
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	23,000	2,400	23,000	Res Soil RBCs
Lead	30.2	30.2	NA	NA	46.7	218	NA	NA	NA	46.7	NA	36	36	2×BG
Manganese	NA	NA	NA	NA	NA	NA	NA	460[10]	NA	NA	1,800	31	460	Other
Mercury	0.13	0.13	NA	NA	0.15	0.71	NA	NA	20	0.15	23	0.09	0.13	FDEP Criteria
Nickel	15.9	15.9	NA	NA	20.9	51.6	NA	NA	2,000	20.9	1,600	4.3	15.9	FDEP Criteria
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	390	1.4	390	Res Soil RBCs
Silver	0.733	2	NA	NA	1	3.7	NA	NA	200	1	390	0.54	0.733	FDEP Criteria
Sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	680	680	2×BG
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	47,000	5.7	47,000	Res Soil RBCs
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	550	10.2	550	Res Soil RBCs
Zinc	124	124	NA	NA	150	410	NA	NA	NA	150	23,000	51	124	FDEP Criteria
PESTICIDES/PCBs (µg/kg)														
2,4,5-TP (silvex)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA	NA	800	NA	780,000	39.2	800	RCRA ALs
4,4'-DDD	1.22	3.3	NA	NA	NA	NA	NA	NA	3,000	16	2,700	13	13	BG
4,4'-DDE	2.07	3.3	NA	NA	2.2	27	NA	NA	2,000	2.2	1,900	19.9	19.9	BG

TABLE C.3-2
POTENTIAL SEDIMENT SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

Detected Parameters	Potential Screening Values												Screening Value	Source
	FDEP Criteria[1]	Reg IV Values[2]	USEPA SQC Fresh[3]	USEPA SQC Marine[4]	ER-L[5]	ER-M[6]	USEPA SQB[7]	Other	Proposed RCRA ALs[11]	Reg III BTAGs[12]	Soil RBCs[13]	BG[14]		
4,4'-DDT	3.89	3.3	NA	NA	1.58	46	NA	NA	2,000	1.58	1,900	13	13	BG
alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA	100	NA	100	7.1	100	RCRA ALs
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA	NA	90	22.7	320	NA	22.7	REG III BTAGs
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	NA	90	22.7	320	NA	22.7	REG III BTAGs
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA	NA	90	22.7	320	NA	22.7	REG III BTAGs
beta-BHC	NA	NA	NA	NA	NA	NA	NA	5[10]	4,000	NA	350	NA	5	Other
delta-BHC	NA	NA	NA	NA	NA	NA	NA	3[10]	NA	NA	NA	7.4	7.4	BG
Dieldrin	0.715	3.3	52	95	NA	NA	NA	NA	40	NA	40	NA	0.715	FDEP Criteria
Endosulfan I	NA	NA	NA	NA	NA	NA	2.9	NA	NA	NA	470,000	6.7	6.7	BG
Endosulfan II	NA	NA	NA	NA	NA	NA	14	NA	NA	NA	NA	NA	14	USEPA SQB
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	3.3	20	3.5	NA	NA	NA	NA	20,000	NA	23,000	12.9	12.9	BG
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (lindane)	0.32	3.3	NA	NA	NA	NA	3.7	NA	500	NA	490	6.7	6.7	2×BG
gamma-chlordane	NA	NA	NA	NA	5.5	0.6	NA	NA	NA	NA	NA	NA	0.5	ER-L
Heptachlor	NA	NA	NA	NA	NA	NA	NA	4.9[10]	200	NA	140	6.5	6.5	BG
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	NA	80	NA	70	NA	70	Res Soil RBCs
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)														
Acenaphthene	6.71	330	620	1,100	16	500	NA	NA	NA	16	4,700,000	NA	6.71	FDEP Criteria
Acenaphthylene	5.87	330	NA	NA	44	640	NA	NA	NA	44	NA	NA	5.87	FDEP Criteria
Anthracene	46.9	330	NA	NA	85.3	1,100	NA	NA	NA	85.3	23,000,000	NA	46.9	FDEP Criteria
Benzo(a)anthracene	74.8	330	NA	NA	261	1,600	NA	NA	NA	261	880	NA	74.8	FDEP Criteria
Benzo(a)pyrene	88.8	330	NA	NA	430	1,600	NA	NA	NA	430	88	NA	88	Res Soil RBCs
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,200	880	NA	880	Res Soil RBCs
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	670	NA	NA	670	REG III BTAGs
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8,800	NA	8,800	Res Soil RBCs
Bis(2-ethylhexyl)phthalate	182	182	NA	NA	NA	NA	NA	890000000[9]	50,000	1,300	46,000	NA	182	FDEP Criteria
Butyl benzyl phthalate	NA	NA	NA	NA	NA	NA	11,000	NA	20,000,000	63	1,600,000	NA	63	REG III BTAGs

TABLE C.3-2
POTENTIAL SEDIMENT SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

Detected Parameters	Potential Screening Values												Screening Value	Source
	FDEP Criteria[1]	Reg IV Values[2]	USEPA SQC Fresh[3]	USEPA SQC Marine[4]	ER-L[5]	ER-M[6]	USEPA SQB[7]	Other	Proposed RCRA ALs[11]	Reg III BTAGs[12]	Soil RBCs[13]	BG[14]		
Chrysene	108	330	NA	NA	384	2,800	NA	NA	NA	384	88,000	NA	108	FDEP Criteria
Di-n-butyl phthalate	NA	NA	NA	NA	NA	NA	11,000	NA	8,000,000	1,400	7,800,000	NA	1,400	REG III BTAGs
Dibenzo(a,h)anthracene	6.22	330	NA	NA	63.4	260	NA	NA	NA	63.4	88	NA	6.22	FDEP Criteria
Dibenzofuran	NA	NA	NA	NA	NA	NA	2,000	NA	NA	540	310,000	NA	540	REG III BTAGs
Fluoranthene	113	330	2,900	1,400	600	5,100	NA	NA	NA	600	3,100,000	NA	113	FDEP Criteria
Fluorene	21.2	330	NA	NA	19	540	540	NA	NA	19	3,100,000	NA	19	ER-L
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	600	880	NA	600	REG III BTAGs
Naphthalene	34.6	330	NA	NA	160	2,100	480	NA	NA	160	3,100,000	NA	34.6	FDEP Criteria
Phenanthrene	86.7	330	850	1,100	240	1,500	NA	NA	NA	240	NA	NA	86.7	FDEP Criteria
Pyrene	153	330	NA	NA	665	2,600	NA	NA	NA	665	2,300,000	NA	153	FDEP Criteria
VOLATILE ORGANIC COMPOUNDS (µg/kg)														
1,2-dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	700,000	NA	700,000	Res Soil RBCs
2-butanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	47,000,000	NA	47000000	Res Soil RBCs
Acetone	NA	NA	NA	NA	NA	NA	NA	64[9]	8,000,000	NA	7,800,000	NA	64	Other
Cis-1,2-dichloroethene	NA	NA	NA	NA	NA	NA	NA	23[10]	NA	NA	780,000	NA	23	Other
Methylene chloride	NA	NA	NA	NA	NA	NA	NA	427[9]	90,000	NA	85,000	NA	427	Other
Tetrachloroethene	NA	NA	NA	NA	NA	NA	530	NA	10,000	57	12,000	NA	57	REG III BTAGs
Toluene	NA	NA	NA	NA	NA	NA	670	NA	20,000,000	NA	16,000,000	NA	670	USEPA SQB
Xylenes, total	NA	NA	NA	NA	NA	NA	25	NA	200,00,000	40	160000000	NA	25	USEPA SQB

1 Florida Sediment Quality Assessment Guidelines (FDEP 1994).
2 EPA Region IV Sediment Screening Values (EPA, 1995e).
3 EPA Freshwater Sediment Quality Criteria (EPA 1996a).
4 EPA Saltwater Sediment Quality Criteria (EPA 1996a).
5 Effects Range-Low Guidelines (Long et al. 1995).
6 Effects Range-Medium Guidelines (Long et al. 1995).
7 EPA Sediment Quality Benchmarks (EPA 1996a).
8 Baudo et al., 1990.
9 OME, 1992.
10 Hull and Suter, 1994.
11 40 CFR Part 264 Proposed RCRA Action Levels for Soil.
12 EPA Region III BTAG Sediment Screening Levels (EPA 1995f).
13 Residential Soil Risk-Based Concentrations (EPA 1997).
14 Twice the Average Background Concentration (Appendix F of the Supplemental RFI/RI for Eight Sites).

TABLE C.3-3
POTENTIAL SURFACE WATER SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

Detected Parameters	Potential Screening Values										Screening Value	Source
	FDEP Criteria(1)	Reg IV Marine(2)	Reg IV Fresh(3)	AWQC Marine(4)	AWQC Fresh(5)	Reg III Marine(6)	Reg III Fresh(7)	Proposed RCRA AL(8)	Tap Water RBC(9)	2×BG(10)		
INORGANICS (µg/L)												
Aluminum	1,500	NA	87	NA	NA	NA	25	NA	37,000	50	50	2×BG
Antimony	4,300	NA	160	500	30	500	30	10	15	67	67	2×BG
Arsenic	50	36	190	36	190	NA	874	50	0.045	7.9	7.9	2×BG
Barium	NA	NA	NA	NA	NA	10,000	10,000	1,000	2,600	14	1,000	Proposed RCRA ALs
Beryllium	0.13	NA	0.53	NA	5.3	1,500	5.3	0.008	0.016	0.44	0.44	2×BG
Cadmium	9.3	9.3	0.66	9.3	1.1	9.3	0.53	10	18	NA	0.53	Reg III Fresh
Chromium	50	50	11	50	11	50	2	NA	180	5.2	5.2	2×BG
Cobalt	NA	NA	NA	NA	NA	NA	35,000	NA	2,200	NA	2,200	Tap Water RBCs
Copper	2.9	2.9	6.54	2.9	12	2.9	6.5	NA	1,500	4.5	4.5	2×BG
Cyanide	1	1	5.2	1	5.2	1	5.2	700	730	NA	1	FDEP Criteria
Iron	300	NA	1,000	NA	1,000	NA	320	NA	11,000	49	300	FDEP Criteria
Lead	5.6	8.5	1.32	8.5	3.2	5.6	3.2	50	NA	NA	1.32	Reg IV Fresh
Manganese	NA	NA	NA	NA	NA	10	14,500	NA	840	4	10	Reg III Marine
Mercury	0.025	0.025	0.012	0.025	0.012	0.025	0.012	2	11	1	1	2×BG
Nickel	8.3	8.3	87.71	8.3	160	8.3	160	700	730	NA	8.3	FDEP Criteria
Silver	2.3	0.23	0.012	0.92	0.12	0.0001	0.0001	NA	180	NA	0.0001	Reg III Marine
Sulfide	NA	2	2	2	2	NA	NA	NA	NA	8,000	8,000	2×BG
Thallium	6.3	21.3	4	2,130	40	2,130	40	NA	2.9	9.8	9.8	2×BG
Tin	NA	NA	NA	NA	NA	0.01	0.026	NA	22,000	NA	0.01	Reg III Marine
Vanadium	NA	NA	NA	NA	NA	10,000	10,000	NA	260	4	260	Tap Water RBCs
Zinc	86	86	58.91	86	110	19	30	NA	11,000	14	19	Reg III Marine
PESTICIDES/PCBs (µg/L)												
2,4,5-TP (silvex)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.005	0.0335	NA	0.000045	FDEP Criteria
Aroclor-1232	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.005	0.0335	NA	0.000045	FDEP Criteria
~~Aroclor-1242~~	~~0.000045~~	~~0.03~~	~~0.014~~	~~0.03~~	~~0.014~~	~~0.03~~	~~0.014~~	~~0.005~~	~~0.0335~~	~~NA~~	~~0.000045~~	~~FDEP Criteria~~
Aroclor-1248	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.005	0.0335	NA	0.000045	FDEP Criteria

TABLE C.3-3
POTENTIAL SURFACE WATER SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

Detected Parameters	Potential Screening Values										Screening Value	Source
	FDEP Criteria[1]	Reg IV Marine[2]	Reg IV Fresh[3]	AWQC Marine[4]	AWQC Fresh[5]	Reg III Marine[6]	Reg III Fresh[7]	Proposed RCRA AL[8]	Tap Water RBC[9]	2×BG[10]		
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)												
Anthracene	110000	NA	NA	NA	NA	300	0.1	NA	11,000	NA	0.1	Reg III Fresh
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	300	NA	NA	NA	NA	300	Reg III Marine
Bis(2-ethylhexyl)phthalate	NA	NA	0.3	360	360	360	30	3	4.8	NA	0.3	Reg IV Fresh
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	300	NA	NA	0.0092	NA	0.0092	Tap Water RBCs
N-nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	NA	0.005	0.0096	NA	0.005	Proposed RCRA ALs
Naphthalene	NA	23.5	62	2,350	620	2,300	100	NA	1,500	NA	23.5	Reg IV Marine
VOLATILE ORGANIC COMPOUNDS (µg/L)												
1,1,1-trichloroethane	NA	312	528	31,200	NA	31,200	9,400	3,000	790	NA	312	Reg IV Marine
Acetone	NA	NA	NA	NA	NA	NA	90,000,000	4,000	3,700	NA	3,700	Tap Water RBCs
Dibromomethane	NA	NA	NA	NA	NA	6,400	11,000	NA	NA	NA	6,400	Reg III Marine
Methylene chloride	1,580	2,560	1,930	NA	NA	6,400	11,000	5	4.1	NA	4.1	Tap Water RBCs

1 Florida Surface Water Quality Standards (FDEP 1995).
2 EPA Region IV Saltwater Surface Water Screening Values (EPA 1995e).
3 EPA Region IV Freshwater Surface Water Screening Values (EPA 1995e).
4 EPA Ambient Water Quality Criteria-- Saltwater (EPA 1991e).
5 EPA Ambient Water Quality Criteria--Freshwater (EPA 1991e).
6 EPA Region III Marine BTAG Surface Water Screening Levels (EPA 1995f).
7 EPA Region III Freshwater BTAG Surface Water Screening Levels (EPA 1995f).
8 40 CFR Part 264 Proposed RCRA Action Levels for Water.
9 Tap Water Risk-Based Concentrations (EPA 1997).
10 Twice the Average Background Concentration (Appendix F of the Supplemental RFI/RI for Eight Sites).

TABLE C.3-4
POTENTIAL GROUNDWATER SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

PAGE 1 OF 4

Detected Parameters	Potential Screening Values									Screening Values	Source
	MCL(1)	Secondary MCL(2)	MCLG(3)	Florida MCL(4)	Secondary Florida MCL(5)	Proposed RCRA AL(6)	FDEP GC(7)	Tap Water RBCs(8)	2×BG(9)		
INORGANICS (µg/L)											
Aluminum	NA	200	NA	NA	200	NA	200	37000	NA	200	Secondary MCL
Antimony	6	NA	6	6	NA	10	6	15	NA	6	MCL
Arsenic	50	NA	NA	50	NA	50	50	0.045	9.3	9.3	2×BG
Barium	2,000	NA	2,000	2,000	NA	1,000	2,000	2,600	21	1,000	Proposed RCRA AL
Beryllium	4	NA	4	4	NA	0.008	4	0.016	NA	0.008	Proposed RCRA AL
Cadmium	5	NA	5	5	NA	10	5	18	NA	5	MCL
Chromium	100	NA	100	100	NA	NA	100	180	5.3	100	MCL
Cobalt	NA	NA	NA	NA	NA	NA	NA	2,200	NA	2,200	Tap Water RBC
Copper	NA	1,000	1,300	NA	1,000	NA	1,000	1,500	5	1,000	Secondary MCL
Cyanide	200	NA	200	200	NA	700	200	730	3.2	200	MCL
Iron	NA	300	NA	NA	300	NA	300	11,000	89.4	300	Secondary MCL
Lead	15	NA	NA	15	NA	50	15	NA	2.8	15	MCL
Manganese	NA	50	NA	NA	50	NA	50	840	7.9	50	Secondary MCL
Mercury	2	NA	2	2	NA	2	2	11	0.19	2	MCL
Nickel	100	NA	100	100	NA	700	100	730	NA	100	MCL
Selenium	50	NA	50	50	NA	NA	50	180	5.6	50	MCL
Silver	NA	100	NA	NA	100	NA	100	180	2.8	100	Secondary MCL
Sulfide	NA	NA	NA	NA	NA	NA	NA	NA	56,000	56,000	2×BG
Thallium	2	NA	0.5	2	NA	NA	2	NA	4.5	4.5	2×BG
Tin	NA	NA	NA	NA	NA	NA	4,200	22,000	NA	4,200	FDEP GC
Vanadium	NA	NA	NA	NA	NA	NA	49	260	5.5	49	FDEP GC
Zinc	NA	5,,000	NA	NA	5,000	NA	5,000	11,000	5.9	5,000	Secondary MCL

TABLE C.3-4
POTENTIAL GROUNDWATER SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

Detected Parameters	Potential Screening Values									Screening Values	Source
	MCL(1)	Secondary MCL(2)	MCLG(3)	Florida MCL(4)	Secondary Florida MCL(5)	Proposed RCRA AL(6)	FDEP GC(7)	Tap Water RBCs(8)	2×BG(9)		
PESTICIDES/PCBs (µg/L)											
2,4,5-TP (silvex)	50	NA	50	50	NA	NA	50	NA	NA	50	MCL
2,4-D	70	NA	70	70	NA	NA	70	61	NA	61	Tap Water RBC
4,4'-DDD	NA	NA	NA	NA	NA	0.1	0.1	0.28	NA	0.1	Proposed RCRA AL
4,4'-DDE	NA	NA	NA	NA	NA	0.1	0.1	0.2	NA	0.1	Proposed RCRA AL
4,4'-DDT	NA	NA	NA	NA	NA	0.1	0.1	0.2	NA	0.1	Proposed RCRA AL
Aldrin	NA	NA	NA	NA	NA	0.002	0.05	0.004	NA	0.002	Proposed RCRA AL
alpha-BHC	NA	NA	NA	NA	NA	0.006	0.05	0.011	NA	0.006	Proposed RCRA AL
alpha-chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA	0.2	0.1	0.037	NA	0.037	Tap Water RBC
Chlordane	2	NA	NA	2	NA	0.03	2	0.052	NA	0.03	Proposed RCRA AL
delta-BHC	NA	NA	NA	NA	NA	NA	0.05	NA	NA	0.05	FDEP GC
Dieldrin	NA	NA	NA	NA	NA	0.002	0.1	0.0042	NA	0.002	Proposed RCRA AL
Endosulfan I	NA	NA	NA	NA	NA	2	NA	220	NA	2	Proposed RCRA AL
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	0.3	NA	NA	0.3	FDEP GC
Endrin	2	NA	2	2	NA	NA	2	11	NA	2	MCL
Endrin aldehyde	NA	NA	NA	NA	NA	NA	0.1	NA	NA	0.1	FDEP GC
gamma-BHC (lindane)	0.2	NA	0.2	0.2	NA	NA	0.2	0.052	NA	0.052	Tap Water RBC
gamma-chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	0.4	NA	NA	0.4	NA	0.008	0.4	0.0023	NA	0.0023	Tap Water RBC
Heptachlor epoxide	0.2	NA	NA	0.2	NA	0.004	0.2	0.0012	NA	0.0012	Tap Water RBC
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)											
1,4-dichlorobenzene	75	NA	75	75	NA	NA	75	0.44	NA	0.44	Tap Water RBC

TABLE C.3-4
POTENTIAL GROUNDWATER SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

Detected Parameters	Potential Screening Values									Screening Values	Source
	MCL(1)	Secondary MCL(2)	MCLG(3)	Florida MCL(4)	Secondary Florida MCL(5)	Proposed RCRA AL(6)	FDEP GC(7)	Tap Water RBCs(8)	2×BG(9)		
1,4-dioxane	NA	NA	NA	NA	NA	3	5	6.1	NA	3	Proposed RCRA AL
2,4-dimethylphenol	NA	NA	NA	NA	NA	NA	400	730	NA	400	FDEP GC
Acenaphthene	NA	NA	NA	NA	NA	NA	20	2,200	NA	20	FDEP GC
Anthracene	NA	NA	NA	NA	NA	NA	2,100	11,000	NA	2,100	FDEP GC
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	10	NA	NA	10	FDEP GC
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	4	0.92	NA	0.92	Tap Water RBC
Bis(2-ethylhexyl)phthalate	6	NA	NA	6	NA	3	NA	4.8	NA	3	Proposed RCRA AL
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	7.5	0.0092	NA	0.0092	Tap Water RBC
Diethyl phthalate	NA	NA	NA	NA	NA	30,000	5,600	29,000	NA	5,600	FDEP GC
Fluoranthene	NA	NA	NA	NA	NA	NA	280	1,500	NA	280	FDEP GC
Fluorene	NA	NA	NA	NA	NA	NA	280	1,500	NA	280	FDEP GC
Naphthalene	NA	NA	NA	NA	NA	NA	6.8	1,500	NA	6.8	FDEP GC
Phenanthrene	NA	NA	NA	NA	NA	NA	10	NA	NA	10	FDEP GC
Pyrene	NA	NA	NA	NA	NA	NA	210	1,100	NA	210	FDEP GC
VOLATILE ORGANIC COMPOUNDS (µg/L)											
1,1-dichloroethane	NA	NA	NA	NA	NA	NA	700	810	NA	700	FDEP GC
1,1-dichloroethene	7	NA	7	7	NA	NA	7	NA	NA	7	MCL
2-butanone	NA	NA	NA	NA	NA	2,000	4,200	1,900	NA	1,900	Tap Water RBC
Acetone	NA	NA	NA	NA	NA	4,000	700	3,700	NA	700	FDEP GC
Benzene	5	NA	NA	1	NA	NA	1	0.36	NA	0.36	Tap Water RBC
Bis(2-chloroisopropyl)ether	NA	NA	NA	NA	NA	NA	7.5	0.26	NA	0.26	Tap Water RBC
Bromodichloromethane	100	NA	NA	NA	NA	0.03	0.6	0.17	NA	0.03	Proposed RCRA AL
Bromoform	100	NA	NA	NA	NA	700	4	2.4	NA	2.4	Tap Water RBC
Carbon disulfide	NA	NA	NA	NA	NA	4,000	700	1,000	NA	700	FDEP GC

TABLE C.3-4
POTENTIAL GROUNDWATER SCREENING VALUES FOR NATURE AND EXTENT DISCUSSION
NAS KEY WEST

Detected Parameters	Potential Screening Values									Screening Values	Source
	MCL[1]	Secondary MCL[2]	MCLG[3]	Florida MCL[4]	Secondary Florida MCL[5]	Proposed RCRA AL[6]	FDEP GC[7]	Tap Water RBCs[8]	2×BG[9]		
Chlorobenzene	100	NA	100	100	NA	700	NA	39	NA	39	Tap Water RBC
Chloroform	100	NA	NA	NA	NA	6	6	0.15	NA	0.15	Tap Water RBC
Dibromochloromethane	100	NA	60	NA	NA	NA	1	0.13	NA	0.13	Tap Water RBC
Dichlorodifluoromethane	NA	NA	NA	NA	NA	7,000	1,400	390	NA	390	Tap Water RBC
Ethylbenzene	700	NA	700	700	30	4,000	30	1,300	NA	30	Secondary FL MCL
Methylene chloride	NA	NA	NA	5	NA	5	5	4.1	NA	4.1	Tap Water RBC
Styrene	100	NA	100	100	NA	7,000	100	1,600	NA	100	MCL
Toluene	1,000	NA	1,000	1,000	40	10,000	40	750	NA	40	Secondary FL MCL
Trans-1,2-dichloroethene	100	NA	100	100	NA	NA	100	120	NA	100	MCL
Trichloroethene	5	NA	NA	3	NA	NA	3	1.6	NA	1.6	Tap Water RBC
Vinyl chloride	2	NA	NA	1	NA	NA	1	0.019	NA	0.019	Tap Water RBC
Xylenes, total	10,000	NA	10,000	10,000	20	70,000	20	12,000	NA	20	Secondary FL MCL

1 Safe Drinking Water Act Maximum Contaminant Levels (EPA 1996c).
2 Safe Drinking Water Act Secondary Maximum Contaminant Levels (EPA 1996c).
3 Safe Drinking Water Act Maximum Contaminant Level Goals (EPA 1996c).
4 Florida Maximum Contaminant Levels (FDEP 1995c).
5 Florida Secondary Maximum Contaminant Levels (FDEP 1995c).
6 40 CFR Part 264 Proposed RCRA Action Levels for Water.
7 Florida Groundwater Guidance Concentrations (FDEP 1994b).
8 Tap Water Risk-Based Concentrations (EPA 1997).
9 Twice the Average Background Concentration (Appendix F of the Supplemental RFI/RI for Eight Sites).

3.1.4.2 Data Tables

Data tables are included within each media-specific discussion under the nature and extent of contamination for each RCRA or CERCLA site. Generally, five tables are provided for each site: one showing contaminant data for subsurface soil, another for surface soil, a third for sediment, a fourth for surface water, and finally, a table showing groundwater contaminant data. In some cases, fewer tables are presented because all five media were not present at a site. Additionally, subsurface soil sampling was not performed at all sites.

Each table lists only the chemicals that were detected in the specific environmental medium being discussed. For example, if a chemical was not detected in any soil sample for a given site, it is not listed in the table containing soil data. These tables provide an inclusive list of the analytes detected at the site by medium, incorporating data gathered during the 1996 field investigation conducted by B&R Environmental, as well as historical data gathered in past field investigations. Data validation qualifiers are provided in these tables and are defined at the end of each table. Rejected data are not included.

As per the Workplan (ABB 1995), the common human nutrients calcium, magnesium, potassium, and sodium are not addressed in the Supplemental RFI/RI, although they were analyzed in some samples.

3.1.4.3 Contaminant Distribution Maps

Sections 2.0 through 9.0 of the Supplemental RFI/RI Report present maps showing the concentration and distribution of the analytes that were detected in excess of screening values for each RCRA or CERCLA site, by medium. Generally, subsurface soil, surface soil, sediment, and surface-water analytical results are shown on individual maps, with groundwater contamination depicted on several maps, by year. Since groundwater samples were often taken repeatedly from the same monitoring well, examining groundwater contaminant trends over time can provide a better understanding of the nature and degree of contamination at a site. In the other media, the density of sampling locations and the large number of exceedances at those locations occasionally necessitated multiple contaminant distribution maps. Where possible, these maps were divided by analytical fraction; however, normally the bulk of the detections were limited to a single fraction. In this case, the maps were divided by location, with each individual map magnifying a particular region of the site. Other media at the same site that did not require additional maps were presented at the normal scale.

The intent of these maps is to display the distribution and extent of COPCs to identify areas of greatest impact, and to link the release and, if applicable, the migration of contaminants to the site's physical features and/or environmental setting. Chemical concentrations are shown at each sampling point where a screening value was exceeded. A number of other considerations made during the preparation of the contaminant distribution maps are discussed below:

- Non-detect data and data that fell below the screening value for a given chemical are not represented on the figures.

- A data box on each figure provides the screening values that were used as a basis of comparison for each chemical shown. Tables C.3-1 through C.3-4 provide an inclusive list of all the ARARs, SALs, and background values that were evaluated as potential screening criteria for the nature and extent discussion.

- In sediment and soil, laboratories commonly report organic concentrations in µg/kg, while inorganic concentrations are reported in mg/kg. Groundwater and surface-water contaminants are normally reported in µg/L. These standardized units are maintained throughout the text and tables. The maps distinguish between organic and inorganic parameters, in order to carry through the standardized units in an easily recognizable, consistent fashion. When data from several sampling events are depicted on a single map, the year of the investigation accompanies each set of data shown at a given sampling location.

- On the contaminant distribution maps that are divided by year (groundwater), all site monitoring wells are presented for reference, regardless of whether they were sampled in that particular year. However, the well location identifier is bolded at the locations that were sampled in that year.

- Where sufficient subsurface soil samples were collected, a separate contaminant distribution map was drafted. At sites where few subsurface soil samples were collected and a limited number of contaminants were detected in those samples, all soil data is depicted on a single contaminant distribution map, with the subsurface samples noted in the legend.

- Subsurface soil samples were sometimes taken from different depths at a site, but due to the limited number of soil borings performed, all the subsurface data for a given site is illustrated on a single map. All subsurface sample depths are included on the data tables which accompany the nature and extent discussion.

- Most sediment samples were surface samples, although subsurface sediment was collected at a few sites (AOC B, IR 1, and SWMU 7). Since the subsurface sediment samples were limited in number and were generally collected close to the surface, they are not presented separately in the text or on the maps. Sediment sample depths are shown on the data tables that accompany the nature and extent discussion in order to distinguish between surface and subsurface sample results from the same location. Where necessary, depths are presented on the maps and discussed in the text in order to make the same distinction.

3.1.5 Facility-Wide Contaminant Fate and Transport

The ultimate fate of chemicals in the environment is determined by a multitude of physical, chemical, and biological factors. The role and significance of different physical properties such as specific gravity, solubility, and vapor pressure in determining what environmental fate and transport processes occur for a particular chemical can depend upon numerous additional factors. For example, solubilities of metals are not truly constant in the environment but may be dramatically enhanced or reduced when certain ligand species are available for complexation or precipitation, when organic matter is present in dissolved form, or when pH is altered. Physical properties such as soil/water partition ratios and groundwater retardation factors can vary considerably from location to location, even within the same geologic regime. Chemical and biological transformational processes can also be significantly affected by localized effects such as clay or mineral catalysts, chemical or biological inhibitors, and pH, Eh, and DO.

This section of the report summarizes the physical and chemical transport properties for chemicals detected at the sites. No distinction of location or magnitude of chemicals will be made in this section. The information presented will discuss chemical persistence and transport phenomena for the general classes of compounds detected in the environmental media sampled at the sites. Each of the site-specific fate and transport sections contained in Chapters 2 through 9 addresses probable contaminant migration routes and qualitatively identify potential routes of human exposure.

3.1.5.1 Physical and Chemical Properties

This section presents and discusses physical and chemical properties of the detected contaminants. These parameters are used to quantitatively describe the environmental behavior of chemicals found at each site. This section describes empirically determined literature values of the specific gravity, vapor pressure, solubility, the octanol/water partition coefficient, the organic carbon partition coefficient, the soil-water partitioning coefficient, and Henry's Law constant. Calculated values are presented if literature values are not available. Table C.3-5 presents a summary of the physical and chemical transport properties for all detected chemicals at NAS Key West. These data are used to evaluate contaminant

TABLE C.3-5

SUMMARY OF PHYSICAL AND CHEMICAL DATA FOR CHEMICALS OF POTENTIAL CONCERN SITEWIDE - SURFACE WATER, SEDIMENT, SURFACE SOIL, AND SUBSURFACE SOIL NAS KEY WEST

CHEMICAL OF CONCERN	MOLECULAR WEIGHT	SOLUBILITY (mg/L)	Log Kow	VAPOR PRESSURE (mmHg, 20C)	HENRY'S LAW CONSTANT (atm cu. m/mol)	BIOCONCENTRATION FACTOR (ug/kg/ug/L)	SPECIFIC GRAVITY	Koc
HERBICIDES								
2,4-D	-	-	-	-	-	-	-	-
Methyl parathion	-	-	-	-	-	-	-	-
INORGANICS								
Aluminum	26.98	INSOLUBLE	-	0	-	-	2.708	-
Antimony	121.75	-	-	1 (886C)	-	1.00E+00	6.684	-
Arsenic	74.92	-	-	1 (372C)	-	4.40E+01	5.72	-
Barium	137.34	DECOMPOSE	-	10 (1049C)	-	1.00E+00	3.5	-
Beryllium	9.01	-	-	1 (1860C)	-	1.90E+01	1.85	-
Cadmium	112.4	INSOLUBLE	-	1 (394C)	-	6.40E+01	8.642	-
Calcium	40.08	DECOMPOSE	-		-	-	1.57	-
Chromium	52	INSOLUBLE	-	0	-	1.60E+01	7.2	-
Cobalt	58.93	INSOLUBLE	-	0	-	1.00E+00	8.9	-
Copper	63.54	INSOLUBLE	-	1 (1628C), 10 (1870C)	-	3.60E+01	8.92	-
Iron	55.85	INSOLUBLE	-	0	-	-	7.86	-
Lead	207.19	INSOLUBLE	-	1 (980C)	-	1.00E+00	11.35	-
Magnesium	24.312	-	-	-	-	-	1.738	-
Manganese	54.94	DECOMPOSE	-	1 (1292C)	-	1.00E+00	7.2	-
Mercury	200.59	5.6E-03g/100cc	-	2E-03 (25C)	-	1.00E+00	13.5939	-
Nickel	58.71	INSOLUBLE	-	1 (1810C)	-	4.70E+01	8.902	-
Potassium	39.1	DECOMPOSE	-	-	-	-	0.862	-
Selenium	78.96	INSOLUBLE	-	0	-	1.00E+00	4.26-4.81	-
Silver	107.87	INSOLUBLE	-	0	-	5.00E-01	10.5	-
Sodium	22.9898	DECOMPOSE	-	-	-	-	0.97	-
Thallium	204.37	-	-	-	-	-	11.85	-
Tin	118.69	-	-	-	-	-	-	-
Vanadium	50.94	-	-	-	-	1.00E+00	5.96	-
Zinc	65.37	-	-	1 (487C)	-	4.70E+01	7.133	-
Cyanide	27	SOLUBLE	-	657.8 (21.9C)	-	-	0.699	-
PESTICIDES/PCBs								
4,4'-DDD	320.1	0.09 (25C)	6.20	1.89E-06 (25C)	2.20E-08	1.80E+05	-	7.70E+05
4,4'-DDE	318	0.04 (20C)	4.28	6.50E-06	6.80E-05	8.00E+06	-	4.40E+06
4,4'-DDT	354.5	0.0055 (25C)	6.19 (20C)	1.9E-07 (25C)	1.58E-05	8.00E+06	-	2.43E+05
Aldrin	364.91	1.80E-01(25C)	5.11E+00	2.30E-06	5.00E-04	4.70E+03	1.7	9.60E+04
Aroclor-1260	375.7	0.08 (24C)	7.15	4E-05 (25C)	0.74	1.00E+05	-	6.70E+06
Alpha-BHC	-	-	-	-	-	-	-	-

TABLE C.3-5

SUMMARY OF PHYSICAL AND CHEMICAL DATA FOR CHEMICALS OF POTENTIAL CONCERN
SITEWIDE - SURFACE WATER, SEDIMENT, SURFACE SOIL, AND SUBSURFACE SOIL
NAS KEY WEST

CHEMICAL OF CONCERN	MOLECULAR WEIGHT	SOLUBILITY (mg/L)	Log Kow	VAPOR PRESSURE (mmHg, 20C)	HENRY'S LAW CONSTANT (atm cu. m/mol)	BIOCONCENTRATION FACTOR (ug/kg/ug/L)	SPECIFIC GRAVITY	Koc
PESTICIDES/PCBs (cont.)								
Beta-BHC	290.83	7.00E-01	3.8	1.70E-01	2.30E-07	1.30E+02	1.9	3.58E+00
Delta-BHC	290.83	2.10E+01	4.14E+00	2.00E-02	2.50E-07	1.30E+02	1.9	3.58E+00
Gamma-BHC	-	-	-	-	-	-	-	-
Endosulfan I	-	-	-	-	-	-	-	-
Endosulfan II	406.95	3.30E-01	3.62E+00	1.00E-05	1.91E-05	2.70E+02	1.7 (20/20C)	2.30E+00
Endosulfan sulfate	422.92	2.20E-01	3.66E+00	NA	2.60E-05	-	-	1.62E+00
Endrin	380.92	2.60E-01	5.60E+00	2.00E-07	4.00E-07	4.00E+03	1.7	3.23E+00
Endrin aldehyde	380.92	2.60E-01	5.60E+00	2.00E-07	3.90E-07	4.00E+03	-	2.83E+00
Endrin ketone	380.92	-	-	-	4.00E-07	7.10E-02	-	-
Heptachlor	373.32	1.80E-01	4.40E+00	3.00E-04	1.50E-03	1.10E+04	1.6	1.2EE+04
Heptachlor epoxide	389.3	3.5E-01	2.70	3.00E-04	-	-	-	2.2E+02
Methoxychlor	345.65	4.00E-02	4.68E+00	-	3.00E-05	8.30E+03	1.4	4.90E+00
Toxaphene	413.8	5.0E-01	3.3	4.0E-01	-	-	1.64	9.64E+02
SEMIVOLATILES ORGANIC COMPOUNDS								
1,2-dichlorobenzene	147.01	100	3.56	1.00E+00	1.93E-03	7.30E+02	1.31E+00	1.70E+03
1,3-dichlorobenzene	147	123	3.60	2.28E+00	-	-	-	1.70E+03
1,4-dichlorobenzene	147.01	79	3.56E+00	1.18	3.10E-03	7.30E+02	1.70E+03	1.70E+03
1,2,4-trichlorobenzene	30	3.90E-01	4.28	2.91E-01	2.30E-03	1.82E+02	1.574	9.23E+03
1-methylnaphthalene	-	-	-	-	-	-	-	-
2,4-dimethylphenol	122.2	1.7E-02	-	6.0E-02	-	-	0.956	-
2-methylnaphthalene	142.19	26-28 (25C)	4.26	0.087 (25C)	6.00E-04	1.00E+03	0.994	5.80E+03
4-methyl-2-pentanone	-	-	-	-	-	-	-	-
Acenaphthene	154.2	3.42 (25C)	3.92	1.55E-03 (25C)	9.10E-05	1.80E+03	1.0242	4.60E+03
Acenaphthylene	152.2	3.93 (25C)	3.72	2.90E-02	1.45E-03	1.00E+03	-	2.50E+03
Acetophenine	-	-	-	-	-	-	-	-
Anthracene	178.2	0.045 (25C)	4.45	1.7E-05 (25C)	8.60E-05	4.70E+03	1.283	1.40E+04
Benzo(a)anthracene	228.28	0.0057	5.61	2.20E-08	1.00E-06	5.30E+04	-	1.38E+06
Benzo(a)pyrene	252	0.0038 (25C)	5.98	5.60E-09	4.90E-07	1.09E+04	-	5.50E+06
Benzo(b)fluoranthene	252.3	0.014 (25C)	6.57	5.00E-07	1.22E-05	1.40E+05	-	5.50E+05
Benzo(g,h,i)perylene	276	0.00026 (25C)	7.23	1.03E-10 (25C)	1.44E-07	3.50E+05	-	1.60E+06
Benzo(k)fluoranthene	252.3	0.0043 (25C)	6.84	5.00E-07	3.87E-05	1.40E+05	-	5.50E+05
Bis(2-chloroisopropyl)ether	171.08	1.70E+03-	2.10	8.50E-01	-	-	-	6.1E+01
Bis(2-ethylhexyl)phthalate	390.62	0.4 (25C)	5.3	2.00E-07	3.00E-07	2.30E+08	0.99	2.00E+09
Chrysene	228.3	0.0018 (25C)	5.61	6.3E-09 (25C)	1.05E-06	5.30E+04	1.274	2.00E+05
Di-n-butylphthalate	278.35	1.30E+01	5.20E+00	1.00E-01	2.80E-07	8.90E+01	1	1.70E+05

TABLE C.3-5

SUMMARY OF PHYSICAL AND CHEMICAL DATA FOR CHEMICALS OF POTENTIAL CONCERN SITEWIDE - SURFACE WATER, SEDIMENT, SURFACE SOIL, AND SUBSURFACE SOIL NAS KEY WEST

CHEMICAL OF CONCERN	MOLECULAR WEIGHT	SOLUBILITY (mg/L)	Log Kow	VAPOR PRESSURE (mmHg, 20C)	HENRY'S LAW CONSTANT (atm cu. m/mol)	BIOCONCENTRATION FACTOR (ug/kg/ug/L)	SPECIFIC GRAVITY	Koc
SEMIVOLATILES ORGANIC COMPOUNDS (cont.)								
Dibenz(a,h)anthracene	278.4	0.005 (25C)	5.97	1.00E-10	7.30E-08	6.90E+05	-	3.30E+06
Dibenzofuran	168.2	10	4.12	-	-	-	-	8.13E+03
Diethylphthalate	222.2	210	2.47	3.5E-03 (25C)	1.20E-06	1.07E+02	1.12	1.42E+02
Fluoranthene	202.3	0.26 (25C)	5.33	5E-06 (25C)	6.50E-06	1.20E+04	1.252	3.80E+04
Fluorene	116.2	1.69 (25C)	4.18	7.10E-04	6.40E-05	3.80E+03	1.203	7.30E+03
Indeno(1,2,3-cd)pyrene	276.3	0.00053 (25C)	7.66	1.00E-10	6.95E-08	3.50E+05	-	1.60E+06
Methacrylonitrile	-	-	-	-	-	-	-	-
Naphthalene	128.2	31.7 (25C)	3.01/3.45	8.7E-02 (25C)	4.60E-04	4.20E+02	1.152	9.40E+02
Phenanthrene	178.2	1.0(25C)	4.45	9.6E-04 (25C)	2.30E-04	4.70E+03	1.025	1.40E+04
Pyrene	202.3	0.13 (25C)	5.18	2.5E-06(25C)	5.10E-06	1.20E+04	-	3.80E+04
VOLATILES ORGANIC COMPOUNDS								
1,1,1-trichloroethane	133.41	720	2.47	1.23E2 (25C)	3.00E-02	8.10E+01	1.35	1.52E+01
1,1-dichlorethane	98.96	5500	1.79	1.80E+02	4.26E-03	1.90E+01	1.174	3.00E+01
1,1-dichloroethene	96.94	400	1.48	5.91E+02	1.90E-01	5.30E+01	1.218	6.50E+01
1,2-dichloroethene (total)	96.94	800 (20C)	-	200 (25C)	4.08E-03	4.80E+01	1.28	5.90E+01
1,1,1,2-tetrachloroethane	-	-	-	-	-	-	-	-
2-butanone	72.1	35300	0.26	78	2.08E-05	6.00E-01	0.805	1.70E+01
2-hexanone	100.16	-	-	-	-	-	-	-
Acetone	58.08	680000	-0.24	2.70E+02	3.43E-05	3.00E-01	0.791	9.20E+00
Acetonitrile	41.06	-	-0.34	7.4E+01	-	-	-	2.2
Benzene	78.12	1780	2.13	95.2 (25C)	5.50E-03	7.84E+00	-	6.50E+01
Benzyl alcohol	-	-	-	-	-	-	-	-
Bromomethane	-	-	-	-	-	-	-	-
Carbon disulfide	76.14	2300	1.84	2.60E+02	1.13E-02	1.10E+01	1.263	1.42E+02
Dibromomethane	-	-	-	-	-	-	-	-
Ethylbenzene	106.16	152	3.15	7.00E+00	6.60E-03	6.68E+01	0.867	1.10E+03
Hexachlorophene	406.89	4.00E-03	7.54	-	-	-	-	9.10E+04
Iodomethane	141.94	-1.40E+04	1.69	4.00E+02	-	-	-	2.30E+01
Methylene chloride	84.93	2.00E+04	1.30	3.49E+02	-	-	1.3266	8.80E+00
Toluene	92.13	534.8 (25C)	2.69 (20C)	2.87E+01	6.66E-03	2.50E+01	0.867	3.00E+02
Trans-1,4-dichloro-2-butene	125	-	-	-	-	-	-	-
Vinyl acetate	-	-	-	-	-	-	-	-
Vinyl chloride	62.5	4.27E+03	1.23	2.66E+03	8.14E-02	5.70E+00	0.9121	5.70E+01
Xylene (total)	106.16	187	2.77-3.2	6.50E+00	4.33E-63	1.50E-02	0.86-0.88	2.48E+02

- = Physical or chemical properties not available for this chemical in this classification.

migration and assess exposures in the risk assessment. A discussion of the environmental significance of each of these parameters follows.

3.1.5.1.1 Specific Gravity

Specific gravity is the ratio of the weight of a given volume of a chemical to the weight of the same volume of water at a given temperature. Its primary use is to determine whether a contaminant will have a tendency to float or sink in water if it is present as a pure compound or at very high concentrations. Contaminants with a specific gravity less than 1.0 will float whereas contaminants with a specific gravity greater than 1.0 will sink.

3.1.5.1.2 Vapor Pressure

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. It is of primary significance at environmental interfaces, such as surface soil/air and surface water/air. Volatilization is not as important when evaluating contaminated groundwater and subsurface soils. However, in order to conservatively evaluate chemical exposures at the sites, it will be considered. Chemicals with high vapor pressures are expected to enter the atmosphere more readily than chemicals with low vapor pressures. Semivolatile organics and pesticide and PCB compounds, which generally have low vapor pressures, are not expected to volatilize readily.

3.1.5.1.3 Solubility

The rate at which a chemical is leached by infiltrating precipitation is directly proportional to its water solubility. Several of the detected VOCs have relatively high water solubilities, but the low concentrations observed in soils indicate low potential for significant desorption. Pesticides and PCBs typically have low solubilities and generally do not migrate through the soil column to the water table. The solubility of inorganics is strongly influenced by their valence state(s) and forms (hydroxides, oxides, carbonates, etc.). The solubility is also strongly dependent on pH, Eh, and the presence of other ionic species in solution (the Debye-Huckel theory). Solubility products reported in the literature vary with the type of ionic species.

3.1.5.1.4 Octanol-Water Partition Coefficient (K_{ow})

The octanol/water partition coefficient (K_{ow}) is a measure of the equilibrium partitioning of chemicals between octanol and water. A linear relationship between the K_{ow} and the uptake of chemicals by fatty tissues of animal and human receptors (the bioconcentration factor) has been determined (Lyman et al.

1990). The K_{ow} is useful in characterizing the sorption of compounds by organic soils where experimental values are not available. Larger organic molecules such as semivolatiles and pesticides and PCBs are very likely to partition to fatty tissues, whereas less complex organic chemicals have lower K_{ow} values.

3.1.5.1.5 Organic Carbon Partition Coefficient (K_{oc})

The soil/sediment partition (organic carbon partition) coefficient (K_{oc}) indicates the tendency of a chemical to bind to soil particles containing organic carbon. Chemicals with high K_{oc} values generally have low water solubilities and vice versa. This parameter may be used to infer the relative rates at which chemicals are transported in groundwater. Complex organic chemicals are relatively immobile and are preferentially bound to the soil phase. These compounds are not subject to rapid groundwater transport. These immobile chemicals are, however, easily transported by erosion processes when they are present in surface soils.

3.1.5.1.6 Distribution Coefficient (K_d)

The soil-water partitioning (distribution) coefficient (K_d) is a measure of the equilibrium distribution of a chemical or ion in soil/water systems. The distribution of organic chemicals is a function of both the K_{oc} and the amount of organic carbon in the soil. The K_{oc} and the fractional organic carbon content of the soil (FOC) may be used to determine an equilibrium distribution coefficient (K_d) for the solid and aqueous matrices:

$$K_d = K_{oc} * FOC$$

where:

K_d = Distribution coefficient

FOC = Fractional organic carbon content of the soil

K_{oc} = Organic carbon partition coefficient

Published values exist for K_d for inorganics. These are specific to the type of mineral-clay; however, K_d values are also dependent on the complexation (ligands) present in solution with the inorganic.

3.1.5.1.7 Henry's Law Constant (H)

Both the vapor pressure and the water solubility are of use in determining volatilization rates from surface-water bodies and groundwater. The ratio of these two parameters (the Henry's Law constant) is used to calculate the equilibrium contaminant concentrations in the vapor versus the liquid phases for dilute solutions. In general, chemicals with a Henry's Law constant below 5×10^{-6} atm-m^3/mole should volatilize very little and be present only in minute amounts in the atmosphere or in soil gas. Henry's Law constant will be used to calculate the equilibrium soil gas vapor concentration for volatile organic compounds in groundwater.

3.1.5.1.8 Bioconcentration Factor (BCF)

The bioconcentration factor (BCF) provides a measure of the accumulation tendency for chemicals in biological and ecological systems. BCFs represent the ratio of aquatic animal tissue concentration to the water concentration of a chemical. The ratio is both contaminant and species specific. When site-specific values are not measured, literature values are used or the BCF is derived from the octanol/water partition coefficient. All of the organic chemicals detected during the Supplemental RFI/RI are bioaccumulative to some extent, but many of the semivolatile organics are more bioaccumulative than the volatile organics.

3.1.5.2 Summary

Table C.3-5 presents a summary of the fate and transport data that are used in this Supplemental RFI/RI in discussions of the nature and extent of contamination, contaminant fate and transport, and the baseline risk assessment sections.

3.1.5.3 Contaminant Persistence

This section discusses the persistence of the classes of organic contaminants. The text addresses general classes of the detected chemicals because the fate of chemicals in the environment is usually similar for chemicals within a particular chemical family.

3.1.5.3.1 Ketones

Ketones are characterized by high aqueous solubility and volatility and are readily biodegradable in both soil and water. Hydrolysis is not considered to be a significant fate process for this class of chemicals. The bioaccumulation of ketones is not significant due to low octanol/water partitioning coefficient. In general, ketones (especially acetone) were detected sporadically in all media.

3.1.5.3.2 Chlorinated Aliphatics

Research has demonstrated that aerobic bacteria are more likely to degrade components with organic compounds containing zero, one, or two halogens, and anaerobic bacteria when more halogens are present. Thus, highly chlorinated aliphatic hydrocarbons such as PCE are subject to reductive dehalogenation via the action of anaerobic bacteria. It does not appear that appreciable degradation of highly halogenated aliphatics occurs in aerobic aquatic systems or unsaturated soils (Lyman et al., 1990).

The transformation pathways for chlorinated aliphatic hydrocarbons in soil systems have been documented by Dragun (1988). PCE and TCE are transformed via reductive dechlorination to 1,1-dichloroethene (1,1-DCE) and 1,2-DCE isomers. The terminal product of the transformation series is vinyl chloride, the chlorinated ethene with highest toxicity.

3.1.5.3.3 Phthalate Esters

Phthalate esters are considered to be relatively persistent environmental contaminants. Although numerous studies have demonstrated that phthalate esters undergo biodegradation, it appears that this is a very slow process in both soil and surface water. Certain microorganisms have been shown to excrete products that increase the solubility of phthalate esters and enhance their biodegradation (Gibbons and Alexander, 1989). Biodegradation of bis(2-ethylhexyl) phthalate and other phthalate esters is an important fate mechanism, as is bioaccumulation. Hydrolysis of phthalate esters is very slow, with calculated half-lives of 3 years (dimethyl phthalate) to 2,000 years [bis(2-ethylhexyl) phthalate] (EPA, 1979). Similarly, photolysis is considered to be an insignificant degradation mechanism (EPA, 1982).

3.1.5.3.4 Monocyclic Aromatic Hydrocarbons

Monocyclic aromatic compounds such as benzene, toluene, ethylbenzene, and xylenes are not considered to be persistent environmental contaminants in comparison to PAHs, phthalate esters, and metals. Monocyclic aromatics are subject to degradation in both soil and water via the action of microorganisms. The biodegradation of these compounds in the soil matrix is dependent on the abundance of microflora, macronutrient availability, soil reaction (pH), temperature, oxygen, etc.

Although these compounds are amenable to microbial degradation, the rate of degradation cannot be predicted without information on the availability of nutrients and the type of bacteria present. If these contaminants discharge to a surface-water body, volatilization and biodegradation may occur relatively rapidly. For example, a reported first-order biodegradation rate constant for benzene is 0.11 day^{-1} in aquatic systems (Lyman et al., 1990). This corresponds to an aquatic half-life of approximately 6 days. Other monocyclic aromatics are subject to similar degradation processes in aquatic environments (EPA, 1982).

Additional degradation processes such as hydrolysis and photolysis are considered to be insignificant fate mechanisms for monocyclic aromatics (EPA, 1982). However, some monocyclic aromatic compounds, such as benzene and toluene, have been shown to undergo clay-, mineral-, and soil-catalyzed oxidation (Dragun, 1988).

3.1.5.3.5 Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs are common constituents of oil and grease. Landspreading applications have indicated that PAHs are amenable to microbial degradation. Studies have demonstrated that PAHs are much more amenable to degradation in soil matrices than in aquatic environments (EPA, 1979). Under existing site conditions, the rate of microbial degradation cannot be predicted without knowledge of microbial populations. PAHs do not contain functional groups that are susceptible to hydrolytic actions, and hydrolysis is considered to be an insignificant degradation mechanism. Photolysis may be a major degradation mechanism in aquatic environments but is probably insignificant in surface soil.

3.1.5.3.6 Pesticides

Pesticides are sprayed, dusted, or applied directly to the soil and are subject to degradation mechanisms in the environment. Pesticides typically have a high affinity for binding to organic particulates in soil, are relatively insoluble in water, and have very low vapor pressures and Henry's Law constants. Consequently, these chemicals are some of the most immobile and persistent of environmental contaminants.

3.1.5.3.7 Metals

The transport and fate of metals in the environment are primarily controlled by sorption to soil/sediment material. The metal-organic relationships, both in soil and water, increase in importance as the organic carbon content increases. Fulvic and humic acids can affect sorption, but the cation exchange capacity of the clay lattice is also important. Some metals, such as arsenic, are extremely soluble and mobile in the environment. Many other metals, such as nickel, selenium, zinc, and copper, have an affinity for hydrous iron and manganese oxides, as well as for organic materials, and are therefore preferentially adsorbed to soil. The mobility of most metals increases as the soil pH decreases.

3.1.5.4 Contaminant Migration Routes

Based on the detected chemicals and associated analytical results for NAS Key West, general conclusions can be made with respect to contaminant fate and transport and the possible exposure endpoints.

Groundwater chemical contaminants can migrate from the original source of the release. The most common transport mechanism is water infiltration through a contaminated zone, where partitioning from solid to aqueous phase can occur. The potential amount of chemical dissolving into infiltration water is determined by a number of factors including residence time, solubility, partitioning factor, and pH of infiltration water.

The dissolved chemicals continue downward migration and are able to interact with stationary (soil) particles in the saturated and/or unsaturated zones. For sites at NAS Key West, the very shallow depth of the groundwater table could shorten the time for vertical migration of chemicals from the surface to the groundwater. In addition, dissolution of chemicals in groundwater is likely to be enhanced by the tidal rise and fall of the groundwater table.

After percolation through the capillary zone, dissolved contaminants are then able to enter groundwater where transport can occur via advection. The chemical concentrations in groundwater increase significantly to a maximum level shortly after initial groundwater impact. The longer-term effects at the source are a gradual decrease in the concentrations over time as chemical removal from the source area occurs. Short-term variations in release rate and impact to groundwater can occur, but long-term trends of decreased levels are usually observed. Molecular diffusion and hydrodynamic dispersion occur in the groundwater flow regime.

As materials are transported by groundwater, a number of processes occur that can reduce the concentration of the chemicals. Diffusion and attenuation effects are nontransformational mechanisms that result in a direct decrease in chemical concentration. Chemical and biological reactions with dissolved chemicals can also result in decreases in chemical concentration. The products of chemical/biological reactions, however, may have significantly different chemical, transport, and toxicological properties from the parent compounds.

Groundwater chemical concentration can vary over periods of time as climatic and meteorological conditions change. Also, as materials from the release (source) area are depleted, lower concentrations of contaminants are released into the groundwater. Eventually, the impacts to groundwater cease, and residual chemicals are subjected to dilution and degradation via natural mechanisms.

Groundwater chemicals can discharge to surface-water bodies, carrying chemicals dissolved in groundwater to the surface water and sediments. For sites at NAS Key West, discharge to the ocean is the endpoint of the groundwater migration pathway. However, aqueous and sediment concentrations at or near groundwater discharge points are expected to be attenuated by dilution and mixing with seawater. Sediments may also be affected by surface-water runoff and erosional dispersion, which can transport contamination from surface soils and allow limited migration of contaminated sediments. Some degree of migration in surface soil could occur also through windblown particulate emissions; however, fugitive dust exposure is controlled by vegetative cover and climatic factors that result in a limited rate of windblown migration at NAS Key West sites. No significant volatilization is expected to occur at the Key West sites.

3.2 METHODS FOR THE HUMAN HEALTH RISK ASSESSMENT APPROACH

This section provides a description of the human health risk assessment methods used for evaluating the NAS Key West data collected at SWMUs 4, 5, 7, IRs 1, 3, 7, 8, and AOC B. The objectives of the risk assessment were to estimate the actual or potential risks to human health resulting from the presence of contamination in surface soil, subsurface soil, sediment, groundwater, surface water, and shellfish tissue and to provide the basis for determining the need for remedial measures for these media in the Corrective Measure Study (CMS).

Three major aspects of chemical contamination must be considered when assessing public health risks: contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; potential exposure points must exist either at the source or via migration pathways if exposure occurs at a remote location other than the source; and human or environmental receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure; without any one of the three factors listed above, there is no risk.

The risk assessment estimated the potential for human health risk attributable to each NAS Key West site. Information regarding the toxicity of the compounds detected in the various media, the distribution of contamination, potential migration pathways, and a site-specific estimate of chemical intake via assumed exposure routes were combined to estimate potential risks for each NAS Key West site. The risk assessment processes used at NAS Key West were in accordance with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a; EPA, 1995a; ABB, 1995) and were performed according to methods established in the ABB Workplan (1995), which was reviewed and approved by EPA Region IV and FDEP.

The human health risk assessment consists of seven sections: Preliminary Risk Evaluation, Data Evaluation, Toxicity Assessment, Exposure Assessment, Risk Characterization, Uncertainty Analysis, and Remedial Goal Options (ABB, 1995). Each section is briefly discussed below.

- Preliminary Risk Evaluation (Section 3.2.1) is primarily concerned with running preliminary risk assessments on all eight sites to determine if a baseline risk assessment was needed for each particular site.

- Data Evaluation (Section 3.2.2) is primarily concerned with the identification of COPCs groundwater, distributional analysis of the data, representative concentrations, and chromium concentrations. COPCs selected in this section are representative of the type expected for potential human health exposure. Distributional analysis of the data, contaminant concentrations relative to background levels, contaminant release and environmental transport mechanisms, exposure routes, and toxicity were all considered in order to develop a list of COPCs used to define the site-associated risks.

- The Toxicity Assessment (Section 3.2.3) presents available reference doses, cancer slope factors, EPA weight of evidence, adjustment of the dose-response parameters, and relative potencies for PAHs. Quantitative toxicity indices, where available, are presented in this section, including any applicable regulatory standards and criteria.

- The Exposure Assessment (Section 3.2.4) identifies potential human health exposure including a characterization of the site setting, selection of potential receptors, selection of exposure routes by medium, a presentation of a site-conceptual model, derivation of exposure estimates for each pathway, and a special explanation of the blood lead modeling. This section identifies potential pathways of COPC migration, selected potential receptors, and the estimated intakes of COPCs for the identified receptors.

- Risk Characterization (Section 3.2.5) presents the approaches for determining carcinogenic risks, noncarcinogenic risks, and lead risks. The risk characterization evaluates the potential for adverse health effects from exposure to COPC concentrations in environmental media by integrating information developed during the toxicity and exposure assessments.

- The Uncertainty Analysis (Section 3.2.6) is a discussion of the uncertainties associated with the human health risk assessment.

- Remedial Goal Options (Section 3.2.7) present the methods for selecting COCs for exposure pathways in each site and determining remedial clean-up goals. The purpose of this section is to provide the risk manager with a range of risk-related media levels as a basis for developing remediation aspects of the Feasibility Study and Proposed Plan for the CMS.

3.2.1 Preliminary Risk Evaluation

A preliminary risk evaluation (PRE) was conducted at each of the eight sites to determine if any required a baseline human health risk assessment. If the risk screening evaluation showed that there were incomplete exposure pathways, or if chemical concentrations were present at de minimus concentrations, then a recommendation for no further action at the site was made. However, if the PRE indicated that there might be site risks that exceed those appropriate for the current or intended land use, it was necessary to perform a risk assessment that quantified risks associated with that site. The risk screening process was as follows (EPA, 1994e):

- Carcinogenic risks and noncarcinogenic hazards were evaluated separately. Since chemicals with both carcinogenic and noncarcinogenic hazards have only one risk-based concentration (RBC), it was necessary, in some cases, to calculate the other RBC from toxicity data.

- A comparison between the maximum detected chemical and the EPA Region III risk-based screening levels was applied (EPA, 1997). This comparison was the ratio between the media concentration and the screening value. These ratios were preliminary estimates of risk and hazards associated with individual chemicals. The risk ratios were as follows:

$$\text{Carcinogenic Risk Ratio} = \frac{\text{Media Concentration}}{\text{Screening Value}} * 1E-06$$

$$\text{Noncarcinogenic Risk Ratio} = \frac{\text{Media Concentration}}{\text{Screening Value} * 0.1}$$

- Soil was evaluated using residential and industrial soil RBCs (EPA, 1997).

- Surface water was evaluated using very conservative Tap Water RBCs (EPA, 1997). Although this represents a conservative approach since the intake of surface water will be well below the drinking water intake level used to calculate a Tap Water RBC, the purpose of a PRE is to determine an estimate of the risks at a site, and this conservative approach was well within those guidelines.

- Sediments were evaluated using Residential Soil RBCs (EPA, 1997).

- These preliminary estimates of risk were then summed to come up with an aggregate risk for that medium. NCP (40 CFR 300) and EPA (1989a) state that individual receptors should be protected; therefore, the sums for each media were added and the aggregate estimated risk/hazard for each use scenario was estimated.

- If the use scenario cancer risks at a given site are greater than 1E-04, or the noncarcinogenic risk is greater than 1.0, the site will require further evaluation.

- No lease restrictions are put on the site; therefore, all media and current and future exposure scenarios were determined. For simplicity's sake, only residential surface soil, sediment, surface-water, and industrial subsurface soil pathways were evaluated.

Chapters 2 through 9 present the results of the PRE and accompanying text for each site in the Supplemental RFI/RI Report.

3.2.2 Data Evaluation

This section presents the approaches for identifying COPCs, distributional analysis of the data, and representative concentrations.

3.2.2.1 Identification of COPCs

COPC selection was based on various aspects of chemical concentration, occurrence, distribution, and toxicity. Chemicals selected represented site contamination and provided the framework for the quantitative risk assessment.

Inorganic and organic samples were collected from the NAS Key West in surface soil at all eight sites except no organics were collected at IR 1 and AOC B. Inorganic and organic samples were collected from the NAS Key West in subsurface soil at seven sites (not at IR 3) except no organics were collected at IR 1. Inorganic and organic samples were collected from the NAS Key West in sediment and surface water at seven sites (not in IR 3). Inorganic and organic samples were collected from the NAS Key West in groundwater at all eight sites. Inorganic and organic samples were collected from the NAS Key West in shellfish tissue samples at IR 1, IR 7, IR 8, and AOC B. The positively detected chemicals for each site are presented in tables in the nature and extent of contamination sections of this report. COPC selection was based on these tables and the following rules (EPA, 1995a):

- Comparison to risk-based criteria (EPA, 1997). A chemical was eliminated as a COPC at a site if the concentration was less than any screening criteria.

  - The maximum concentration detected in surface soils (collected at a depth of 0 to 12 feet) was compared to the residential screening values for soil ingestion determined at a risk level of 1E-06 or a HQ of 0.1. The screening values for noncarcinogenic compounds were multiplied by a factor of 0.1 to arrive at the applicable risk-based screening level.

  - The maximum concentration detected in subsurface soils (collected below a depth of 0 to 12 feet) was compared to the industrial screening values for soil ingestion determined at a risk level of 1E-06 or a HQ of 0.1.

  - The maximum concentration detected in sediment was compared to the residential screening values for soil ingestion determined at a risk level of 1E-06 or a HQ of 0.1.

  - The maximum concentration detected in surface water was compared to the Water Quality Standard for human health (consumption of water and organisms) values.

  - The maximum concentration detected in shellfish was compared to the fish values determined at a risk level of 1E-06 or a HQ of 0.1.

- Essential nutrients, including calcium, chlorine, iodine, magnesium, phosphorus, potassium, and sodium, were eliminated as COPCs if they were not present at high concentrations at a site (EPA, 1989a; EPA, 1995a).

- If the maximum detected concentration was less than twice the arithmetic mean of the background concentration (for inorganics and pesticides only) the analyte was excluded as a COPC. In the event that the only detection for a given analyte met this criteria, it was not eliminated as a COPC (EPA, 1995a). This criteria applied to the pesticides 4,4'-DDT, 4,4'-DDD, 4,4'-DDE in soil, gamma-BHC and alpha-BHC in sediment, and all pesticides in shellfish tissue.

- Chemicals were eliminated as COPCs based on a comparison to blank contamination (EPA, 1989a; EPA, 1995a). Blank samples provided a measure of contamination that was introduced into the sample set either in the field or in the laboratory. Blanks should be compared to results from samples with which the blanks were associated; however, if this was not possible because of logistical problems, the entire site data set was compared against the entire blank data set.

- Previously eliminated chemicals were evaluated to determine whether any fell within the following two classifications and, therefore, must be retained as COPCs:

  - If the chemical was a breakdown product of a COPC, it was included as a COPC for that medium.

  - If a chemical was a member of the same class of chemicals that were selected as COPCs, that chemical was included as a COPC for that media (e.g., carcinogenic PAHs).

3.2.2.2 Special Note Concerning Groundwater

Groundwater was not considered as a medium of concern at the Key West sites for several reasons. As discussed in Section 1.4.3 of this RI report, the State of Florida classified groundwater at Key West as Class G-III (nonpotable water), based on a criterion of total dissolved solids greater than 10,000 mg/L. Groundwater obtained from the surficial aquifer at Key West has a high salinity, and is unsuitable for drinking, as documented by a 1990 groundwater quality sampling study by USGS (ABB, 1995). The Monroe County Health Department recognizes the public water supply obtained from the mainland as the only potable water source available on Key West. No freshwater public or registered domestic wells exist on NAS Key West, although reported surficial aquifer wells are used by domestic residences for nonpotable uses such as flushing water. These alternative sources of water might, in some cases be used for drinking after treatment such as reverse osmosis; however, the local water authority regulates all potable supplies in the Keys.

For comparison purposes, the concentrations of COPCs in groundwater at all eight sites were compared to Tap Water RBCs (EPA, 1997) and MCLs (EPA, 1996a) for each site. Chapters 2 through 9 of the Supplemental RFI/RI Report provide these results.

If the groundwater is classified as potable water in the future, a reevaluation of the quantitative risks associated with groundwater exposure to potential receptors should be conducted.

3.2.2.3 Special Note Concerning Fish

Shellfish and fish data were collected at seven sites (SWMU 4, SWMU 5, SWMU 7, IR 1, IR 7, IR 8, and AOC B). Fish samples were primarily minnows and were considered not edible. Therefore, only shellfish (e.g., lobsters or crabs) collected at IR 1, IR 7, IR 8, and AOC B are considered for human health risk assessment via ingestion.

3.2.2.4 Distributional Analysis of the Data

Risk Assessment Guidance for Superfund (RAGS) (EPA, 1989a) suggests the use of statistics in data evaluation, especially concerning distributional analysis of the data. Statistical analyses discussed in this section adhere to the guidance referenced in several EPA and related publications (EPA, 1989a, 1989b, 1991b, 1992c, 1995a and Gilbert, 1987). Before representative concentrations were estimated for each site, the underlying statistical distribution of data (using the Shapiro-Wilk W test) was determined for each chemical in each medium. However, EPA (1995a) states that it is generally reasonable to assume that Superfund solid sampling data are lognormally distributed. Lognormally distributed data have a skewed shape (more results at the high-concentration tail). Lognormal distribution was assumed for this risk assessment.

3.2.2.5 Representative Concentrations

The risk assessment for NAS Key West was performed using a representative concentration for each COPC in each medium identified at the particular site of interest. Current and historic concentrations of detected chemicals at each site medium were evaluated. Usability of results is discussed below. The representative concentration was calculated using the latest risk assessment guidance from EPA (EPA, 1989a, 1995a).

The validated data were used to calculate representative concentrations. The data were collected over several years by various parties. For chemicals with at least one positive detection, the corresponding non-detects were assumed to be one-half the detection limit (sample quantitation limit). For the data set collected by B&R Environmental during January 1996, rejected values (R) were eliminated from further consideration. Estimated and biased values (J, K, L) were used as the reported value.

Duplicate samples were averaged together and considered as one result. For duplicates, where one result was positive and the other result was a non-detect, the problem of calculating an average result arose whenever half the detection limit exceeded the positive result. In these situations, the positive result was used to represent the non-detect.

The calculation of the representative concentration is a two-step process. First, the distribution of the data must be determined as discussed in the preceding section. Then, based on the distribution of the data, a representative concentration is either calculated or selected. Environmental data collected at these sites were determined to be lognormally distributed (default).

For data that are considered to be lognormally distributed, the standard deviation of the log-transformed sample set must be determined, as follows:

$$S = \sqrt{\Sigma\left(\frac{\left(X_i - \mu\right)^2}{n-1}\right)}$$

where:

S	=	Standard deviation of the log-transformed data
X_i	=	Individual sample value (log-transformed)
μ	=	Arithmetic mean of the log-transformed n samples
n	=	Number of samples

The one-sided upper 95 percent confidence limit (UCL_{LOG}) is then calculated as follows:

$$UCL_{LOG} = e^{\left[\mu + 0.5s^2 + \left(\frac{sH}{\sqrt{n-1}}\right)\right]}$$

where:

e	=	constant (base of the natural log, equal to 2.718)
μ	=	Arithmetic mean of the log-transformed data
H	=	H-statistic (e.g., from table published in Gilbert, 1987)
S	=	Standard deviation of the log-transformed data
n	=	Number of samples

The representative concentration is then selected as the lesser value of the one-sided 95 percent UCL and the maximum positive value in the data set.

The maximum positive value is frequently the default choice when the number of samples in the data set is small or when a lognormal distribution (having a higher upper confidence limit from the distributional shape) is used. For example, the surface-water samples taken at each site are generally low in number, and the representative concentration was estimated based on lognormal distribution of the surface-water data; therefore, the representative concentration normally defaulted to the maximum detection of a chemical in those surface-water samples.

3.2.2.6 Special Note Concerning Chromium Concentrations

A conservative approach to the treatment of chromium was applied to this human health risk assessment. Chromium data were considered to be the hexavalent chromium (VI) form as opposed to the trivalent form (chromium III) because no speciation data were available. Hexavalent chromium is considered the more toxic form, and this is considered the conservative approach.

3.2.3 Toxicity Assessment

The purpose of this section is to identify the potential health hazards associated with exposure to each of the COPCs. A toxicological evaluation characterizes the inherent toxicity of a compound. The literature indicates that the COPCs have the potential to cause carcinogenic and/or noncarcinogenic health effects in humans. Although the COPCs may cause adverse health effects, dose-response relationships and the potential for exposure must be evaluated before the risks to receptors can be determined. Dose-response relationships correlate the magnitude of the intake with the probability of toxic effects, as discussed below. Table C.3-6 and Appendix A present toxicity information for the COPCs at all sites at NAS Key West in the form of toxicological profiles.

An important component of the risk assessment process is the relationship between the intake of a compound (the amount of a chemical that is absorbed by a receptor) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts can be quantified. The published information of doses and responses is used in conjunction with information on the nature and magnitude of human exposure to develop an estimate of potential health risks.

TABLE C.3-6

DOSE-RESPONSE PARAMETERS - POTENTIAL CHEMICALS OF CONCERN
NAS KEY WEST
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Substance	Fraction of COPC Absorbed in the Gastrointestinal Tract (unitless)**	Toxicity Values											
		Noncarcinogenic					Carcinogenic						
		RfD Oral (mg/kg)/day	Target Organ/Critical Effect	RfD Dermal (mg/kg)/day	RfD Inhalation (mg/kg)/day	Critical Effect	SF* Oral [(mg/kg)/day]-1	Tumor Type	Weight of Evidence	SF Dermal [(mg/kg)/day]-1	SF Inhalation [(mg/kg)/day]-1	Tumor Type	Weight of Evidence
INORGANICS													
Aluminum	0.20	1.00E+00 E	–	2.00E-01	–	–	–	–	–	–	–	–	–
Antimony	0.20	4.00E-04	C	8.00E-05	–	–	–	–	D	–	–	–	–
Arsenic (total)	0.20	3.00E-04	S	6.00E-05	–	–	1.50E+00	Skin - humans	A	7.50E+00	1.51E+01	Lung - Occupational	A
Barium	0.20	7.00E-02	C, GI M, RS	1.40E-02	1.43E-04 A	F	–	–	D	–	–	–	–
Beryllium	0.20	5.00E-03	L	1.00E-03	–	–	4.30E+00	Various - rats	B2	–	8.40E+00	Lung - Occupational	B2
Cadmium (in water)	0.20	5.00E-04	K	1.00E-04	5.71E-05 E	RI	–	–	D	–	6.30E+00	Lung - Occupational	B1
Cadmium (in soil)	0.20	1.00E-03	K	2.00E-04	–	–	–	–	–	–	–	–	–
Chromium, hexavalent	0.20	5.00E-03	K	1.00E-03	–	–	–	–	A	–	4.20E+01	Lung - Occupational	A
Cobalt	0.20	6.00E-02	C	1.20E-02	–	–	–	–	–	–	–	–	–
Copper	0.20	4.00E-02 E	B, K, L	8.00E-03	–	–	–	–	D	–	–	–	–
Iron	0.20	3.00E-01 E	L, P	6.00E-02	–	–	–	–	–	–	–	–	–
Lead, total	0.20	–	B, CNS	–	–	–	–	Renal - mice/rats	B2	–	–	–	–
Manganese (in water)	0.20	5.00E-03	CNS	1.00E-03	1.43E-05	RI	–	–	–	–	–	–	–
Manganese (in soil)	0.20	1.40E-01	CNS	2.80E-02	–	–	–	–	–	–	–	–	–
Mercury	0.20	1.00E-04 H	K, CNS	2.00E-05	8.57E-05 H	CNS	–	–	D	–	–	–	–
Nickel	0.20	2.00E-02	CNS	4.00E-03	–	–	–	–	D	–	–	–	–
Thallium	0.20	8.00E-05	S, K, L, CNS	1.60E-05	–	–	–	–	–	–	–	–	–
Tin	0.20	6.00E-01	–	1.2E-01	–	–	–	–	–	–	–	–	–
Vanadium	0.20	7.00E-03 H	–	1.40E-03	–	–	–	–	D	–	–	–	–
Zinc	0.20	3.00E-01	B	6.00E-02	–	–	–	–	D	–	–	–	–
PESTICIDES/PCBs													
2,4,5-TP (Silvex)	0.50	8.00E-03	CNS	4.00E-03	–	–	–	–	–	–	–	–	–
4,4'-DDD	0.50	–	–	–	–	–	2.40E-01	Lung, liver - rats	B2	4.80E-01	–	–	–
4,4'-DDE	0.50	–	–	–	–	–	3.40E-01	Liver, tyroid - rats	B2	6.80E-01	–	–	–
4,4'-DDT	0.50	5.00E-04	L	2.50E-04	–	–	3.40E-01	Liver - mice/rats	B2	6.80E-01	3.40E-01	Liver - mice/rats	B2

TABLE C.3-6

DOSE-RESPONSE PARAMETERS - POTENTIAL CHEMICALS OF CONCERN
NAS KEY WEST

Substance	Fraction of COPC Absorbed in the Gastrointestinal Tract (unitless)**	Toxicity Values											
		Noncarcinogenic					Carcinogenic						
		RfD Oral (mg/kg)/day	Target Organ/Critical Effect	RfD Dermal (mg/kg)/day	RfD Inhalation (mg/kg)/day	Critical Effect	SF* Oral $[(mg/kg)/day]^{-1}$	Tumor Type	Weight of Evidence	SF Dermal $[(mg/kg)/day]^{-1}$	SF Inhalation $[(mg/kg)/day]^{-1}$	Tumor Type	Weight of Evidence
PESTICIDES/PCBs (continued)													
Aldrin	0.50	3.00E-05	L, CNS	1.50E-05	–	–	1.7E+01	Liver - mice/rats	B2	3.4E+01	1.7E+01	Liver - mice/rats	B2
Aroclor-1016	0.50	7.00E-05	S, H, RS, L	3.50E-05	–	–	2.00E+00	Liver - rats	B2	4.00E+00	–	–	–
Aroclor-1232	0.50	–	–	–	–	–	2.00E+00	Liver - rats	B2	4.00E+00	–	–	–
Aroclor-1242	0.50	–	–	–	–	–	2.00E+00	Liver - rats	B2	4.00E+00	–	–	–
Aroclor-1248	0.50	–	–	–	–	–	2.00E+00	Liver - rats	B2	4.00E+00	–	–	–
Aroclor-1254	0.50	2.00E-05	S, H, RS, L	1.00E-05	–	–	2.00E+00	Liver - rats	B2	4.00E+00	–	–	–
Aroclor 1260	0.50	–	–	–	–	–	2.00E+00	Liver - rats	B2	4.00E+00	–	–	–
Delta-BHC	0.50	–	–	–	–	–	–	–	D	–	–	–	–
Heptachlor Epoxide	0.50	1.30E-05	L	6.50E-06	–	–	9.10E+00	Liver - mcie	B2	1.82E+01	9.1E+00	Liver - mice	B2
SEMIVOLATILE ORGANIC COMPOUNDS													
2-Methylnaphthene	0.50	–	–	–	–	–	–	–	–	–	–	–	–
Acenaphthylene	0.50	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(a)anthracene	0.50	–	–	–	–	–	7.30E-01 E	Same as B(A)P	B2	1.46E+00	3.10E-01 E	Same as B(A)P	B2
Benzo(a)pyrene	0.50	–	–	–	–	–	7.30E+00 E	Various - mice/rats	B2	1.46E+01	3.10E+00 W	Various - mice/rats	B2
Benzo(b)fluoranthene	0.50	–	–	–	–	–	7.30E-01 E	Same as B(A)P	B2	1.46E+00	3.10E-01 E	Same as B(A)P	B2
Benzo(g,h,i)perylene	0.50	–	–	–	–	–	–	–	D	–	–	–	–
Benzo(k)fluoranthene	0.50	–	–	–	–	–	7.30E-02 E	Same as B(A)P	B2	1.46E-01	3.10E-02 E	Same as B(A)P	B2
Bis(2-ethylhexyl)phthalate	0.50	2.00E-02	L	1.00E-02	–	–	1.40E-02	Liver - mice	B2	2.8E-02	–	–	–
Chlorobenzilate	0.50	2.00E-02	–	1.00E-02	–	–	2.70E-01		B2	5.40E-01	2.70E-01 H		B2
Chrysene	0.50	–	–	–	–	–	7.30E-03 E	Same as B(A)P	B2	1.46E-02	3.10E-03 E	Same as B(A)P	B2
Dibenz(a,h)anthracene	0.50	–	–	–	–	–	7.30E+00 E	Same as B(A)P	B2	1.46E+01	3.10E+00 E	Same as B(A)P	B2
Indeno(1,2,3-cd)pyrene	0.50	–	–	–	–	–	7.30E-01 E	Same as B(A)P	B2	1.46E+00	3.10E-01 E	Same as B(A)P	B2

TABLE C.3-6

DOSE-RESPONSE PARAMETERS - POTENTIAL CHEMICALS OF CONCERN
NAS KEY WEST
PAGE 3 OF 3

Substance	Fraction of COPC Absorbed in the Gastrointestinal Tract (unitless)**	Toxicity Values											
		Noncarcinogenic					Carcinogenic						
		RfD Oral (mg/kg)/day	Target Organ/Critical Effect	RfD Dermal (mg/kg)/day	RfD Inhalation (mg/kg)/day	Critical Effect	SF* Oral $[(mg/kg)/day]^{-1}$	Tumor Type	Weight of Evidence	SF Dermal $[(mg/kg)/day]^{-1}$	SF Inhalation $[(mg/kg)/day]^{-1}$	Tumor Type	Weight of Evidence
SEMIVOLATILE ORGANIC COMPOUNDS (continued)													
Naphthene	0.50	4.00E-02 W		2.00E-02	–	–	–	–	–	–	–	–	–
N-Nitroso-di-n-propylamine	0.50	–	–	–	–	–	7.00E+00		B2	1.4E+01	–	–	–
Phenanthrene	0.50	–	–	–	–	–	–	–	–	–	–	–	–
VOLATILE ORGANIC COMPOUNDS													
Acetone	0.80	1.00E-01	L	8.00E-02	–	–	–	–	–	–	–	–	–
Dibromomethane	0.80	–	–	–	–	–	–	–	–	–	–	–	–

– = No dose-response value is available for this chemical in this classification.
* = All toxicity values are from Integrated Risk Information System (IRIS) unless otherwise noted
** = Modifying factor applied only to the dermal RfDs and SFs, from EPA (1995a)

A = HEAST Alternative (EPA, 1995c)
B = Blood
C = Heart
CNS = Central Nervous System
E = EPA-NCEA Regional Support provisional service (EPA, 1995b)
H = Health Effects Assessment Summary Tables (HEAST)(EPA, 1995c)
K = Kidney
L = Liver
RS = Reproductive System
S= Skin
W = Withdrawn from IRIS or HEAST

Reference doses (RfDs) and slope factors (SFs) have been developed by EPA (1997a, 1995b) and other sources for many organics and inorganics. This section provides a brief description of these parameters.

3.2.3.1 Reference Doses (RfDs)

The RfD is developed by EPA for chronic and/or subchronic human exposure to hazardous chemicals and is based solely on the noncarcinogenic effects of chemical substances. The RfD is usually expressed as a dose (mg) per unit body weight (kg) per unit time (day). It is generally derived by dividing a No-Observed-Adverse-Effect-Level (NOAEL) or a Lowest-Observed-Adverse-Effect-Level (LOAEL) by an appropriate uncertainty factor. NOAELs are determined from laboratory animal or epidemiological toxicity studies. The uncertainty factor is based on the extent and applicability of toxicity data to human exposure.

Uncertainty factors are generally applied as multiples of 10 to represent specific areas of uncertainty in the available data. A factor of 10 is used to account for variations in the general population (to protect sensitive subpopulations), extrapolation of test results from animals to humans (to account for interspecies variability), derivation of a NOAEL from a subchronic study (instead of a chronic study) for developing the RfD, and use of a LOAEL instead of a NOAEL. In addition, EPA reserves the use of a modifying factor of up to 10 for professional judgment of uncertainties in the database not already accounted for. The default value of the modifying factor is 1. The RfD incorporates the reliability of the evidence for chronic human health effects. Even if applicable human data exist, the RfD (as reduced by the uncertainty factor) still maintains a margin of safety so that chronic human health effects are not underestimated. Thus, the RfD is an acceptable guideline for evaluation of noncarcinogenic risk, although the associated uncertainties preclude its use for precise risk quantitation. Table C.3-6 lists RfDs for NAS Key West site contaminants.

Noncarcinogenic risks for lead were not quantitated and compared to RfDs because EPA has implemented an approach to evaluating lead risks that goes beyond providing a single point estimate output. Instead, expected blood-lead increases were estimated, and a discussion of these results is presented in Section 3.2.4.6.

3.2.3.2 Cancer Slope Factors (SFs)

SFs are applicable for estimating the lifetime probability (assumed 70-year lifespan) of human receptors developing cancer as a result of exposure to known or potential carcinogens. This factor is generally reported in units of 1/(mg/kg/day) and is derived through an assumed low-dosage linear relationship of extrapolation from high to low dose responses determined from animal studies. The value used in reporting the slope factor is the upper 95 percent confidence limit. Table C.3-6 lists SFs for NAS Key West site contaminants.

Carcinogenic risks for lead were not quantitated because no EPA consensus currently exists with respect to an inorganic lead SF. Instead, potential lead exposures were calculated using a biokinetic model to estimate expected blood-lead increases, and a discussion of these results is presented in Section 3.2.4.6.

3.2.3.3 EPA Weight-of-Evidence

The weight-of-evidence designations indicate the preponderance of evidence regarding carcinogenic effects in humans and animals. Table C.3-7 defines the categories (EPA, 1992d).

3.2.3.4 Adjustment of Dose-Response Parameters

Risks associated with dermal exposures are evaluated using toxicity values that are specific to dermally absorbed doses. Most oral toxicity values are based on administered doses rather than absorbed doses (TCE being an important exception). Therefore, in accordance with Region IV EPA (1995a) and EPA (1989a, Appendix A), the toxicity values based on administered doses were adjusted before they were used for evaluation of absorbed doses. Dermal RfDs and SFs are obtained from oral RfDs and SFs via the following relationships:

$$RfD_{Adjusted} = RfD_{Oral} * ABSEFF_{Oral}$$

$$SF_{Adjusted} = SF_{Oral} / ABSEFF_{Oral}$$

where:

ABSEFFOral = Absorption efficiency in the study that is the basis of the oral toxicity value.

The default ABSEFFs are as follows (EPA, 1995a):

- 80 percent for volatile organics chemicals
- 50 percent for semivolatile organics and pesticides
- 20 percent for inorganic chemicals

TABLE C.3-7

EPA WEIGHT OF EVIDENCE
NAS KEY WEST

EPA Category	Description of Group	Description of Evidence
Group A	Human carcinogen	Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer
Group B1	Probable human carcinogen	Limited evidence of carcinogenicity in humans from epidemiologic studies
Group B2	Probable human carcinogen	Sufficient evidence of carcinogenicity in animals; inadequate evidence of carcinogenicity in humans
Group C	Possible human carcinogen	Limited evidence of carcinogenicity in animals
Group D	Not classified	Inadequate evidence of carcinogenicity in animals
Group E	No evidence of carcinogenicity	No evidence for carcinogenicity in at least two adequate animal tests or in both epidemiological and animal studies

3.2.3.5 Relative Potency Factors for PAHs

Carcinogenic PAHs are related by chemical structure. Only benzo(a)pyrene [B(a)P] has an EPA-published SF (EPA, 1997). All other carcinogenic PAHs have SFs based on their potency relative to B(a)Ps, and these factors are published by EPA (1995a). Table C.3-8 shows the relative potency factors (which are also commonly known as toxicity equivalence factors (TEFs).

3.2.4 Exposure Assessment

The purpose of this section is to evaluate the potential for human exposure to the chemicals detected in the environmental media at the NAS Key West sites investigated under this RI. This section characterizes the exposure setting, characterizes the potentially exposed populations, identifies actual or potential exposure routes, presents a general conceptual site model, and summarizes the methods used to generate exposure estimates. Chapters 2 through 9 of the Supplemental RFI/RI Report present the nature and extent of contamination upon which the exposures are based. To determine whether there is an actual or potential exposure, the most likely pathways of contaminant release and transport, as well as the human and environmental activity patterns, must be considered. A complete exposure pathway has three components: a source, a route of transport, and an exposure point for receptors. These components are addressed in this section.

3.2.4.1 Characterization of the Exposure Setting

Chapter 1 of the Supplemental RFI/RI Report provides a characterization of general site conditions, including physiography and topography, climate, soil, surface-water hydrology, and public water supply and use. Section 1.2 of the Supplemental RFI/RI describes the facility, its setting, and its surroundings.

3.2.4.2 Potential Receptors

This section presents the receptors chosen for the sites at NAS Key West. All of the receptors listed below are not applicable to every site because not all media were sampled at each site. However, if applicable media were present at a site, the following receptors apply.

TABLE C.3-8

RELATIVE POTENCY FACTORS FOR CARCINOGENIC PAHs
NAS KEY WEST

Carcinogenic PAH	Relative Potency Factor
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-cd)pyrene	0.1

The current exposure scenarios are, as follows:

- Adolescent and Adult Trespasser - A trespasser is an adult or adolescent who trespasses at NAS Key West. These receptors are potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in surface soil and ingestion of and dermal contact with COPCs in sediment and surface water.

- Occupational Worker - The full-time onsite worker is an adult who works at NAS Key West all year. This receptor is potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in surface soil.

- Site-Maintenance Worker - The site-maintenance worker is an adult who works at NAS Key West but is exposed in shorter durations than the Occupational Worker. This receptor is potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in surface soil.

Future exposure scenarios are, as follows:

- Future Excavation Worker - A future excavation worker is an adult who is assumed to work at NAS Key West in the future during any type of excavation activity. This receptor is potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in subsurface soil.

- Future Resident - A future resident is a person who will live in a residence at or near NAS Key West in a hypothetical future scenario. This receptor resides at a residence for both as a child and as an adult. This receptor is potentially exposed via ingestion of, dermal contact with, and inhalation of COPCs in surface soil and ingestion of and dermal contact with COPCs in sediment and surface water. Additionally, an adult future resident is exposed via ingestion of COPCs in shellfish.

3.2.4.3 Exposure Routes by Medium

There are five environmental media at NAS Key West through which potential receptors (see previous section) can be either directly or indirectly exposed to site-related COPCs: surface soil, subsurface soil, sediment, surface water, or shellfish tissue. Potential exposure routes include ingestion, dermal contact, and inhalation.

3.2.4.3.1 Surface Soil

Surface soil exposure routes include incidental ingestion, dermal contact, and inhalation of fugitive dust. All scenarios are based on COPC representative concentrations in surface soils. All three exposure routes were evaluated using occupational workers, maintenance workers (current scenarios), and residential receptors (future scenario). These receptors were chosen because it is unknown whether NAS Key West will remain open to industrial employees only or whether NAS Key West (or a portion of it) might become a residential area in the future. For fugitive dust emissions under both scenarios, the assumption of surface cover would resemble the type of vegetation, paving, and buildings that are currently in place. For surface soil, low levels of VOCs did not warrant full-scale modeling and an estimation of the exposure. VOCs were generally not detected in surface soil. Therefore, exposure to volatilized chemicals is expected to be negligible at NAS Key West, and ingestion and dermal contact would contribute to the bulk of the risk.

3.2.4.3.2 Subsurface Soil

Because there is currently no direct contact with subsurface soil, only potential future incidental ingestion, dermal contact, or inhalation of fugitive dusts could be evaluated. All three exposure routes were evaluated using excavation workers (future scenario). The exposure scenarios for subsurface soil are based on the assumption that subsurface soil could eventually become surface soil if excavations, erosion, construction, or landscaping activities occurred. Exposure scenarios related to concentrations in subsurface soil are conservative based on this assumption. For fugitive dust emissions from subsurface soil under the future industrial scenario, the assumption of surface cover would be based on the type of vegetation, paving, and buildings that are currently in place.

Subsurface soil contamination may also have an impact upon future groundwater quality, especially for relatively mobile contaminants such as VOCs. This risk assessment does take into account future loading of COPCs from subsurface soils to groundwater in the fate and transport and remedial goal options sections of the report.

3.2.4.3.3 Sediment

Sediment exposure routes include incidental ingestion and dermal contact. These exposure routes were evaluated using adult and adolescent trespassers (current scenario) and residential receptors (future scenario). Inhalation of chemicals in sediment was eliminated as a pathway because the sediment is not expected to be in a dry streambed. Furthermore, the frequency of contact with sediment by these receptors is expected to be low.

3.2.4.3.4 Surface Water

Surface-water exposure routes include incidental ingestion and dermal contact. These exposure routes were evaluated using adult and adolescent trespassers (current scenario) and residential receptors (future scenario). Inhalation of VOCs in surface water was eliminated as a pathway because VOCs were detected infrequently in surface water. Furthermore, the frequency of contact with surface water by the these receptors is expected to be low.

3.2.4.3.5 Shellfish

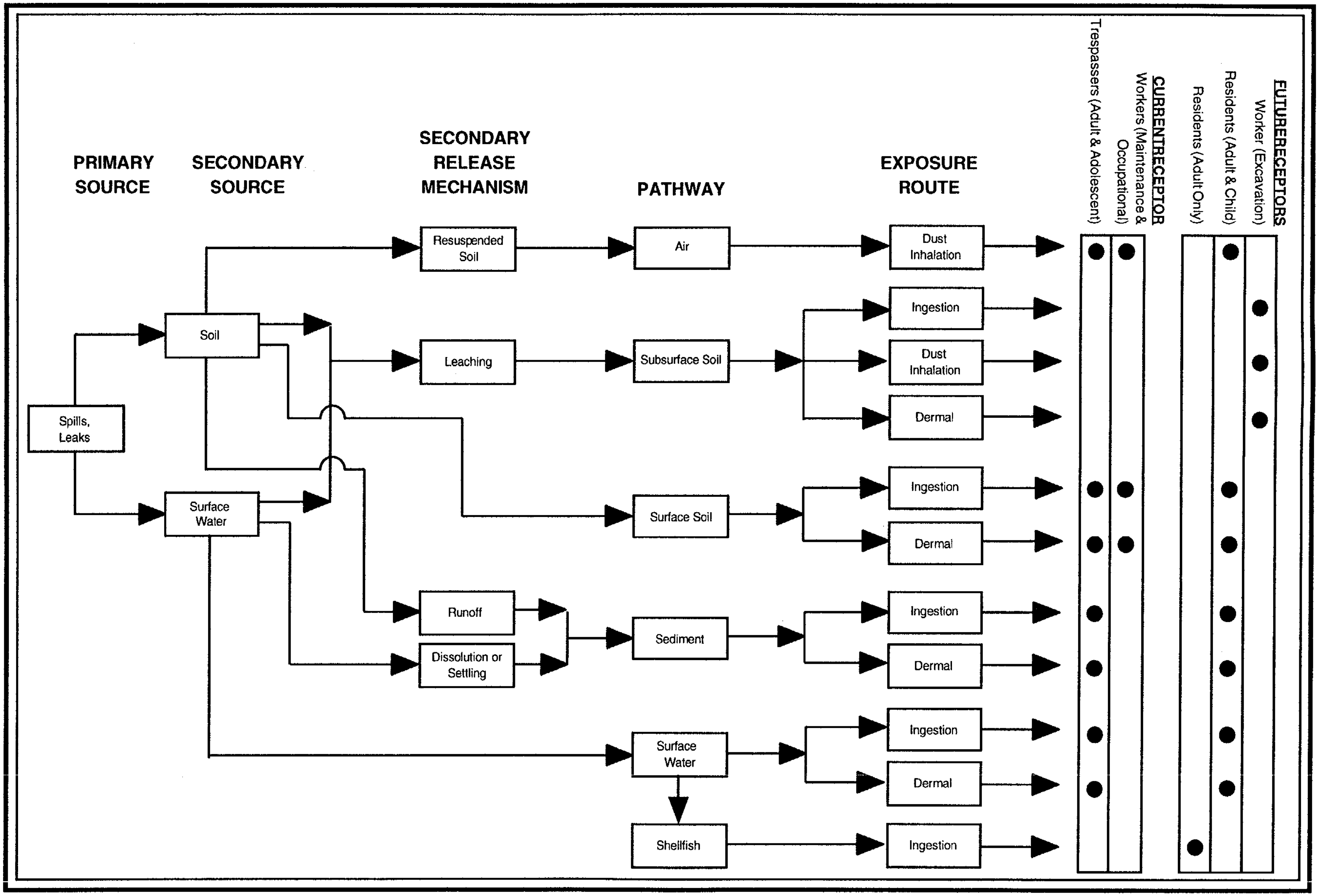
The shellfish exposure route includes ingestion. This exposure route was evaluated using adult residential receptors (future scenario).

3.2.4.4 Conceptual Site Model

The conceptual site model for NAS Key West incorporates information on the potential chemical sources, affected media, release mechanisms, routes of migration, and known or potential human receptors. The purpose of the conceptual site model is to provide a framework in which to identify potential exposure pathways occurring at the sites. Information provided on-site characterization, chemical characterization, local land and water uses, and potential receptors is used to identify potential exposure pathways for the site. Figure C.3-1 shows the general conceptual site model for NAS Key West.

3.2.4.5 Exposure Estimates

The estimation methods and models used in this section are consistent with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a; EPA, 1995a). Exposure estimates (in the form of chemical intake) associated with each exposure route are presented below. All exposure scenarios incorporate the representative concentrations in the estimation of intakes. Two types of exposure scenarios are considered in this HHRA, reasonable maximum exposure (RME and central tendency exposure (CTE). RME incorporates input parameters into the exposure scenarios that are protective of ninety percent of the population, whereas CTE incorporates input parameters that representative of an average exposure scenario.



7046-24PC\Mod1-RFI-RI\FC3-1.ppt

Figure C.3-1. General Conceptual Site Model for NAS Key West.

Noncarcinogenic risks are estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represent the number of hours per day and the number of days per year that exposure occurs. This is used with the "averaging time," which converts the daily exposure frequency and duration to an annual exposure by dividing by 365 days per year of exposure. Noncarcinogenic risks for some exposure routes (e.g., soil) are generally greater for children than for adults because of the much lower body weights of children and their similar or higher ingestion rates. Carcinogenic risks, on the other hand, are calculated as an incremental lifetime risk and, therefore, incorporate terms to represent the exposure duration (years) over the course of a lifetime (70 years).

3.2.4.5.1 Surface Soil Exposure

Three potential exposure routes are associated with direct exposure to surface soil at the NAS Key West sites. These exposure routes include ingestion, dermal contact, and inhalation of fugitive dust. The methods used to assess these routes of exposure are discussed in the following text.

Incidental soil ingestion, dermal contact, and inhalation of fugitive dust exposure is estimated from the following equations (EPA, 1989a):

$$INTAKE_{INGESTION}(mg/kg)/day = \frac{CS * IR_{soil} * FI * CF * EF * ED}{BW * AT * 365\ ^{days}/_{year}}$$

$$INTAKE_{DERMAL}(mg/kg)/day = \frac{DA_{event} * SA * EF * ED}{BW * AT * 365\ ^{days}/_{year}}$$

$$DA_{event} = CS * AF * ABS_{dermal} * CF$$

$$INTAKE_{INHALATION}(mg/kg)/day = \frac{CA * IR_{air} * ET * EF * ED}{BW * AT * 365\ ^{days}/_{year}}$$

where:

CA	=	Chemical concentration in air (mg/m^3)
CS	=	Chemical concentration in soil (mg/kg or µg/kg soil)
IR_{soil}	=	Soil ingestion rate (mg soil/day)
IR_{air}	=	Inhalation rate (m^3/hr)
FI	=	Fraction ingested from contaminated source (unitless)

ET	=	Exposure time (hr/day)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
CF	=	Conversion factor (1×10^{-6} kg/mg for inorganics; 1×10^{-9} kg/µg for organics)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Soil-to-skin adherence factor (mg/cm^2)
ABS_{dermal}	=	Absorption fraction (unitless)

Appendix A of the Supplemental RFI/RI Report provides a sample RME and CTE calculation for the occupational worker for ingestion of, dermal contact with, and inhalation of fugitive dust exposure pathways. Tables C.3-9 through C.3-12 list the RME and CTE input parameters for these exposure routes, along with the rationale for the selection of each value. As discussed in Section 3.2.4.2, the potential receptors for this scenario were current trespassers, current occupational workers, current maintenance workers, and future residents. EPA or conventional values were selected for all input parameters.

Absorption factors for the dermal pathway were assumed to be as follows (EPA, 1992a, 1995d): PCBs (6 percent), chlorinated dioxins (3 percent), cadmium (1 percent), arsenic (3.2 percent), ethylbenzene (3 percent), toluene (3 percent), xylenes (3 percent), PCE (3 percent), pesticides (10 percent), and pentachlorophenol (24.4 percent). If no chemical-specific data were available, the following absorption factors were assumed (EPA, 1995a): 1 percent for organics and 0.1 percent for inorganics.

Exposure to fugitive dust emissions can be calculated by first estimating the rate of distribution and COPC emission from the site and then translating this to the exposure rate for the receptors. The derivation of the CA term in the inhalation equation is rather lengthy and complicated; explanation of the derivation of this term is provided in Appendix A of the Supplemental RFI/RI Report. The input parameters were generally those provided in the Cowherd model (Cowherd et al., 1985), which allows limited parameter choices for area and distance to the site.

TABLE C.3-9

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SURFACE SOILS
FUTURE RESIDENT
NAS KEY WEST

Parameter	Child (0-6 yrs) RME	Child (0-6 yrs) CTE	Adult RME	Adult CTE	Units	Source
CS	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	200	200	100	100	mg/day	EPA, 1991a
FI	1.0	1.0	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	1E-09	1E-09	kg/µg	
EF	350	350	350	350	days/year	EPA, 1991a
ED	6	2	24	7	years	EPA, 1989a, 1991a
ET	16	16	16	16	hours/day	Assumption
AT_{cancer}	70	70	70	70	years	EPA, 1991a
$AT_{non\text{-}cancer}$	6	2	24	7	years	EPA, 1991a
SA	See Appendix A	See Appendix A	5,750*	5,750*	cm^2	EPA, 1992a
IR_{air}	0.833	0.833	0.833	0.833	m^3/hour	EPA, 1991a
BW	15	15	70	70	kg	EPA, 1991a
AF	1	0.2	1	0.2	mg/cm^2 per event	EPA, 1992a, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	unitless	EPA, 1995a EPA,1995d
CA	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	mg/m^3	See Appendix A of Supplemental RFI/RI Report

*25% of total body surface

TABLE C.3-10

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SURFACE SOILS CURRENT ADOLESCENT AND ADULT TRESPASSERS NAS KEY WEST

Parameter	Adolescent RME	Adolescent CTE	Adult RME	Adult CTE	Units	Source
CS	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	100	50	100	50	mg/day	EPA, 1991a
FI	1.0	1.0	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	1E-09	1E-09	kg/µg	
EF	30	15	24	12	days/year	EPA, 1991a
ED	11	2	19	7	years	EPA, 1989a, 1991a
ET	4	4	4	4	hours/day	Assumption
AT_{cancer}	70	70	70	70	years	EPA, 1991a
$AT_{non-cancer}$	11	2	19	7	years	EPA, 1991a
SA	See Appendix A	See Appendix A	5,750*	5,750*	cm^2	EPA, 1992a
IR_{air}	0.833	0.833	0.833	0.833	m^3/hour	EPA, 1991a
BW	40	40	70	70	kg	EPA, 1991a
AF	1	0.2	1	0.2	mg/cm^2 per event	EPA, 1992a, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	unitless	EPA, 1995a EPA, 1995d
CA	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	mg/m^3	See Appendix A of Supplemental RFI/RI Report

*25% of total body surface

TABLE C.3-11

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SURFACE SOILS-SITE MAINTENANCE WORKER NAS KEY WEST

Parameter	Maintenance Worker RME	Maintenance Worker CTE	Units	Source
CS	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	118	50	mg/day	EPA, 1991a
FI	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	kg/µg	
EF	12	12	days/year	EPA, 1991a
ED	25	9	years	EPA, 1989a, 1991a
ET	8	8	hours/day	Assumption
AT_{cancer}	70	70	years	EPA, 1991a
$AT_{non\text{-}cancer}$	25	9	years	EPA, 1991a
SA	5,750*	5,750*	cm^2	EPA, 1992a
IR_{air}	0.833	0.833	m^3/hour	EPA, 1991a
BW	70	70	kg	EPA, 1991a
AF	1	0.2	mg/cm^2 per event	EPA, 1992a, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	unitless	EPA, 19915a EPA, 1995d
CA	Chemical Specific	Chemical Specific	mg/m^3	See Appendix A of Supplemental RFI/RI Report

*25% of body surface

TABLE C.3-12

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SURFACE SOILS-INDUSTRIAL WORKER NAS KEY WEST

Parameter	Industrial Worker RME	Industrial Worker CTE	Units	Source
CS	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	50	50	mg/day	EPA, 1991a
FI	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	kg/µg	
EF	250	250	days/year	EPA, 1991a
ED	25	9	years	EPA, 1989a, 1991a
ET	8	8	hours/day	Assumption
AT_{cancer}	70	70	years	EPA, 1991a
$AT_{non\text{-}cancer}$	25	9	years	EPA, 1991a
SA	2,300*	2,300*	cm^2	EPA, 1992a
IR_{air}	0.833	0.833	m^3/hour	EPA, 1991a
BW	70	70	kg	EPA, 1991a
AF	1	0.2	mg/cm^2 per event	EPA, 1992a, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	unitless	EPA, 1995a EPA, 1995d
CA	Chemical Specific	Chemical Specific	mg/m^3	See Appendix A of the Supplemental RFI/RI Report

*10% of total body surface

For the dermal pathway, it was assumed that the primary areas of skin available for contact would be 25 percent of the total body surface area of adult residents and maintenance workers, 10 percent of the total body surface area of occupational workers, and the arms, hands, and legs of adolescents.

3.2.4.5.2 Subsurface Soil Exposure

Three potential exposure routes are associated with direct exposure to subsurface soil (as future surface soils) at the NAS Key West sites: ingestion, dermal contact, and inhalation of fugitive dust. The methods used to assess these routes of exposure are the same as the equations for surface soil presented in the previous section. Table C.3-13 provides the input parameters for a future excavation worker and the assumptions for subsurface soil exposure.

3.2.4.5.3 Sediment Exposure

Two potential exposure routes are associated with direct contact with sediment at the NAS Key West sites: ingestion and dermal contact. The methods used to assess these routes of exposure are discussed in the following text. These scenarios were evaluated in the same way as ingestion and dermal exposures for surface soil, which were explained above. Incidental sediment ingestion and dermal contact exposure are estimated from the following equations (EPA, 1989a):

$$INTAKE_{INGESTION}(mg/kg)/day = \frac{CS * IR_{sediment} * FI * CF * EF * ED}{BW * AT * 365 \, {}^{days}/_{year}}$$

$$INTAKE_{DERMAL}(mg/kg)/day = \frac{DA_{event} * SA * EF * ED}{BW * AT * 365 \, {}^{days}/_{year}}$$

$$DA_{event} = CS * AF * ABS_{dermal} * CF$$

AT	=	Averaging time (days)
CF	=	Conversion factor (1 x 10^{-6} kg/mg for inorganics; 1 x 10^{-9} kg/µg for organics)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Soil-to-skin adherence factor (mg/cm^2)
ABS_{dermal}	=	Absorption factor (unitless)

TABLE C.3-13

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION, DERMAL, AND INHALATION EXPOSURE TO SUBSURFACE SOIL-SITE EXCAVATION WORKER NAS KEY WEST

Parameter	Excavation Worker RME	Excavation Worker CTE	Units	Source
CS	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{soil}	118	50	mg/day	EPA, 1991a
FI	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	kg/µg	
EF	30	15	days/year	EPA, 1991a
ED	1	0.5	years	EPA, 1991a
ET	8	8	hours/day	Assumption
AT_{cancer}	70	70	years	EPA, 1991a
$AT_{non-cancer}$	1	0.5	years	EPA, 1991a
SA	5,750*	5,750*	cm^2	EPA, 1992a
IR_{air}	2.5	2.5	m^3/hour	EPA, 1991a
BW	70	70	kg	EPA, 1991a
AF	1	0.2	mg/cm^2 per event	EPA, 1992a, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	unitless	EPA, 1995a EPA, 1995d
CA	Chemical Specific	Chemical Specific	mg/m^3	See Appendix A of the Supplemental RFI/RI Report

*25% of total body surface

Appendix A provides sample RME and CTE calculation for the adult trespasser for the ingestion of and dermal contact with sediment. Tables C.3-14 and C.3-15 present the RME and CTE input parameters for these exposure routes, along with the rationale for the selection of each value. As discussed in Section 3.2.4.2, the potential receptors for this scenario were current trespassers and future residents. EPA or conventional values were selected for all input parameters.

For the dermal pathway, it was assumed that the primary areas of skin available for contact would be 25 percent of the total body surface area of adult residents and adult trespassers and workers and the arms, hands, and legs of child residents and adolescent trespassers. Absorption factors for the dermal pathway were assumed to be as follows (EPA, 1992a, 1995d): PCBs (6 percent), chlorinated dioxins (3 percent), cadmium (1 percent), arsenic (3.2 percent), ethylbenzene (3 percent), toluene (3 percent), xylenes (3 percent), PCE (3 percent), pesticides (10 percent), and pentachlorophenol (24.4 percent). If no chemical-specific data were available, the following absorption factors were assumed (EPA, 1995a): 1 percent for organics and 0.1 percent for inorganics.

3.2.4.5.4 Surface-Water Exposure

Two potential exposure routes are associated with surface-water exposure at the NAS Key West sites: ingestion and dermal contact during wading. The methods used to assess these routes of exposure are discussed in the following text. Incidental ingestion and dermal contact exposure are estimated from the following equations (EPA, 1989a):

$$INTAKE_{INGESTION}(mg/kg)/day = \frac{CW * IR_{surface\ water} * CF_1 * EF * ED}{BW * AT * 365\ ^{days}/_{year}}$$

$$INTAKE_{DERMAL}(mg/kg)/day = \frac{DA_{event} * SA * EF * ED * EV}{BW * AT * 365\ ^{days}/_{year}}$$

$$DA_{event} = PC_{event} * CW * CF_1 * CF_2$$

where:

CW	=	Concentration of contaminant in surface water (µg/L)
$IR_{surface\ water}$	=	Surface-water ingestion rate (l/day)

TABLE C.3-14

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION AND DERMAL EXPOSURE TO SEDIMENT (WADING SCENARIO)
FUTURE RESIDENT
NAS KEY WEST

Parameter	Child (0-6 yrs) RME	Child (0-6 yrs) CTE	Adult RME	Adult CTE	Units	Source
CS	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
$IR_{sediment}$	200	200	100	100	mg/day	EPA, 1991a
FI	1.0	1.0	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	1E-09	1E-09	kg/µg	
EF	100	50	100	50	days/year	EPA, 1991a
ED	6	2	24	7	years	EPA, 1989a, 1991a
AT_{cancer}	70	70	70	70	years	EPA, 1991a
$AT_{non\text{-}cancer}$	6	2	24	7	years	EPA, 1991a
SA	See Appendix A	See Appendix A	5,750*	5,750*	cm^2	EPA, 1992a
IR_{air}	0.833	0.833	0.833	0.833	m^3/hour	EPA, 1991a
BW	15	15	70	70	kg	EPA, 1991a
AF	1	0.2	1	0.2	mg/cm^2 per event	EPA, 1992a, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	unitless	EPA, 1995a EPA, 1995d

*25% of total body surface

TABLE C.3-15

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION AND DERMAL EXPOSURE TO SEDIMENT (WADING SCENARIO) CURRENT ADOLESCENT AND ADULT TRESPASSERS NAS KEY WEST

Parameter	Adolescent RME	Adolescent CTE	Adult RME	Adult CTE	Units	Source
CS	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	mg/kg or μg/kg	
$IR_{sediment}$	100	50	100	50	mg/day	EPA, 1991a
FI	1.0	1.0	1.0	1.0	unitless	Assumption
$CF_{inorganics}$	1E-06	1E-06	1E-06	1E-06	kg/mg	
$CF_{organics}$	1E-09	1E-09	1E-09	1E-09	kg/μg	
EF	30	15	24	12	days/year	EPA, 1991a
ED	11	2	19	7	years	EPA, 1989a, 1991a
AT_{cancer}	70	70	70	70	years	EPA, 1991a
$AT_{non\text{-}cancer}$	11	2	19	7	years	EPA, 1991a
SA	See Appendix A	See Appendix A	5,750*	5,750*	cm^2	EPA, 1992a
IR_{air}	0.833	0.833	0.833	0.833	m^3/hour	EPA, 1991a
BW	40	40	70	70	kg	EPA, 1991a
AF	1	0.2	1	0.2	mg/cm^2 per event	EPA, 1992a, 1995a
ABS_{dermal}	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	unitless	EPA, 1995a EPA, 1995d

*25% of total body surface

CF_1	=	Conversion factor (mg/10^3 µg)
CF_2	=	Conversion Factor (l/10^3 cm^3)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
EV	=	Event frequency (events/day)
AT	=	Averaging time (years)
SA	=	Surface area (cm^2)
BW	=	Body weight (kg)
DA_{event}	=	Dose absorbed per unit area per event (mg/event- cm^2); See Appendix A of the Supplemental RFI/RI Report for further explanation
PC_{event}	=	Diffusion depth per event (cm/event); See Appendix A of the Supplemental RFI/RI Report for further explanation

A RME and CTE sample calculation for the adult trespasser is provided in Appendix A of the Supplemental RFI/RI Report for the ingestion of and dermal contact with surface water. Tables C.3-16 and C.3-17 present the RME and CTE input parameters for these exposure routes, along with the rationale for the selection of each value. As discussed in Section 3.2.4.2, the potential receptors for this scenario were current trespassers and future residents. EPA or conventional values were selected for all input parameters.

For the dermal pathway, it was assumed that the primary areas of skin available for contact would be 25 percent of the total body surface area of adult residents and adult trespassers, and the arms, hands, and legs of child residents and adolescent trespassers. Permeability constants and derivation of the dermal exposure pathway are shown in Appendix A of the Supplemental RFI/RI Report. The exposure time is 2.6 hours for both the residential and the trespasser scenario.

3.2.4.5.5 Shellfish Exposure

One potential exposure route is associated with shellfish exposure at the NAS Key West sites: ingestion. The methods used to assess these routes of exposure are discussed in the following text. Ingestion exposures are estimated from the following equations (EPA, 1989a):

$$INTAKE_{INGESTION}(mg / kg) / day = \frac{CF * IR_{fish} * FI * CF_1 * EF * ED}{BW * AT * 365 \, {}^{days}/_{year}} \text{ Inorganics Only}$$

TABLE C.3-16

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION AND DERMAL EXPOSURE TO SURFACE WATER (WADING SCENARIO) FUTURE RESIDENTS NAS KEY WEST

Parameter	Child (0-6 yrs) RME	Child (0-6 yrs) CTE	Adult RME	Adult CTE	Units	Source
CW	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	μg/L	Analysis
$IR_{surface\ water}$	0.13	0.13	0.13	0.13	liters/day	EPA, 1988
CF1	0.001	0.001	0.001	0.001	mg/μg	
CF2	0.001	0.001	0.001	0.001	liters/cm^3	
EF	100	50	100	50	days/year	EPA, 1991a
EV	1	1	1	1	events/day	
ED	6	2	24	7	years	EPA, 1991a
AT_{cancer}	70	70	70	70	years	EPA, 1991a
$AT_{non-cancer}$	6	2	24	7	years	EPA, 1991a
SA	See Appendix A	See Appendix A	5,750*	5,750*	cm^2	EPA, 1992a
BW	15	15	70	70	kg	EPA, 1991a
DA_{event}**	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	mg/event- cm^2	EPA, 1995a
PC_{event}**	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	cm/event	EPA, 1992a

*25% of total body surface
**See Appendix A of the Supplemental RFI/RI Report for a derivation of PC for each COPC.

TABLE C.3-17

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION AND DERMAL EXPOSURE TO SURFACE WATER (WADING SCENARIO) CURRENT ADOLESCENT AND ADULT TRESPASSERS NAS KEY WEST

Parameter	Adolescent RME	Adolescent CTE	Adult RME	Adult CTE	Units	Source
CW	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	µg/L	Analysis
$IR_{surface\ water}$	0.13	0.13	0.13	0.13	liters/day	EPA, 1988
CF1	0.001	0.001	0.001	0.001	mg/µg	
CF2	0.001	0.001	0.001	0.001	liters/cm^3	
EF	30	15	24	12	days/year	EPA, 1991a
ED	11	2	19	7	years	EPA, 1991a
EV	1	1	1	1	event/day	
AT_{cancer}	70	70	70	70	years	EPA, 1991a
$AT_{non\text{-}cancer}$	11	2	19	7	years	EPA, 1991a
SA	See Appendix A	See Appendix A	5,750*	5,750*	cm^2	EPA, 1992a
BW	40	40	70	70	kg	EPA, 1991a
DA_{event}**	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	mg/event- cm^2	EPA, 1995a
PC_{event}**	Chemical Specific	Chemical Specific	Chemical Specific	Chemical Specific	cm/event	EPA, 1992a

*25% of total body surface

**See Appendix A of the Supplemental RFI/RI Report for derivation of PC for each COPC.

$$INTAKE_{INGESTION}(mg / kg) / day = \frac{CF * IR_{fish} * FI * CF_1 * CF_{organics} * EF * ED}{BW * AT * 365 \, {}^{days}\!/_{year}} \text{ Organics Only}$$

where:

CF	=	Concentration of contaminant in shellfish (mg/kg or µg/kg)
IR_{fish}	=	Shellfish ingestion rate (g/day)
CF_1	=	Conversion factor (kg/10^3 mg)
$CF_{organics}$	=	Conversion factor (mg/10^3 µg) for organics only
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time (years)
BW	=	Body weight (kg)

Appendix A of the Supplemental RFI/RI Report provides RME and CTE sample calculation for the residential adult for the ingestion of shellfish. Table C.3-18 presents the RME and CTE input parameters for these exposure routes, along with the rationale for the selection of each value. As discussed in Section 3.2.4.2, the potential receptors for this scenario were future adult residents. EPA or conventional values were selected for all input parameters.

3.2.4.6 Blood-Lead Modeling

As outlined in the Office of Solid Waste and Emergency Response (OSWER) directive 9355.4-12 (EPA, 1994a), EPA has implemented an approach to evaluating lead risks that recognizes the multimedia nature of lead exposures, incorporating absorption and pharmacokinetic information. Research has been done concerning lead intake and resultant blood-lead levels. Determinations of lead uptake from soil, sediment, drinking water, and surface water were considered. For the purposes of this risk assessment, each pathway was evaluated separately so that the contribution of lead from each source and each exposure route could be evaluated. Potential blood-lead level increases were estimated and are discussed, along with the potential implications of blood-lead results for each site. The following paragraphs present information that is useful in estimating lead exposure.

No threshold has been defined for effects related to blood-lead increases. The estimated increases at these sites are well below the concentrations at which effects such as anemia and neuropathy occur (40 µg/dL and above) (Doull et al., 1986). Effects below 10 µg/dL are difficult to define. Inhibition of

TABLE C.3-18

RME AND CTE INPUT PARAMETERS FOR CALCULATING CHEMICAL INTAKE FROM INGESTION EXPOSURE TO SHELLFISH-FUTURE ADULT RESIDENT NAS KEY WEST

Parameter	Adult CTE	Adult RME	Units	Source
CF	Chemical Specific	Chemical Specific	mg/kg or µg/kg	Analysis
IR_{fish}	54	6.5	g/day	EPA, 1989a, 1991a
FI	1.0	1.0	unitless	Assumption
CF_1	0.001	0.001	kg/mg	
$CF_{organics}$	1E-03	1E-03	mg/µg	
EF	365	365	days/year	EPA, 1989a
ED	30	9	years	EPA, 1989a, 1991a
AT_{cancer}	70	70	years	EPA, 1991a
$AT_{non-cancer}$	30	9	years	EPA, 1989a, 1991a
BW	70	70	kg	EPA, 1991a

certain enzymes involved in red blood cell metabolism has been reported to occur at 10 to 15 µg/dL and possibly lower (EPA, 1991c). Small increases in blood pressure have been related to adults with blood-lead levels down to 7 µg/dL (EPA, 1991c). Probably the subpopulation most sensitive to effects at the 3 to 7 µg/dL range (where the concentrations estimated for this study area would fall) would be infants, whose early neurological development can be affected by blood-lead concentrations reportedly down to 5 µg/dL (EPA, 1991c). Lead is also a fairly common environmental contaminant and, for this reason, typical blood-lead levels in the population at large may already exceed the concentrations discussed here.

For drinking water exposure, children 0 through 6 months old are expected to experience blood lead increases at the rate of 0.26 µg/dL per µg/L lead in water up to 15 µg/L and at the rate of 0.04 µg/dL for every µg/L lead in water above 15 µg/L (EPA, 1991c). For older children, the ratio is 0.12 µg/dL blood lead per µg/L lead in water up to 15 µg/L and 0.06 µg/dL for every µg/L lead in water above 15 µg/L (EPA, 1991c). For adults, the ratio is approximately 0.06 µg/dL blood lead per µg/L in water (EPA, 1991c).

Dietary intake of lead is assumed to produce increases of 0.02 to 0.04 µg/dL blood lead per µg/day ingested by adults and 0.16 µg/dL blood lead per µg/day ingested by infants (EPA, 1986a).

Blood-lead levels are estimated to increase by 0.6 to 6.8 µg/dL per 1,000 mg/kg lead in soil (EPA, 1986a).

Estimates of blood-lead levels in residential children (age 0 through 6 years) were made using the Integrated Exposure and Uptake Biokinetic (IEUBK) Model (version 0.99) developed by EPA. The model was applied to each site where lead was selected as a COPC in surface soil. The output for each run of the IEUBK Model is a histogram that presents the estimated percentage of residential children (age 0 through 6 years) with a blood lead level above 10 µg/dL (considered to be the significance cutoff level above which adverse effects cannot be ruled out). When the percentage of the population estimated to have blood levels above 10 µg/dL is greater than five percent, then EPA considers the potential for adverse effects to be significant (EPA, 1994c). Appendix A of the Supplemental RFI/RI Report presents these histograms, along with input information particular to each run of the IEUBK model. The estimated percentage of residential children (age 0 through 6 years) with a blood-lead level above 10 µg/dL is also presented in the site-specific text contained in subsequent sections of this report. Section 3.2.6.4 discusses uncertainties associated with the IEUBK model.

3.2.5 Risk Characterization

Potential human health risks resulting from the exposures outlined in the preceding sections are characterized on a quantitative and qualitative basis in this section. Quantitative risk estimates are generated based on risk assessment methods outlined in current EPA guidance (EPA, 1989a; EPA, 1995a).

Noncarcinogenic risk estimates are presented in the form of Hazard Quotients (HQs) and Hazard Indices (HIs) that are determined through integration of estimated intakes with published RfDs. Incremental cancer risk estimates are provided in the form of dimensionless probabilities based on SFs.

Estimated human intakes were developed for each of the specific exposure routes discussed in the preceding sections. Both carcinogenic and noncarcinogenic risks are summarized for each exposure route on a series of tables in this section.

3.2.5.1 Carcinogenic Risks

Incremental cancer risk estimates are generated for each of the exposure pathways using the estimated intakes and published SFs, as follows:

$$\text{Risk} = \text{Intake} * \text{SF}$$

If the above equation results in a risk greater than 0.01, the following equation is used:

$$\text{Risk} = 1 - e^{-(\text{Intake}*\text{SF})}$$

The risk determined using these equations is a unitless expression of an individual's increased likelihood of developing cancer as a result of exposure to carcinogenic chemicals. An incremental cancer risk of 1E-06 indicates that the exposed receptor has a one in a million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons. The calculated cancer risks should be recognized as upper-limit estimates. SFs are the upper 95 percent confidence limit of a dose-response curve generally derived from animal studies. Actual human risk, while not identifiable, is not expected to exceed the upper limit based on the SFs and may, in fact, be lower.

EPA has generally defined risks in the range of 1E-04 to 1E-06 or less as being acceptable for most hazardous waste facilities addressed under the CERCLA. For CERCLA activities, residual risks on the order of 1E-06 are the primary goal but are often modified by such regulatory requirements as MCLs or chemical-specific clean-up goals.

3.2.5.2 Noncarcinogenic Risks

Noncarcinogenic risks are estimated using the concept of HQs and HIs. The HQ is the ratio of the estimated intake and the RfD for a selected chemical of concern, as follows:

$$HQ = \frac{\text{Intake}}{\text{RfD}}$$

HIs are the sums of the individual HQs for the COPCs. If the value of the HQ or the HI exceeds unity (1.0), the potential for noncarcinogenic health risks associated with exposure to that particular chemical or particular chemical mixture, respectively, cannot be ruled out (EPA, 1986b). If the individual HQs are less than 1.0 and the HI is greater than 1.0, particular attention should be paid to the target organ(s) affected by each chemical because these are generally the organ(s) associated with RfD-derived effects, and toxicity for different organs is not truly additive. The HI is not a mathematical prediction of the severity of toxic effects; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

3.2.5.3 Lead Risks

EPA's approach to evaluating lead risks goes beyond providing a single point estimate output and incorporates absorption and pharmacokinetic properties. Section 3.2.4.6 discusses background information related to blood-lead estimation methods. Soil concentrations for lead were assessed for each applicable site.

3.2.5.4 Receptor Risks

Receptor risks are presented for each NAS Key West site in the form of tables and summary text. Each of these sections includes summaries of risks estimated by the exposure scenarios. It should be noted that, in each risk summary table where HQs are reported as "N/A," the HQs were not calculable because no RfD has been established. Usually in such cases, carcinogenicity is considered to be more important, since carcinogenicity will generally be seen at lower doses than noncarcinogenic effects. Cancer risks of zero or "N/A" generally indicate that the chemical is not carcinogenic or that an SF has not yet been developed.

3.2.6 Uncertainty Analysis

There are uncertainties associated with each aspect of risk assessment, from data evaluation through risk characterization. Significant uncertainties in the risk assessment for NAS Key West are noted in the following sections.

3.2.6.1 Data Evaluation

The chemical-analytical database has some limitations that add to the uncertainty of the risk assessment. Data were collected over several years at all eight sites. The contaminant concentrations could have changed at the site based on migration or physical removal of contaminated media. Therefore uncertainty exists in using historical data because current conditions may not be represented by historical data. Areal extent of the samples (including the number collected and location of the sampling points) in a particular medium at a site was one such uncertainty. Every effort was made to collect samples that reflect actual site conditions. However, biased sampling may have occurred if an unknown area of contamination at a particular site was under- or over-sampled. Established data validation procedures were applied to define uncertainties in terms of qualifying data as inaccurate or imprecise and eliminate data points that are unusable for risk assessment. This treatment does not eliminate all uncertainty but focuses attention on potential areas of concern regarding accuracy, precision, and data gaps.

After the data have been selected for use in the risk assessment, uncertainties exist regarding selection of a concentration for input into the quantitative risk assessment. The use of the representative concentration to estimate risk is generally regarded as a conservative estimate since this entails using either the upper 95 percent confidence limit on the arithmetic mean (based on lognormal data distribution) or the maximum concentration. The choice of the representative concentration as the value for input into the risk assessment generally lowers the chances of underestimation of the actual risk present in a pathway at a particular site to a potential receptor. However, the use of the representative concentration may overestimate the actual risk present in an exposure pathway at a particular site.

The use of current subsurface soil concentrations to represent future subsurface excavation exposure concentrations assumes two things that add to the uncertainty of this risk assessment. First, this exposure scenario assumes that soil would be excavated to the sampling depth. Second, this exposure scenario assumes that once the soil is excavated to the subsurface soil sampling depth, no degradation of the chemicals in the subsurface soil would have taken place and/or no additional contamination would be transported to the soils. These uncertainties may cause either an under- or over-estimation of the exposure at a particular site.

Uncertainties associated with the lack of groundwater modeling and soil-to-groundwater loading at each site include the assumption that current conditions are indicative of future concentrations of contaminants. Contaminants may increase (due to migration, loading, or chemical transformation) or decrease (due to migration or transformation) over time and vary from site to site and within the mixing zone. This does not add uncertainty to the quantitative risk; rather, it adds uncertainty to media concentrations that are inputs to the risk assessment.

The chemical-specific parameters such as K_{oc} were literature-derived values that are measured under conditions that may or may not be representative of on-site conditions. Parameters such as vapor pressure and solubility were not always obtainable at the desired temperature.

The use of unfiltered monitoring well data for the evaluation of groundwater inorganics can provide an overestimation of exposure and risk.

3.2.6.2 Toxicity Assessment

There is uncertainty associated with the RfDs and SFs. The uncertainty results from the extrapolation of animal data to humans, the extrapolation of carcinogenic effects from the laboratory high-dose to the environmental low-dose scenarios, and interspecies and intraspecies variations in toxicological endpoints caused by chemical exposure. The use of EPA SF values is generally considered to be conservative because the doses are based on no-effect or lowest-observed-effect levels and then further reduced with uncertainty factors to increase the margin of safety. The RfDs and SFs of some chemicals have not been established, and therefore toxicity could not be quantitatively assessed. In most cases, where RfDs were unavailable for carcinogens, the carcinogenic risk is considered to be much more significant since carcinogenic effects usually occur at much lower doses.

3.2.6.3 Exposure Assessment

Exposure assumptions can add uncertainty into the risk assessment process based on input values selected for each exposure route. For example, not all people weigh 70 kilograms, drink 2 liters of water per day, and live at the same residence for 30 years. The rationale for each assumption was provided in each table of input parameters. Receptor characteristics, such as age and body weight, were based on published values. Land use and activity patterns in the area were limited to the observations made during the field investigation and known land uses in the surrounding area. Conservative values (based on reasonable maximum exposure or professional judgment) were used in most exposure equations, except where average values were expected to better correspond to actual site conditions.

In addition to activity patterns and receptor characteristics, uncertainties are also associated with chemical-specific properties and chemical transport modeling assumptions. For example, dermal exposure to soil and sediment assumes constant factors for absorption from soil for each class of compounds under all conditions. As estimated by EPA (1992a), the absorbed dermal dose could vary by as much as a factor of 50 from the model estimates, even presuming that activity patterns lead to the exposure duration applied in the model. Exposure to fugitive dust emissions conservatively assumes that residents and workers will be exposed to the same concentration indoors as outdoors; that soils within an area have unlimited erosion potential; that emissions can be estimated from mean annual windspeed and vegetative cover; and that dispersion concentrations can be estimated from source area, downwind distance to receptors, and region-wide meteorological factors. Uncertainties exist in the exposure model for the inhalation of volatiles during showering such as chemical-specific rates of volatilization, droplet size, and droplet residence time in the shower. Most of the inputs into the models were considered conservative; therefore, the output may overestimate the exposure for these routes.

3.2.6.4 Risk Characterization

From a toxicological standpoint, it is not strictly correct to add HQs for a total HI because RfDs are based on effects to various target organs. However, if the HI is less than or equal to 1.0, this demonstrates that, even when this conservative calculation is performed, the noncarcinogenic HI does not indicate a hazard for a particular exposure pathway. This is a conservative approach that will generally overestimate the HI for a particular pathway. The site-specific text for each NAS Key West site with an exposure pathway HI greater than 1.0 presents additional information that may indicate whether HQs for different chemicals can be truly additive within a particular pathway. The target organs affected by those chemicals that significantly contribute to the pathway-specific HI are indicated. This information will give an indication of whether two or more chemicals that significantly contribute to the HI can affect the same target organs.

These models also assumed that chemicals did not interact synergistically (a possible underestimation of the actual risk) or antagonistically (a possible overestimation of the actual risk). Finally, degradation was not taken into account; this is generally a conservative approach.

The IEUBK model accounts for the multimedia nature of lead exposure, incorporates absorption and pharmacokinetic information, and allows the risk manager to consider the potential distributions of exposure and risk likely to occur at a site (the model goes beyond providing a single point estimate output). Although uncertainties are associated with blood lead modeling using the IEUBK model, these uncertainties are considered lower than those that conceivably would result from similar lead evaluations performed using a traditional toxicity slope-based approach. Important uncertainties and limitations in the use of the IEUBK model follows.

The IEUBK model is predictive of blood lead for residential children in the range of 6 months to 7 years of age, which typically is considered to be a more sensitive subpopulation than adults. The model does not apply to adults in either residential or occupational settings. In addition, the IEUBK model does not predict the blood lead levels of pregnant women and does not include an exposure component based on the transfer of lead from the mother's blood to the fetus before birth, although a significant potential exists for adverse effects of prenatal lead exposure on neurobehavioral and physical development (EPA, 1994c).

The IEUBK model uses a default of 30 percent lead absorption from soil. However, the bioavailability of lead from different sources may be variable due to differences in lead speciation, particle size, and mineral matrix and may also vary as a function of physiological parameters such as age, nutritional status, gastric pH, and transit time. For example, lead absorption from paint chips in soil may be different than lead absorption from other chemical forms.

Blood lead variability in the IEUBK model is characterized by a single number, the geometric standard deviation, which is set to a default value of 1.6. This value represents the aggregate uncertainty in all sources of population variability, including biological, uptake, exposure, sampling, and analytical components.

Child blood lead level predictions obtained using the IEUBK model reflect only the contributions of sources entered into the model and do not take into account any existing body burden that may be the result of prior exposures or any exposures that may have taken place at alternate locations away from the household or neighborhood level, such as parks or daycare centers.

3.2.7 Remedial Goal Options

This section presents the methods for selecting human health risk assessment COCs for exposure pathways at each site and determining, for these COCs, a range of possible remedial clean-up goals for consideration by risk managers in the Feasibility Study and the Proposed Plan for the Corrective Measures Study. Remedial Goal Options (RGOs) for COCs are adopted from media-specific ARARs and TBCs and are also derived from risk-based remediation goals as estimated threshold acceptable concentrations of hazardous chemicals which are protective of human health under a receptor exposure scenario.

The subset of chemicals considered for RGO evaluation consists of a portion of the COPCs chosen in Section 3.2.2 for baseline risk calculations. Based on the following criteria, a list of COCs is developed for each receptor and medium considered under a land use scenario:

- COCs are included that exceed a state or Federal chemical-specific ARAR or TBC.

- RGO analysis also includes COPCs that individually contribute a risk of greater than 1E-06 towards a cumulative cancer risk (considering all pathways, media and routes of exposure) of greater than 1E-04.

- COCs are also included that provide a non-carcinogenic HQ contribution greater than 0.1 towards a cumulative (across pathways) HI for a particular target organ of greater than 1.0.

- COCs are not included for any receptor exposure scenario where the cumulative cancer risk (across pathways) is less than 1E-04 and the cumulative hazard index for each target organ is less than or equal to 1.0.

Several types of media-specific RGOs protective of human health are applicable to exposure pathways associated with soil and surface water. Media specific RGOs protective of human health are not currently available. The soil and surface-water RGOs include the following:

- The FDEP (FDEP, 1994) Soil Cleanup Goals (SCGs) are presented in each site-specific RGO section. These RGOs are risk-based levels that have been calculated (FDEP, 1995) for residential and industrial receptors under generalized exposure assumptions. Although FDEP recommends that site-specific soil characteristics such as porosity, carbon content, moisture content, and dry bulk density are needed to refine SCGs for a site, the generalized assumptions represent a conservative approximation of exposure conditions and are useful as an initial benchmark in considering whether any type remedial action should be further investigated. The FDEP SCGs consider incidental soil ingestion, dermal contact, and inhalation of COCs volatilized from soil or present in fugitive dust emissions and were derived by rearranging generic risk equations to solve for the concentration term.

- RCRA Corrective Action Levels (CALs), which are presented in each site-specific RGO section, are risk-based levels calculated to be protective of incidental ingestion of soil/sediment. CALs are used to evaluate contamination for deciding whether a RCRA-regulated site requires a CMS. EPA has established procedures for determining CALs under Subpart S of 40 CFR 264 for SWMUs at Hazardous Waste Management Facilities. CALs are based on generalized exposure assumptions;

however, the CAL approach is somewhat less rigorous and comprehensive relative to other soil risk-based RGOs presented for NAS Key West sites. In particular, it should be noted that CALs consider only the incidental soil ingestion pathway under a residential exposure scenario and generally do not include modifications for combining child plus adult aggregate lifetime cancer risk.

- Federal AWQC (for consumption of water and organisms), which are presented in each site-specific RGO section, are risk-based levels calculated to be protective of ingestion of water and fish in surface-water media. AWQC are used to evaluate contamination for deciding whether a RCRA-regulated site requires a Corrective Measure Study (CMS). AWQCs are based on generalized exposure assumptions for consumption of water and organisms; however, the CAL approach is somewhat conservative based on the fact that is assumes a person is drinking 2 L/day of surface water and eating 6.5 g/day of locally caught shellfish.

- Each RGO section also presents comprehensive, site-specific RGOs for soil, sediment, and surface water, which account for all of the same exposure pathways and intake scenarios applied in the baseline risk assessment for each site. For the residential and industrial receptors, site-specific RGOs were developed for each soil and sediment COC by altering the representative concentration that was used in the calculation of baseline cancer risk or HQ by the required proportion to yield a concentration with a target risk equal to the designated threshold of acceptable risk (1E-06 cancer risk or HQ of 1.0). These calculations incorporate current EPA toxicity factors (IRIS, 1995) as well as appropriate site-specific intake assumptions, and were generated as follows:

$$RGO_{chemical1} = \frac{EPC_{chemical1} * TR}{CRisk_{chemical1}}$$

where:

$EPC_{chemical1}$ = Representative Concentration of a Chemical (in appropriate units: mg/kg or µg/kg)

TR = Target Risk (either a carcinogenic risk of 1E-04, 1E-05, or 1E-06; or an HQ of 0.1, 1.0, or 3.0, unitless).

$CRisk_{chemical1}$ = Calculated Risk Due to a Chemical (presented in Appendix A, unitless).

$RGO_{chemical1}$ = Remedial Goal (in appropriate units: mg/kg, µg/kg, or µg/L).

Each site-specific RGO section contains tables providing a range of clean-up levels for carcinogenic COCs based on 1E-04, 1E-05, and 1E-06 risk levels and a range of cleanup levels for noncarcinogenic COCs based on HQs of 0.1, 1.0, and 3.0. EPA (1995a) has adopted an HQ range of 0.1 to 3.0 to account for uncertainty inherent in the RfD derivation process (EPA, 1989a). The presentation of RGOs based on multiple risk levels allows the risk manager to address any site-specific factors where the use of various target risk levels within this range may be justified (for example, more conservative RGOs may apply when multiple carcinogens are present or when non-cancer effects are potentially additive, affecting the same target organs).

In comparing the usefulness of the different soil RGOs, it should be noted that all TBC values are risk-based values, but the sophistication involved in deriving the various types of TBC values varies considerably. Overall, the RCRA CAL values are the least sophisticated, considering only one route of exposure (incidental soil ingestion) and receptor (future resident). The site-specific RGOs are considered the most sophisticated and comprehensive TBC value, providing the risk manager with different values for residential versus industrial scenarios and indicating concentrations corresponding to both non-cancer and cancer risks at three potential target risk levels. For the evaluation of sediment exposure, site-specific RGOs consider a recreational (wading) exposure scenario, while the FDEP SCGs and CAL criteria treat only surface soil exposure. For the evaluation of soil, the FDEP SCGs are of nearly comparable sophistication as the site-specific RGOs, but are not as versatile for the risk manager in the form presented because only one risk level is indicated, which is either an HQ of 1.0 or a cancer risk of 10^{-6}, whichever occurs at a lower soil concentration. Although the FDEP generic SCGs lack the use of site-specific VOC and particulate emission variables, they address the same soil exposure pathways, are based on recent toxicity data for COCs, and include different variable default values for the general worker versus resident. In addition, the resident is further divided into child and aggregate resident (part of the time as a child and part of the time as an adult), which is done in the baseline risk

3.3 ECOLOGICAL RISK ASSESSMENT METHODOLOGY

Ecological receptors at NAS Key West may be at risk from contaminants associated with the eight RCRA/CERCLA sites under investigation. Accordingly, an ecological risk assessment (ERA) was performed to characterize the potential risks from site-related contaminants to ecological receptors that inhabit the installation. The ERA was based on the laboratory analyses of surface soil, surface-water, groundwater, sediment, and biota samples collected from each site. Concentrations of contaminants in soil, surface water, groundwater, and sediment were compared to concentrations protective of ecological receptors. Concentrations of contaminants in biological samples were compared to background concentrations and to ecological toxicity threshold values, and were also used in foodchain modeling. Foodchain modeling of contaminant intake doses for representative terrestrial and piscivorous receptors was performed, and estimated doses were compared to toxicity reference values.

This section provides an outline of the general approach that was taken to assess the impacts of site contamination on aquatic biota, terrestrial biota, and the habitats that support these organisms. This assessment generally followed a two-step process, as follows:

Step 1: Problem Formulation (Section 3.3.1.1) and Ecological Effects Characterization (Section 3.3.1.2)

- Problem Formulation - This is the first phase of an ERA, which discusses the goals, breadth, and focus of the assessment. It includes general descriptions of NAS Key West RCRA/CERCLA sites with emphasis on the habitats and ecological receptors present. This phase also involves characterization of site contaminants, contaminant sources, and migration routes, and an evaluation of routes of contaminant exposure. Assessment and measurement endpoints that will be evaluated are also selected. Finally, a conceptual model is developed that describes how contaminants associated with the eight RCRA/CERCLA sites may come into contact with ecological receptors.

- Ecological Effects Characterization - In this component, medium-specific ecological thresholds for each contaminant (i.e., concentrations of each contaminant above which adverse effects to ecological receptors may occur) are identified. Contaminant intake doses above which potential risks may occur for selected ecological receptors are also identified or derived. This step is undertaken concurrently with the exposure assessment described below.

Step 2: Preliminary Exposure Assessment (Section 3.3.2.1) and Risk Characterization (Section 3.3.2.2)

- Exposure Assessment - This portion of the ERA includes the identification of the data used to represent concentrations of contaminants to which ecological receptors may be exposed in various media and the actual selection of exposure point concentrations from those data. Contaminant doses are also estimated for representative species on the station.

- Risk Characterization - In this step, exposure concentrations are compared to ecological thresholds in order to characterize potential risk to ecological receptors of concern from contaminant exposure. Also, estimated contaminant doses are compared to doses above which adverse effects may occur. Contaminants found to pose potential risk after these comparisons are placed on a list of ecological contaminants of potential concerns (COPCs). Biological sampling performed in the ERA is also discussed and interpreted in this step. Furthermore, toxicity profiles are established that summarize the toxic effects and environmental fate of all COPCs.

When these two steps are completed, the results are interpreted, COCs are selected, and the uncertainties associated with the ERA are addressed. COCs consist of COPCs which are shown to present unacceptable risks to ecological receptors based on their concentrations, distributions, and modes of toxicity. The above process, described in further detail below, represents the general approach recommended in EPA guidance (EPA, 1996b), which served as the basis for the ERA methodology. Furthermore, the ERA was conducted in accordance with other available ERA guidance documents (EPA, 1992b; Wentsel et al. 1994), and recent publications (Suter, 1993; Calabrese and Baldwin, 1993). Due to the potential complexity of ERAs, they are often conducted using a tiered approach and punctuated with Scientific/Management Decision Points (SMDPs; Figure C.3-2), which are meetings involving the risk assessors, risk managers, and client to control costs, prevent unnecessary analyses, and ensure that the ERA is proceeding in an efficient, timely manner. Information analyzed in one tier is evaluated to determine whether the objectives of the study have been met and then may be used to identify the data required for the next tier, if necessary.

Screening-level risk assessments were previously conducted for each of the eight sites (SWMUs 4, 5, 7; IRs 1,3, 7, 8; and AOC B) investigated in this ERA (IT Corporation, 1994). Based on those assessments, potential risks at IRs 1, 7, and 8 were categorized as "moderate to high," and potential risks at SWMUs 5 and 7 were categorized as "low to moderate." Sites IR 3 and SWMU 4 were concluded as unlikely to pose any ecological risks, based on the lack of complete exposure pathways and restricted receptor access (IT Corporation, 1994). AOC B was not categorized due to insufficient data but was ranked as "medium" potential ecological risk by ABB (1995). EPA and FDEP reviewed the RFI/RI report (IT Corporation, 1994), and noted that in general, the characterization of the nature and extent of contamination and potential ecological risks were incomplete. Based on EPA and FDEP comments, as well as on the results of the screening-level assessments and all other pertinent data and information, additional ecological investigations were performed at the eight sites. The screening-level risk assessments previously performed can be viewed as a Tier 1 assessment, and for the most part, the analyses in this ERA can be viewed as a Tier 2 assessment. Tier 2 and Tier 3 assessments are more focused studies that incorporate the initial screening but also encompass detailed laboratory and field studies or extensive modeling.

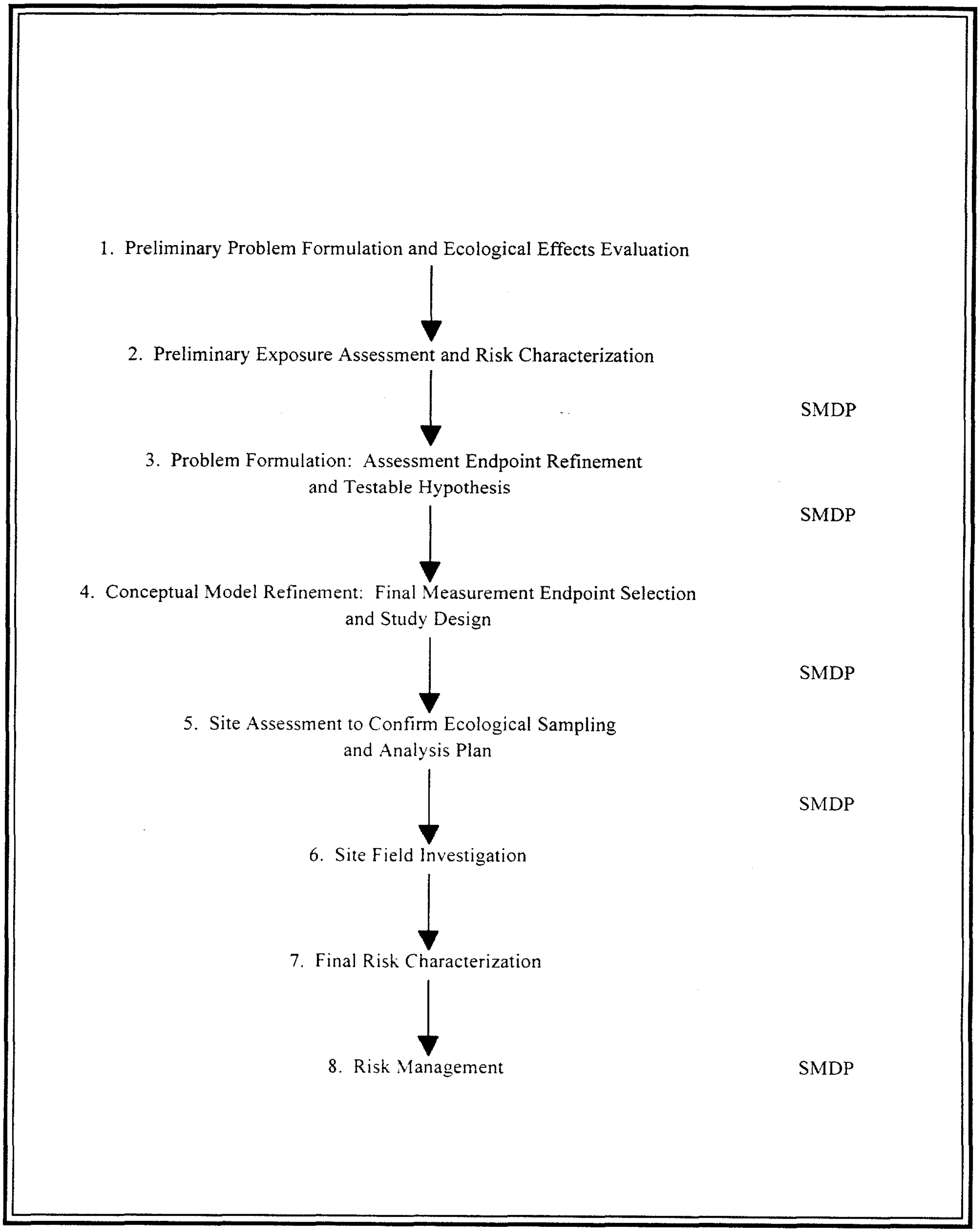


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Figure C.3-2. Steps in the Ecological Risk Assessment Process.

3.3.1 Problem Formulation and Ecological Effects Characterization

Section 3.3.1.1 discusses the components of problem formulation, and Section 3.3.1.2 discusses the components of ecological effects characterization.

3.3.1.1 Problem Formulation

The goal of problem formulation is to define a number of factors including the ecological setting, habitat types and ecological receptors, contaminants known to exist at the site, contaminant sources, contaminant release mechanisms, contaminant migration pathways, exposure routes, assessment and measurement endpoints, and the conceptual model. These factors are all addressed in the following subsections.

3.3.1.1.1 Ecological Setting

The first step in problem formulation is a general NAS Key West ecological characterization, specifically describing the ecological setting and natural resources on NAS Key West. This includes a physiographic description of the station as it relates to the overall ecological setting in the Florida Keys. This description of the ecological setting at NAS Key West is provided in Section 1.4.8 of the Supplemental RFI/RI Report.

3.3.1.1.2 Habitat Types and Ecological Receptors

Ecological risk assessments were conducted for all eight RCRA/CERCLA sites at NAS Key West. As a result, site-specific descriptions of habitat types and ecological receptors were composed and are located in site-specific sections of this RFI/RI. These encompass aquatic and terrestrial habitats at each site except IR 3, where no aquatic habitat exists. An evaluation of threatened and endangered species and wetlands on and around each site is provided, in accordance with Endangered Species Act (ESA) and Clean Water Act (CWA) requirements, which are ARARs. ARARs pertinent to this assessment are listed below:

- Executive Order 11988, Protection of Floodplains
- Executive Order 11990, Protection of Wetlands
- Clean Water Act, as amended (33 USC 1251 et seq.)
- Migratory Bird Treaty Act (16 USC 703 et seq.)
- Fish and Wildlife Coordination Act (16 USC 661 et seq.)/Endangered Species Act (16 USC 1531 et seq.)
- Federal Water Quality Criteria and State Water Quality Standards

3.3.1.1.3 Contaminant Sources, Release Mechanisms, and Migration Pathways

The unique nature of the eight sites presents several different contaminant sources, release mechanisms, and migration pathways. These items were investigated on a site-specific basis, and are presented in site-specific sections of the RFI/RI. Contaminants selected for evaluation consisted of all contaminants detected in groundwater, surface-water, sediment, and surface soil samples at the eight sites under investigation. However, calcium, magnesium, potassium, and sodium were excluded for evaluation since they are essential nutrients that are toxic only in extremely high concentrations. Initially, iron was excluded for evaluation in all media except surface water and groundwater. Subsequent to submittal of the first draft of the RFI/RI, however, EPA requested that iron be assessed in all media at AOC B because of the contaminant source at that site (i.e., automobile body parts) and because iron was detected at high concentrations in site sediments. Therefore, iron was evaluated in all media at AOC B. In general, release pathways that were evaluated on the installation include volatilization, wind erosion, wave erosion, overland runoff, and infiltration of contaminants. Constituents in site soils may volatilize from surficial material or become airborne via resuspension. Contaminated fugitive dust may also be generated during ground-disturbing activities such as construction or excavation. These contaminants are dispersed in the surrounding environment and transported to downwind locations where they may re-partition to surface soil, surface water, or sediment through gravitational settling, precipitation, and deposition.

Precipitation runoff and wave erosion may carry constituents to nearby surface water, sediments, and soils. Infiltrating precipitation may cause the contamination of subsurface soil and groundwater. Contaminants with a stronger tendency to adsorb to organic matter in a soil are expected to migrate at a slower rate. Upon infiltrating the soil column and reaching the water table, a contaminant may be carried with the flow of groundwater to downgradient locations. Groundwater from the site may eventually discharge to surface-water; contaminants may be subsequently deposited in sediment or they may accumulate in the tissues of aquatic organisms.

3.3.1.1.4 Exposure Routes

The unique nature of the eight sites also results in the presence of several possible contaminant exposure routes. A brief description of general contaminant exposure routes that were investigated on a site-specific basis at NAS Key West is provided below.

Terrestrial animals may be exposed to soil contaminants through ingestion of contaminated food items. Animals can also incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items to which soil has adhered (such as roots and tubers). Terrestrial vegetation may be exposed to contaminants via direct aerial deposition and root translocation. However, aerial deposition was not investigated, primarily because the contaminant sources at the sites under investigation are largely covered by vegetation and water. Terrestrial animal receptors may also come into contact with contaminants in surface water by using surface water for drinking water, although this exposure route represents a negligible portion of total exposure for most receptors. Exposure to contaminants in the soil via dermal contact may occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize transfer of contaminants across dermal tissue.

Volatile constituents are present in some site soils; soil-bound contaminant resuspension may occur; and combustion may release contaminants into the air at some sites. However, inhalation does not represent a significant exposure pathway because air contaminant concentrations are assumed to be quite low, even for burrowing wildlife. In addition, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Aquatic and semi-aquatic organisms inhabiting the NAS Key West area may be exposed to contaminants via direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated food items. Aquatic and semi-aquatic organisms may also be exposed to constituents from contaminated groundwater that flows into surface water.

3.3.1.1.5 Assessment and Measurement Endpoints

As discussed in EPA (1996b) and Wentsel et al. (1994), one of the major tasks in problem formulation is the selection of assessment and measurement endpoints. An assessment endpoint is defined as "an explicit expression of actual environmental values that are to be protected" (EPA, 1992b). Measurement endpoints are "measurable ecological characteristics that are related to the valued characteristic chosen as the assessment endpoint" (EPA, 1992b). For this ERA, the most appropriate assessment endpoint was the maintenance of groups of aquatic and terrestrial receptor populations. Therefore, the specific objectives of this assessment were to determine if exposure to contaminants present in the surface water, sediment, soil, and groundwater on and near the sites are likely to result in declines in ecological receptor populations. Declines in populations could result in a shift in community structure and possible elimination of resident species from aquatic, semi-aquatic, and terrestrial environments.

As indicated above, measurement endpoints are related to assessment endpoints, but these endpoints are more easily quantified or observed. In essence, measurement endpoints serve as surrogates for assessment endpoints. While declines in populations and shifts in community structure can be quantified, studies of this nature are generally time-consuming and difficult to interpret. However, measurement endpoints indicative of observed adverse effects on individuals are relatively easy to measure in toxicity studies and can be related to the assessment endpoint. For example, contaminant concentrations that lead to decreased reproductive success could, if found in the environment, result in shifts in population structure, potentially altering the community composition associated with the sites investigated in this ERA.

For surface-water, and indirectly for groundwater, the measurement endpoints are contaminant concentrations in surface water associated with adverse effects on growth, survival, and reproduction of aquatic organisms (surface-water toxicity threshold values). For sediments, the measurement endpoints are contaminant concentrations in sediment associated with adverse effects on growth, survival, and reproduction of aquatic (benthic) organisms (sediment toxicity threshold values). For surface soils, the measurement endpoints are contaminant concentrations in soils associated with adverse effects on growth, survival, and reproduction of terrestrial invertebrates (surface soil toxicity threshold values). In addition, another measurement endpoint for surface soils are the contaminant concentrations in surface soils associated with adverse effects on growth, reproduction, and survival of terrestrial plants. Furthermore, for the Lower Keys marsh rabbit, cotton rat, raccoon, and kestrel (representative terrestrial receptors) the measurement endpoint will be the total contaminant dose from all exposure routes associated with adverse effects on growth, survival, and reproduction. Finally, the measurement endpoint for piscivorous birds and mammals will be the contaminant concentrations in fish and aquatic organisms (prey) associated with potential adverse effects on growth, reproduction, and survival. For the great blue heron, (piscivorous receptor), the measurement endpoint will be the total contaminant dose (based on chemical concentrations in minnows) in prey items associated with adverse effects on growth, survival, and reproduction.

3.3.1.1.6 Conceptual Site Model

The conceptual model is designed to diagrammatically identify potentially exposed receptor populations and applicable exposure pathways based on the physical nature of the site and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with the sites were determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: a source of contaminants that can be released to the environment; a route of contaminant transport through an environmental medium; and an exposure or contact point for an ecological receptor. Conceptual ERA models for each site are presented in site-specific sections.

3.3.1.2 Ecological Effects Assessment

For this ERA, ecologically-based threshold values, which are concentrations of contaminants in various media protective of ecological receptors, were selected to screen exposure point concentrations of site contaminants in surface water, groundwater sediment, and soil to determine if they qualify as COPCs. In addition, modeling of contaminant intake doses for the Lower Keys marsh rabbit, cotton rat, raccoon, kestrel, and great blue heron was also performed, and estimated doses were compared to derived toxicity reference values (TRVs), which are doses above which potential risks may be present. Methods used for the selection of media-specific benchmarks and derivation of TRVs are provided below.

3.3.1.2.1 Selection of Surface-Water Thresholds

Actual exposures of NAS Key West aquatic receptors to surface water contaminants were assumed to be primarily chronic (long-term) exposures, usually at sublethal concentrations. For this ERA, ecological threshold values used to identify surface-water COPCs were chronic screening values, primarily Federal AWQCs (EPA, 1996a), Florida Water Quality Standards (FDEP, 1995), and EPA Region IV surface-water screening levels (EPA, 1995e). Due to the high salinity of surface water at the sites under investigation, saltwater threshold values from these sources were utilized. There is no surface freshwater at any of the sites under investigation, except for the water in a small roadside ditch at SWMU 4. The surface-water thresholds are ARARs and are protective of a wide variety of sensitive species. Table C.3-19 presents surface-water ecological thresholds used in this ERA and their sources. Surface-water ecological thresholds used to assess surface-water samples collected from the ditch at SWMU 4 are provided in the ecological risk assessment section for that site.

3.3.1.2.2 Selection of Groundwater Thresholds

Groundwater-to-surface-water migration of groundwater contaminants is possible at NAS Key West, especially since groundwater on the station is shallow. However, ecological receptors are not directly exposed to groundwater. Additionally, no groundwater thresholds have been developed based on ecological concerns. Potential ecological risks associated with groundwater contaminants are reflected to a great extent in the evaluation of the potential risks associated with surface water and sediment, since the sources of contamination at the eight sites under investigation have been in place long enough for groundwater plumes to discharge into nearby surface water and sediment. Nevertheless, groundwater analyte concentrations were compared to marine (saltwater) surface-water thresholds to identify groundwater COPCs, in accordance with FDEP requirements. Surface-water thresholds are discussed in Section 3.3.1.2.1 and are presented in Table C.3-18.

TABLE C.3-19

**SURFACE-WATER THRESHOLD VALUES
NAS KEY WEST
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Analyte	Benchmark Value (µg/L)	Source*
INORGANICS		
Aluminum	1,500	Florida Water Quality Standard (FDEP, 1995)
Antimony	4,300	Florida Water Quality Standard (FDEP, 1995)
Arsenic	50	Florida Water Quality Standard (FDEP, 1995)
Barium	10,000	EPA Region III BTAG Screening Level (EPA, 1995f)
Beryllium	0.13	Florida Water Quality Standard (FDEP, 1995)
Cadmium	9.3	Florida Water Quality Standard (FDEP, 1995)
Chromium	50	Florida Water Quality Standard for hexavalent chromium (FDEP, 1995)
Cobalt	3.0	EPA Tier II value for freshwater (EPA, 1996a)
Copper	2.4	Ambient Water Quality Criterion (EPA, 1996a)
Cyanide	1	Florida Water Quality Standard (FDEP, 1995)
Iron	300	Florida Water Quality Standard (FDEP, 1995)
Lead	5.6	Florida Water Quality Standard (FDEP, 1995)
Manganese	10	EPA Region III BTAG Screening Level (EPA, 1995f)
Mercury	0.025	Florida Water Quality Standard (FDEP, 1995)
Nickel	8.2	Ambient Water Quality Criterion (EPA, 1996a)
Silver	0.05	Florida Water Quality Standard (FDEP, 1995)
Selenium	71	Florida Water Quality Standard (FDEP, 1995)
Thallium	6.3	Florida Water Quality Standard (FDEP, 1995)
Tin	73	Tier 2 Secondary Chronic Value (Suter and Tsao, 1996)
Vanadium	10,000	EPA Region III BTAG Screening Level (EPA, 1995f)
Zinc	86	Florida Water Quality criterion (FDEP, 1995)
PESTICIDES/PCBs		
2,4-D	100	Florida Water Quality Standard for freshwater (FDEP, 1995)
4,4'-DDD	0.025	EPA Region IV Screening Level (EPA, 1995e)
4,4'-DDE	0.14	EPA Region IV Screening Level (EPA, 1995e)
4,4'-DDT	0.0006	Florida Water Quality Standard (FDEP, 1995)
Aldrin	0.00014	Florida Water Quality Standard (FDEP, 1995)
alpha-BHC	1,400	EPA Region IV Screening Level (EPA, 1995e)
Aroclor-1016	0.03	EPA Region IV Screening Level (EPA, 1995e)
Aroclor-1232	0.03	EPA Region IV Screening Level (EPA, 1995e)
Aroclor-1242	0.03	EPA Region IV Screening Level (EPA, 1995e)
Aroclor-1248	0.03	EPA Region IV Screening Level (EPA, 1995e)
beta-BHC	0.046	Florida Water Quality Standard (FDEP, 1995)
Chlordane	0.00059	Florida Water Quality Standard (FDEP, 1995)
delta-BHC	0.016	EPA Region IV Screening Level for gamma-BHC (EPA, 1995e)
Dieldrin	0.00014	Florida Water Quality Standard (FDEP, 1995)
Endrin	0.0023	Florida Water Quality Standard (FDEP, 1995)
Endrin aldehyde	0.0023	Florida Water Quality Standard for endrin (FDEP, 1995)
Endosulfan I	0.0087	Florida Water Quality Standard (FDEP, 1995)

TABLE C.3-19

**SURFACE-WATER THRESHOLD VALUES
NAS KEY WEST
PAGE 2 OF 2**

Analyte	Benchmark Value (μg/L)	Source
PESTICIDES/PCBs (continued)		
Endosulfan II	0.0087	Florida Water Quality Standard for endosulfan I (FDEP, 1995)
Endosulfan sulfate	0.0087	Florida Water Quality Standard for endosulfan I (FDEP, 1995)
gamma-BHC	0.016	EPA Region IV Screening Level (EPA, 1995e)
Heptachlor	0.00021	Florida Water Quality Standard (FDEP, 1995)
Heptachlor epoxide	0.00021	Florida Water Quality Standard for heptachlor (FDEP, 1995)
SEMIVOLATILE ORGANIC COMPOUNDS		
Anthracene	300	EPA Region III BTAG Acute Screening Level (EPA, 1995f)
Benzo(g,h,i)perylene	300	EPA Region III BTAG Acute Screening Level (EPA, 1995f)
Bis(2-ethylhexyl)phthalate	360	EPA Region III BTAG Screening Level (EPA, 1995f)
Chrysene	0.031	Florida Water Quality Standard for total PAHs (FDEP, 1995)
Dibenzo(a,h)anthracene	0.031	Florida Water Quality Standard for total PAHs (FDEP, 1995)
Di-n-butyl phthalate	3.4	EPA Region III BTAG Screening Level (EPA, 1995f)
Fluoranthene	370	Florida Water Quality Standard (FDEP, 1995)
Naphthalene	24	EPA Tier II valve for freshwater (EPA, 1996a)
N-nitroso-di-n-propylamine	33,000	EPA Region IV Screening Level (EPA, 1995e)
Pyrene	11,000	Florida Water Quality Standard (FDEP, 1995)
VOLATILE ORGANIC COMPOUNDS		
1,1-dichloroethane	1,130	EPA Region IV Screening Level for 1,2-dichloroethane (EPA, 1995e)
1,1,1-trichloroethane	312	EPA Region IV Screening Level (EPA, 1995e)
Acetone	9.0E+06	EPA Region III BTAG screening value for freshwater (EPA, 1995f)
Carbon disulfide	2	EPA Region III BTAG Screening Level (EPA, 1995f)
Chloroform	470.8	Florida Water Quality Standard (FDEP, 1995)
Dibromomethane	34	Florida Water Quality Standard for halomethanes (FDEP, 1995)
Ethylbenzene	4.3	EPA Region IV Screening Level (EPA, 1995e)
Methylene chloride	2,560	EPA Region IV Screening Level (EPA, 1995e)
Xylene	6,000	EPA Region III BTAG Screening Level (EPA, 1995f)

*All values are for saltwater unless otherwise noted

3.3.1.2.3 Selection of Sediment Thresholds

Ecological screening levels for sediment-dwelling organisms were gathered from the most widely accepted guidance. Florida Sediment Quality Guidelines (FDEP, 1994) and EPA Region IV sediment screening levels (EPA, 1995e) were preferentially used. When values were not available from these sources for some contaminants, thresholds were obtained from most recent EPA guidance (EPA, 1996a), which includes EPA sediment quality criteria (SQC), EPA sediment quality benchmarks (SQB) calculated using equilibrium partitioning methods, and Effects-Range Low (ER-L) and Effects-Range Medium (ER-M) values from NOAA guidance (Long et al. 1995; Long and Morgan, 1991). Table C.3-20 presents sediment benchmarks used in this assessment.

Most commonly used and widely accepted sediment thresholds are designed to represent contaminant concentrations in sediments indicative of a very low level of risk and subsequently are inherently conservative. Therefore, a risk range was established using less conservative thresholds when sediment contaminant concentrations exceeded the most conservative thresholds available. For example, ER-L screening levels obtained from Long et al. (1995) as presented by EPA (1996a) were used as most conservative threshold values, when available. However, an ER-L is defined as the concentration below which adverse ecological "effects would rarely be observed" (Long et al., 1995). The ER-M is the point below which adverse effects "would occasionally occur" (Long et al., 1995). Therefore, ascribing risk to a sediment contaminant detected in a concentration that exceeds the ER-L but is below the ER-M can be misleading. Hence, as stated above, when contaminant concentrations exceeded the most conservative thresholds available, concentrations were also compared to less conservative thresholds, such as ER-Ms, when available, to obtain a risk range.

3.3.1.2.4 Selection of Surface Soil Thresholds

Widely accepted and comprehensive sets of threshold values for screening risk to terrestrial invertebrates from surface soil contaminants do not exist. While many sources have identified conservative, "safe" soil contaminant levels from a human health perspective, only a few have developed soil threshold values with protection of ecological receptors as a goal. When available, soil threshold values that consider impacts to soil invertebrates were used since they are in constant contact with the soil. The primary source of surface soil threshold values for inorganics used in this assessment was Oak Ridge National Laboratory (ORNL) surface soil screening levels for soil invertebrates which are based primarily on risks to earthworms (Will and Suter, 1995a). Surface soil threshold values for organics were primarily EPA Region III Biological Technical Assistance Group (BTAG) screening levels for terrestrial invertebrates (EPA, 1995f). Table C.3-21 presents surface soil ETs utilized in this ERA.

TABLE C.3-20

SEDIMENT THRESHOLD VALUES
NAS KEY WEST
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Analyte	Benchmark Value	Source
INORGANICS (mg/kg)		
Antimony	12	EPA Region IV Screening Level (EPA, 1995e)
Arsenic	7.24/70	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Barium	40	Baudo et al. (1990)
Cadmium	0.676/9.6	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Chromium	52.3/160	Florida Sediment Quality Guideline (FDEP, 1994)
Cobalt	50	Threshold for Soils (Direction des Substances Dangerous, 1988)
Copper	18.7/270	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995))
Cyanide	0.1	ORNL sediment Screening Level (Hull and Suter, 1994)
Iron	0,000/40,000	ORNL Sediment Screening Level (Jones et al., 1996)
Lead	30.2/218	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Manganese	460/1110	Ontario Sediment Quality Guidelines (OME, 1992)
Mercury	0.13/0.71	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Nickel	15.9/42.8	Florida Sediment Quality Guideline (FDEP, 1994)
Silver	0.733/3.7	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Zinc	124/410	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
PESTICIDES/PCBs (µg/kg)		
4,4'-DDD	1.22/7.81	Florida Sediment Quality Guideline (FDEP, 1994)
4,4'-DDE	2.07/27	Florida Sediment Quality Guideline (FDEP, 1995)/ER-M (Long et al., 1995)
4,4'-DDT	1.19/4.77	Florida Sediment Quality Guideline (FDEP, 1994)
alpha-BHC	6/100	Ontario Sediment Quality Guidelines (OME, 1992)
Aroclor 1248	30/1,500	Ontario Sediment Quality Guidelines (OME, 1992)
Aroclor 1254	60/340	Ontario Sediment Quality Guidelines (OME, 1992)
Aroclor 1260	5/240	Ontario Sediment Quality Guidelines (OME, 1992)
Beta-BHC	5	Ontario Sediment Quality Guideline (OME, 1992)
Delta-BHC	3	Ontario Sediment Quality Guideline (OME, 1992)
Dieldrin	0.715/95	Florida Sediment Quality Guideline (FDEP, 1994)/EPA Sediment Quality Criterion (EPA, 1996a)
Endosulfan I	2.9	EPA Sediment Quality Benchmark (EPA, 1996a)
Endosulfan II	14	EPA Sediment Quality Benchmark (EPA, 1996a)
Endosulfan sulfate	5.4	EPA Sediment Quality Benchmark for Endosulfan mixed isomers (EPA, 1996a)
Endrin	3.3/3.5	EPA Region IV Screening Level (EPA, 1995e)/EPA Sediment Quality Criterion (EPA, 1996a)
Endrin aldehyde	3.3/3.5	EPA Region IV Screening Level for Endrin (EPA, 1995e)/EPA Sediment Quality Criterion for Endrin (EPA, 1996a)
gamma-BHC	0.32/0.99	Florida Sediment Quality Guidelines (FDEP, 1994)
gamma-chlordane	0.5/6	ER-L/ER-M for chlordane (Long and Morgan, 1991)
Heptachlor	4.9	ORNL Sediment Screening Level (Hull and Suter, 1994)
Heptachlor epoxide	5/50	Ontario Sediment Quality Guidelines (OME, 1992)
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)		
1,2,4-Trichlorobenzene	9,200	EPA Sediment Quality Benchmark (EPA, 1996a)
1,2-Dichlorobenzene	340	EPA Sediment Quality Benchmark (EPA, 1996a)
1,3-Dichlorobenzene	1,700	EPA Sediment Quality Benchmark (EPA, 1996a)
1,4-Dichlorobenzene	350	EPA Sediment Quality Benchmark (EPA, 1996a)

TABLE C.3-20

SEDIMENT THRESHOLD VALUES
NAS KEY WEST
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Analyte	Benchmark Value	Source
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg) (continued)		
2,4-Dinitrotoluene	520	Sediment Benchmark for 2,4,6-TNT
2,6-Dinitrotoluene	520	Sediment Benchmark (Talmage and Opresko, 1995)
2-Methylnapthalene	20.2/201	Florida Sediment Quality Guidelines (FDEP, 1994)
2-Methylphenol	63	Washington State Sediment Quality Standard (Ginn and Pastorak 1992)
Acenapthene	6.71/500	Flordida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Acenapthylene	5.87/128	Florida Sediment Quality Guidelines (FDEP, 1994)
Anthracene	46.9/245	Florida Sediment Quality Guidelines (FDEP, 1994)
Benzo(a)anthracene	74.8/1,600	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Benzo(a)pyrene	88.8/1,600	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Benzo(b)fluoranthene	655/1,700	EPA Region IV value for high MW PAHs (EPA 1995e)/ER-L (Long et al., 1995)
Benzo(g,h,i)perylene	655/1,700	EPA Region IV value for high MW PAHs (EPA 1995e)/ER-L (Long et al., 1995)
Benzo(k)fluoranthene	655/1,700	EPA Region IV value for high MW PAHs (EPA, 1995e)/ER-L (Long et al., 1995)
Benzyl alcohol	57	Washington State Sediment Quality Standard (Ginn and Pastorak, 1992)
Bis(2-Ethylhexyl)phthalate	182/2,647	Florida Sediment Quality Guideline (FDEP, 1994)
Butylbenzylphthalate	11,000	EPA Sediment Quality Benchmark (EPA, 1996a)
Chrysene	108/2,800	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Di-n-butyl phthalate	11,000	EPA Sediment Quality Benchmark (EPA, 1996a)
Di-n-octylphthalate	11,000	EPA Sediment Quality Benchmark for Di-n-butylphthalate (EPA, 1996a)
Dibenzo(a,h)anthracene	6.22/260	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Dibenzofuran	540/2,000	EPA Region III BTAG Screening Level (EPA, 1995f) EPA Sediment Quality Benchmark (EPA, 1996a)
Dietlylphthalate	630	EPA Sediment Quality Benchmark (EPA, 1996a)
Dimethylphenol	29	Washington State Sediment Quality Standard (Ginn and Pastorak, 1992)
Dimethylphthalate	630	EPA Sediment Quality Benchmark for diethylphthalate (EPA, 1996a)
Fluoranthene	113/5,100	Florida Sediment Quality Guideline (FDEP, 1994)/ER-M (Long et al., 1995)
Fluorene	21.2/144	Florida Sediment Quality Guidelines (FDEP, 1994)
Hexachloroethane	1,000	EPA Sediment Quality Benchmark (EPA, 1996a)
Indeno(1,2,3-cd)pyrene	655/9,600	EPA Region IV value for high MW PAHs (EPA, 1995e)/ER-M (Long et al., 1995)
Napthalene	34.6/391	Florida Sediment Quality Guidelines (FDEP, 1994)
Pentachlorobenzene	690	EPA Sediment Quality Benchmark (EPA, 1996a)
Pentachlorophenol	360	Washington State Sediment Quality Standard (Ginn and Pastorak, 1992)
Phenanthrene	86.7/1,100	Florida Sediment Quality Guideline (FDEP, 1994)/EPA Sediment Quality Criterion (EPA, 1996a)
Phenol	420	Washington State Sediment Quality Standard (Ginn and Pastorak, 1992)
Pyrene	153/2,600	Florida Sediment Quality Guidelines (FDEP, 1994)/ER-M (Long et al., 1995)
VOLATILE ORGANIC COMPOUNDS (µg/kg)		
Acetone	64	ORNL Sediment Screening Level (Hull and Suter, 1994)
Carbon disulfide	13	ORNL Sediment Screening Level (Hull and Suter, 1994)
Cis-1,2-Dichloroethene	23	ORNL Sediment Screening Level (Hull and Suter, 1994)
Methylene chloride	427	ORNL Sediment Screening Level (Hull and Suter, 1994)
Tetrachloroethene	530	EPA Sediment Quality Benchmark (EPA, 1996a)
Toluene	670	EPA Sediment Quality Benchmark (EPA, 1996a)
Xylenes (total)	25	EPA Sediment Quality Benchmark (EPA, 1996a)

TABLE C.3-21

SURFACE SOIL THRESHOLD VALUES
NAS KEY WEST
PAGE 1 OF 2

Analyte	Benchmark Value	Source
INORGANICS (mg/kg)		
Aluminum	600	ORNL Soil Screening Level (Will and Suter, 1995a)
Arsenic	60	ORNL Soil Screening Level (Will and Suter, 1995a)
Barium	440	EPA Region III BTAG Screening Level (EPA, 1995f)
Cadmium	20	ORNL Soil Screening Level (Will and Suter, 1995a)
Chromium	0.4	ORNL Soil Screening Level (Will and Suter, 1995a)
Cobalt	200	EPA Region III BTAG Screening Level (EPA, 1995f)
Copper	50	ORNL Soil Screening Level (Will and Suter, 1995a)
Cyanide	0.005	EPA Region III BTAG Screening Level (EPA, 1995f)
Iron	200	ORNL Soil Screening Level (Will and Suter, 1995a)
Lead	500	ORNL Soil Screening Level (Will and Suter, 1995a)
Manganese	100	ORNL Soil Screening Level (Will and Suter, 1995a)
Mercury	0.1	ORNL Soil Screening Level (Will and Suter, 1995a)
Nickel	200	ORNL Soil Screening Level (Will and Suter, 1995a)
Selenium	70	ORNL Soil Screening Level (Will and Suter, 1995a)
Silver	50	ORNL Soil Screening Level (Will and Suter, 1995a)
Tin	0.89	EPA Region III BTAG Screening Level (EPA, 1995f)
Vanadium	20	ORNL Soil Screening Level (Will and Suter, 1995a)
Zinc	200	ORNL Soil Screening Level (Will and Suter, 1995a)
PESTICIDES/PCBs (µg/kg)		
4,4'-DDD	100	EPA Region III BTAG Screening Level (EPA, 1995f)
4,4'-DDE	100	EPA Region III BTAG Screening Level (EPA, 1995f)
4,4'-DDT	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Aldrin	100	EPA Region III BTAG Screening Level (EPA, 1995f)
alpha-BHC	100	EPA Region III BTAG Screening Level for Gamma-BHC (EPA, 1995f)
Dieldrin	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Endosulfan I	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Endosulfan II	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Endosulfan sulfate	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Endrin	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Endrin aldehyde	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Endrin ketone	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Gamma-BHC (lindane)	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Heptachlor	100	EPA Region III BTAG Screening Level for Heptachlor Epoxide (EPA, 1995f)
Heptachlor epoxide	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Methoxychlor	100	EPA Region III BTAG Screening Level (EPA, 1995f)
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)		
1,2-Dichlorobenzene	20,000	ORNL Soil Screening Level for 1,4-Dichlorobenzene (Will and Suter, 1995a)
1,3-Dichlorobenzene	20,000	ORNL Soil Screening Level for 1,4-Dichlorobenzene (Will and Suter, 1995a)
1,4-Dichlorobenzene	20,000	ORNL Soil Screening Level (Will and Suter, 1995a)
Anthracene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Benzo(a)anthracene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Benzo(a)pyrene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Benzo(b)fluoranthene	100	EPA Region III BTAG Screening Level (EPA, 1995f)

TABLE C.3-21

SURFACE SOIL THRESHOLD VALUES
NAS KEY WEST
PAGE 2 OF 2

Analyte	Benchmark Value	Source
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg) (continued)		
Benzo(g,h,i)perylene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Benzo(k)fluoranthene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Chlorobenzene	40,000	ORNL Soil Screening Level (Will and Suter, 1995a)
Chrysene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Dibenzo(a,h)anthracene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Fluoranthene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Indeno(1,2,3-cd)pyrene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Phenanthrene	100	ORNL Soil Screening Level (Will and Suter, 1995a)
Pyrene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
VOLATILE ORGANIC COMPOUNDS (µg/kg)		
1,1,2,2-tetrachloroethane	300	EPA Region III BTAG Screening Level (EPA, 1995f)
Carbon Tetrachloride	300	EPA Region III Screening Level (EPA, 1995f)
Cis-1,2-dichloroethene	300	EPA Region III BTAG Screening Level (EPA, 1995f)
Ethylbenzene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Methylene chloride	300	EPA Region III BTAG Screening Level (EPA, 1995f)
Tetrachloroethene	300	EPA Region III Screening Level (EPA, 1995f)
Toluene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Trans-1,4-dichloro-2-butene	100	EPA Region III BTAG Screening Level (EPA, 1995f)
Xylenes (total)	100	EPA Region III BTAG Screening Level (EPA, 1995f)

3.3.1.2.5 Selection of Terrestrial Plant Thresholds

Threshold values for initial screening of risk from soil contaminants to terrestrial plants were obtained from Will and Suter (1995b). However, terrestrial plant screening levels for several organics were not available from any source. It should be noted that the terrestrial plant thresholds for metals presented by Will and Suter (1995b) are very conservative, and in some cases, are lower than common background concentrations. This is probably because most toxicity tests used to derive these thresholds dose growth substrates with soluble salts of metals. As a result, they are much more bioavailable than most naturally occurring metals, and even metals at many, if not most, hazardous waste sites (Will and Suter, 1995b). The terrestrial plant thresholds used in this ERA are presented in Table C.3-22.

3.3.1.2.6 Derivation of Toxicity Reference Values

As mentioned above, potential risks to terrestrial and piscivorous receptors were also evaluated by foodchain modeling. These potential risks were evaluated by estimating the total potential dose received by receptor organisms and comparing these doses to toxicity reference values (TRVs), which are contaminant doses protective of these receptors. Information on the toxicity of environmental contaminants to terrestrial and piscivorous wildlife is generally limited. Most information generated to date involves impacts of agricultural contaminants on non-target wildlife species; little information exists on the impact of industrial chemicals and other contaminants on ecological receptors (Opresko et al., 1994). Furthermore, much of the data that are available reflect acute effects (e.g., mortality), and interpretation of the potential effects that long-term, chronic exposure to a contaminant might have on wildlife populations is difficult. Because of these and other data limitations, species-specific NOAELs for chronic exposures to a given contaminant must be derived from the results of toxicity tests performed on different species of wildlife or, more frequently, on laboratory animals.

When possible, NOAELs for surrogate species were obtained from the primary literature, EPA review documents, and secondary sources such as the Integrated Risk Information System (IRIS), Opresko et al. (1994), and Sample et al. (1996). If NOAELs were not available, LOAELs (lowest observed adverse effects levels) were obtained from these sources. NOAELs and LOAELs represent daily contaminant dose levels normalized to the body weight of the test animals. To reduce the need to extrapolate between data and to limit the uncertainty associated with deriving TRVs, emphasis was placed on those studies in which reproductive and developmental endpoints were considered (i.e., toxicity test endpoints indicative of potential population-level effects). These endpoints are also reflective of the assessment endpoints that were selected. Non-sensitive endpoints are primarily non-reproductive or non-development endpoints, such as decreased organ weights or histological anomalies.

**TABLE C.3-22
TERRESTRIAL PLANT THRESHOLD VALUES
NAS KEY WEST**

Analyte	Benchmark Value (mg/kg)	Source
INORGANICS		
Aluminum	50	Will and Suter (1995b)
Antimony	5	Will and Suter (1995b)
Arsenic	10	Will and Suter (1995b)
Barium	500	Will and Suter (1995b)
Beryllium	10	Will and Suter (1995b)
Cadmium	3	Will and Suter (1995b)
Chromium	1	Will and Suter (1995b)
Cobalt	20	Will and Suter (1995b)
Copper	100	Will and Suter (1995b)
Iron	10	Will and Suter for plants in solution (1995b)
Lead	50	Will and Suter (1995b)
Manganese	500	Will and Suter (1995b)
Mercury	0.3	Will and Suter (1995b)
Nickel	30	Will and Suter (1995b)
Selenium	1	Will and Suter (1995b)
Silver	2	Will and Suter (1995b)
Tin	50	Will and Suter (1995b)
Vanadium	2	Will and Suter (1995b)
Zinc	50	Will and Suter (1995b)
PESTICIDES/PCBs		
Aroclor 1260	40	Will and Suter (1995b)
SEMIVOLATILE ORGANIC COMPOUNDS		
Di-n-butyl phthalate	200	Will and Suter (1995b)
VOLATILE ORGANIC COMPOUNDS		
Toluene	200	Will and Suter (1995b)
Xylene	100	Will and Suter for plants in solution (1995b)

Although NOAELs were preferentially sought, these values were not uniformly available. In order to derive NOAEL values for each of the representative ecological receptors considered in this risk assessment, "Uncertainty Factors" (UFs) were applied to the available toxicity data. UFs are designed to account for the uncertainty associated with extrapolating from toxicity data experimentally obtained from one organism in order to estimate the potential toxic impact on another receptor organism, and account for the uncertainty associated with differences in test endpoints, types, parameters, as described below. The UFs used in this ERA were based on recommended values employed by Calabrese and Baldwin (1993) and those recommended by EPA Region IV. The following UFs were developed to account for the uncertainty associated with:

- Deriving NOAEL values from test results reported in terms of LOAEL values (UF = 10).
- Extrapolations of toxicity test data generated on test organisms to receptors belonging to a different class (UF = 10).

Although EPA Region IV does not specify the use of an uncertainty factor for class-to-class extrapolations, one was employed in this ERA due to the high degree of uncertainty involved in this type of extrapolation. This UF was used primarily for avian species when only mammalian data were available. Tables C.3-23 and C.3-24 summarizes the derivation of TRVs for each analyte and the receptor species considered in this ERA. These tables list the analyte, surrogate species used in each laboratory test evaluated, the endpoint used to quantify the toxic response of the surrogate organisms, and the laboratory test result [expressed as a dose (mg/kg/day)]. The UF values applied to these test results are also listed. Using the following formula, a "total uncertainty factor," defined as the product of the reciprocals of all applicable UFs, was calculated:

$$\text{Total Uncertainty Factor (TUF)} = (1/UFa \times 1/UFb)$$

Receptor-specific TRVs were then derived by multiplying the laboratory test result by the contaminant-specific total uncertainty factor:

$$\text{Receptor-Specific TRV (mg/kg/day)} = \text{TUF} \times \text{Laboratory Test Result (mg/kg/day)}$$

3.3.2 Preliminary Exposure Assessment and Risk Characterization

Section 3.3.2.1 describes the components of preliminary exposure assessment, and Section 3.3.2.2 describes the components of risk characterization.

TABLE C.3-23

DERIVATION OF TOXICITY REFERENCE VALUES FOR THE LOWER KEYS MARSH RABBIT, COTTON RAT, AND RACCOON
NAS KEY WEST
PAGE 1 OF 2

Contaminant	Test Species	Endpoint	Lab Test Result (mg/kg/day)	LOAEL to NOAEL UFa	Class to Class UFb	*Total Uncertainty Factor	**Derived TRV (mg/kg/day)	Source of Lab Test Result
INORGANICS								
Aluminum	Mouse	Reproduction; NOAEL	1.93E+00	1	1	1	1.93E+00	1
Antimony	Mouse	Longevity; LOAEL	1.25E+00	10	1	10	1.25E-01	1
Arsenic	Mouse	Reproduction; LOAEL	1.26E+00	10	1	10	1.26E-01	1
Barium	Rat	Growth; NOAEL	5.06E+00	1	1	1	5.06E+00	2
Beryllium	Rat	Reproduction; NOAEL	6.60E-01	1	1	1	6.60E-01	1
Cadmium	Rat	Reproduction; NOAEL	1.00E+00	1	1	1	1.00E+00	1
Chromium	Mouse	Body weights; NOAEL	3.28E+00	1	1	1	3.28E+00	1
Cobalt	Rat	Liver damage; LOAEL	1.57E+02	10	1	10	1.57E+01	3
Copper	Mink	Reproduction; NOAEL	1.51E+01	1	1	1	1.51E+01	1
Cyanide	Rat	Reproduction; LOAEL	6.87E+01	10	1	10	6.87E+00	4
Lead	Rat	Reproduction; NOAEL	8.00E+00	1	1	1	8.00E+00	1
Manganese	Rat	Reproduction; NOAEL	8.80E+01	1	1	1	8.80E+01	1
Mercury	Mouse	Reproduction; NOAEL	1.32E+01	1	1	1	1.32E+01	1
Nickel	Rat	Reproduction; NOAEL	4.00E+01	1	1	1	4.00E+01	1
Selenium	Rat	Reproduction; NOAEL	2.00E-01	1	1	1	2.00E-01	1
Silver	Rat	Mortality; LOAEL	1.81E+02	10	1	10	1.81E+01	5
Tin	Rat	Immunotoxicity; LOAEL	5.00E+00	10	1	10	5.00E-01	6
Vanadium	Rat	Reproduction; NOAEL	1.14E+01	1	1	1	1.14E+01	4
Zinc	Rat	Reproduction; NOAEL	1.60E+02	1	1	1	1.60E+02	1
PESTICIDES/PCBs								
4,4'-DDD	Rat	Reproduction; NOAEL	8.00E-01	1	1	1	8.00E-01	1
4,4'-DDE	Rat	Reproduction; NOAEL	8.00E-01	1	1	1	8.00E-01	1
4,4'-DDT	Rat	Reproduction; NOAEL	8.00E-01	1	1	1	8.00E-01	1
Alpha-BHC	Mink	Reproduction; LOAEL	1.37E-01	10	1	10	1.37E-02	1
Aroclor-1260	Mouse	Reproduction; LOAEL	1.35E+00	10	1	10	1.35E-01	4
Beta-BHC	Mink	Reproduction; LOAEL	1.37E-01	10	1	10	1.37E-02	1
2,4-D	Rat	Blood/Liver/Kidney; NOAEL	1.00E+00	1	1	1	1.00E+00	6
2,4,5-T	Rat	Reproduction; NOAEL	3.00E+00	1	1	1	3.00E+00	6
2,4,5-TP (Silvex)	Dog	Growth/Blood; NOAEL	7.50E-01	1	1	1	7.50E-01	6
Endosulfan I	Rat	Reproduction; NOAEL	1.50E+00	1	1	1	1.50E+00	1
Endosulfan II	Rat	Reproduction; NOAEL	1.50E+00	1	1	1	1.50E+00	1
Endrin	Mouse	Reproduction; LOAEL	9.20E-01	10	1	10	9.20E-02	4
Heptachlor epoxide	Mink	Reproduction; NOAEL	1.00E-01	1	1	1	1.00E-01	1
Heptachlor	Mink	Reproduction; NOAEL	1.00E-01	1	1	1	1.00E-01	1

TABLE C.3-23

DERIVATION OF TOXICITY REFERENCE VALUES FOR THE LOWER KEYS MARSH RABBIT, COTTON RAT, AND RACCOON NAS KEY WEST

Contaminant	Test Species	Endpoint	Lab Test Result (mg/kg/day)	LOAEL to NOAEL UFa	Class to Class UFb	*Total Uncertainty Factor	**Derived TRV (mg/kg/day)	Source of Lab Test Result
SEMIVOLATILE ORGANIC COMPOUNDS								
Benzo(a)anthracene		NA						
Benzo(a)pyrene	Mouse	Reproduction; LOAEL	1.00E+01	10	1	10	1.00E+00	1
Benzo(b)fluoranthene		NA						
Benzo(g,h,i)perylene		NA						
Benzo(k)fluoranthene		NA						
Bis(2-ethylhexyl)phthalate	Mouse	Reproduction; NOAEL	1.83E+01	1	1	1	1.83E+01	1
Chrysene		NA						
Fluoranthene	Mouse	Reproduction; NOAEL	1.25E+02	1	1	1	1.25E+0 2	7
Indeno(1,2-cd)pyrene		NA						
Phenanthrene		NA						
Pyrene	Mouse	Kidney lesions; NOAEL	7.50E+01	1	1	1	7.50E+01	8
VOLATILE ORGANIC COMPOUNDS								
1,1,2,2-tetrachloroethene	Mouse	Liver damage; NOAEL	2.00E+01	1	1	1	2.00E+01	1
4-methyl-2-pentanone	Rat	Liver/Kidney damage; NOAEL	2.50E+01	1	1	1	2.50E+01	1
2-chloro-1,3-butadiene		NA						
1,2-dichlorobenzene		NA						
1,3-dichlorobenzene		NA						
1,4-dichlorobenzene		NA						
2-butanone	Rat	Birth weights; NOAEL	1.77E+03	1	1	1	1.77E+03	6
Acetone	Rat	Liver/Kidney: NOAEL	1.00E+02	1	1	1	1.00E+02	1
Carbon Tetrachloride	Rat	Reproduction; NOAEL	1.60E+01	1	1	1	1.60E+01	1
Cis-1,2-dichlorethene	Mouse	Hepatic function; NOAEL	4.52E+02	1	1	1	4.52E+02	1
Ethylbenzene	Rat	Liver histology; LOAEL	4.08E+02	10	1	10	4.08E+01	6
Methylene chloride	Rat	Liver histology; NOAEL	5.85E+00	1	1	1	5.85E+00	1
Toluene	Mouse	Reproduction; LOAEL	2.60E+02	10	1	10	2.60E+01	4
Xylene	Mouse	Reproduction; NOAEL	2.06E+00	1	1	1	2.06E+00	1

NA = Not Available

1 Sample et al. (1996)
2 Opresko et al. (1994)
3 ~~ATSDR (1991)~~
4 Will and Suter (1995a)
5 ATSDR (1990)
6 IRIS (1995)
7 ~~IRIS (1990)~~
8 USEPA (1989e)

UFa = LOAEL to NOAEL

UFb = Class to Class

*Total Uncertainty Scaling Factor = (1/UFa*1/UFb)
**Derived Wildlife TRV = Lab Test Endpoint * Scaling Factor

TABLE C.3-24

DERIVATION OF TOXICITY REFERENCE VALUES FOR THE AMERICAN KESTREL AND GREAT BLUE HERON
NAS KEY WEST

Contaminant	Test Species	Endpoint	Lab Test Result (mg/kg/day)	LOAEL to NOAEL UFa	Class to Class UFb	*Total Uncertainty Factor	**Derived TRV (mg/kg/day)	Source of Lab Test Result
INORGANICS								
Aluminum	Dove	Reproduction; NOAEL	1.10E+02	1	1	1	1.10E+02	1
Antimony	Mouse	Longevity; LOAEL	1.25E+00	10	10	100	1.25E-02	1
Arsenic	Mouse	Reproduction; LOAEL	1.26E+00	10	10	100	1.26E-02	1
Barium	Rat	Growth; NOAEL	5.06E+00	1	10	10	5.06E-01	2
Beryllium	Rat	Reproduction; NOAEL	6.60E-01	1	10	10	6.60E-02	1
Cadmium	Mallard	Reproduction; NOAEL	1.45E+00	1	1	1	1.45E+00	1
Chromium	Black Duck	Reproduction; NOAEL	1.00E+00	1	1	1	1.00E+00	1
Cobalt	Rat	Liver damage; LOAEL	1.57E+02	10	10	100	1.57E+00	3
Copper	Chicks	Growth; NOAEL	4.70E+01	1	1	1	4.70E+01	1
Cyanide	Rat	Reproduction; LOAEL	6.87E+01	10	10	100	6.87E-01	4
Lead	Kestrel	Reproduction; NOAEL	3.85E+00	1	1	1	3.85E+00	1
Manganese	Quail	Growth; NOAEL	9.77E+02	1	1	1	9.77E+02	1
Mercury	Quail	Reproduction; NOAEL	4.50E-01	1	1	1	4.50E-01	1
Nickel	Rat	Reproduction; NOAEL	4.00E+01	1	10	10	4.00E+00	1
Selenium	Heron	Reproduction; NOAEL	1.80E+00	1	1	1	1.80E+00	1
Silver	Rat	Mortality; LOAEL	1.81E+02	10	10	100	1.81E+00	5
Tin	Quail	Reproduction; NOAEL	6.80E+00	1	1	1	6.80E+00	1
Vanadium	Mallard	Body weight; NOAEL	1.14E+01	1	1	1	1.14E+01	4
Zinc	Hens	Reproduction; NOAEL	1.45E+01	1	1	1	1.45E+01	1
PESTICIDES/PCBs								
2,4,5-T	Rat	Reproduction; NOAEL	3.00E+00	1	10	10	3.00E-01	6
2,4,5-TP (Silvex)	Dog	Growth/Blood; NOAEL	7.50E-01	1	10	10	7.50E-02	6
2,4-D	Rat	Blood/Liver/Kidney; NOAEL	1.00E+00	1	10	10	1.00E-01	6
4,4'-DDD	Pelican	Reproduction; NOAEL	2.80E-03	1	1	1	2.80E-03	1
4,4'-DDE	Pelican	Reproduction; NOAEL	2.80E-03	1	1	1	2.80E-03	1
4,4'-DDT	Pelican	Reproduction; NOAEL	2.80E-03	1	1	1	2.80E-03	1
Aldrin	Rat	Reproduction; NOAEL	2.00E+00	1	10	10	2.00E-01	1
Alpha-BHC	Quail	Reproduction; NOAEL	5.60E-01	1	1	1	5.60E-01	1
Aroclor-1260	Pheasant	Reproduction; NOAEL	1.80E-01	1	1	1	1.80E-01	1
Beta-BHC	Quail	Reproduction; NOAEL	5.60E-01	1	1	1	5.60E-01	1
Chlorobenzilate		NA						
Delta-BHC	Quail	Reproduction; NOAEL	5.60E-01	1	1	1	5.60E-01	1
Dieldrin	Owl	Reproduction; NOAEL	7.70E-02	1	1	1	7.70E-02	1

TABLE C.3-24

DERIVATION OF TOXICITY REFERENCE VALUES FOR THE AMERICAN KESTREL AND GREAT BLUE HERON
NAS KEY WEST
PAGE 2 OF 3

Contaminant	Test Species	Endpoint	Lab Test Result (mg/kg/day)	LOAEL to NOAEL UFa	Class to Class UFb	*Total Uncertainty Factor	**Derived TRV (mg/kg/day)	Source of Lab Test Result
Endosulfan I	Partridge	Reproduction; NOAEL	1.00E+01	1	1	1	1.00E+01	1
Endosulfan II	Partridge	Reproduction; NOAEL	1.00E+01	1	1	1	1.00E+01	1
Endosulfan sulfate	Partridge	Reproduction; NOAEL	1.00E-01	1	1	1	1.00E-01	1
Endrin	Mallard	Reproduction; NOAEL	3.00E-01	1	1	1	3.00E-01	1
Endrin aldehyde	Mallard	Reproduction; NOAEL	3.00E-01	1	1	1	3.00E-01	1
Gamma-BHC	Quail	Reproduction; NOAEL	5.60E-01	1	1	1	5.60E-01	1
Heptachlor	Mink	Reproduction; NOAEL	1.00E-01	1	10	10	1.00E-02	1
Heptachlor epoxide	Mink	Reproduction; NOAEL	1.00E-01	1	10	10	1.00E-02	1
Isodrin		NA						
Methoxychlor	Rat	Reproduction; NOAEL	4.00E+00	1	10	10	4.00E-01	1
SEMIVOLATILE ORGANIC COMPOUNDS								
Benzo(a)anthracene		NA						
Benzo(a)pyrene	Mouse	Reproduction; LOAEL	1.00E+01	10	10	100	1.00E-01	1
Benzo(b)fluoranthene		NA						
Benzo(g,h,i)perylene		NA						
Benzo(k)fluoranthene		NA						
Bis(2-ethylhexyl)phthalate	Dove	Reproduction; NOAEL	1.10E+00	1	1	1	1.10E+00	1
Chrysene		NA						
Fluoranthene	Mouse	Reproduction; NOAEL	1.25E+02	1	10	10	1.25E+01	7
Indeno(1,2-cd)pyrene		NA						
Phenanthrene		NA						
Phenol		NA						
Pyrene	Mouse	Kidney lesions; NOAEL	7.50E+01	1	10	10	7.50E+00	8
VOLATILE ORGANIC COMPOUNDS								
1,1,2,2-tetrachloroethene	Mouse	Liver damage; NOAEL	2.00E+01	1	10	10	2.00E+00	1
1,2-dichlorobenzene		NA						
1,3-dichlorobenzene		NA						
1,4-dichlorobenzene		NA						
2-butanone	Rat	Birth weights; NOAEL	1.77E+03	1	10	10	1.77E+02	6
2-chloro-1,3-butadiene		NA						
4-methyl-2-pentanone	Rat	Liver/Kidney damage; NOAEL	2.50E+01	1	10	10	2.50E+00	1
~~Acetone~~	~~Rat~~	~~Liver/Kidney; NOAEL~~	~~1.00E+02~~	~~1~~	~~10~~	~~10~~	~~1.00E+01~~	~~1~~
Carbon Tetrachloride	Rat	Reproduction; NOAEL	1.60E+01	1	10	10	1.60E+00	1
Cis-1,2-dichlorethene	Mouse	Hepatic function; NOAEL	4.52E+02	1	10	10	4.52E+01	1
Ethylbenzene	Rat	Liver histology; LOAEL	4.08E+02	10	10	100	4.08E+00	6

TABLE C.3-24

DERIVATION OF TOXICITY REFERENCE VALUES FOR THE AMERICAN KESTREL AND GREAT BLUE HERON
NAS KEY WEST
PAGE 3 OF 3

Contaminant	Test Species	Endpoint	Lab Test Result (mg/kg/day)	LOAEL to NOAEL UFa	Class to Class UFb	*Total Uncertainty Factor	**Derived TRV (mg/kg/day)	Source of Lab Test Result
Methylene chloride	Rat	Liver histology.; NOAEL	5.85E+00	1	10	10	5.85E-01	1
Toluene	Mouse	Reproduction; LOAEL	2.60E+02	10	10	100	2.60E+00	4
Xylene	Mouse	Reproduction; NOAEL	2.06E+00	1	10	10	2.06E-01	1

NA = Not Available

1 Sample et al. (1996)
2 Opresko et al. (1994)
3 ATSDR (1991)
4 Will and Suter (1995a)
5 ATSDR (1990)
6 IRIS (1995)
7 IRIS (1990)
8 USEPA (1989e)

UFa = LOAEL to NOAEL

UFb = Class to Class

*Total Uncertainty Scaling Factor = (1/UFa*1/UFb)
**Derived Wildlife TRV = Lab Test Endpoint * Scaling Factor

3.3.2.1 Preliminary Exposure Assessment

In order to perform a preliminary exposure assessment, exposure point contaminant concentrations are determined for comparison to ecological threshold values. Exposure point contaminant concentrations are also used in dose calculations. These elements of the preliminary exposure assessment are described below.

3.3.2.1.1 Exposure Point Contaminant Concentrations

Data used to obtain contaminant concentrations in environmental media used for this ERA were those generated from 1996 RFI/RI Phase II and previous sampling activities. The maximum detected concentrations of analytes in current and previous surface-water, sediment, and surface soil samples were used as representative exposure point concentrations for screening against threshold values. Groundwater was assessed by using samples collected during 1996 from monitoring wells nearest to adjacent surface-water bodies, in accordance with FDEP guidance (Caspary, 1997). Data from these samples most accurately depicts potential groundwater to surface water discharge of contaminants. Background data are presented for comparative purposes and were obtained from background sampling conducted on and near NAS Key West. Background sampling is described in detail in Appendix F of the Supplemental RFI/RI Report.

3.3.2.1.2 Dose Calculations

As discussed in Section 3.3.1.2, the potential risks to ecological receptors resulting from exposure to site-related contaminants were also evaluated by estimating the total contaminant doses that organisms on the site might receive and comparing them to doses above which adverse effects may occur. Foodchain modeling was used to estimate doses to the Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*), the cotton rat (*Sigmodon hispidus*), the raccoon (*Procyon lotor*), the American kestrel (*Falco sparverius)*, and the great blue heron (*Ardea herodias*).

Terrestrial foodchain modeling was performed since soil screening benchmarks are scarce and most available benchmarks are based only on potential risks to soil invertebrates. The terrestrial foodchain model utilized measured contaminant concentrations in soil to estimate the transfer of soil contaminants to plants as well as the plant-to-herbivore and herbivore-to-carnivore transfer of contaminants. However, vegetation was collected for laboratory analyses of metals, pesticides, and PCBs at SWMUs 4, 5, and 7. As a result, actual concentrations of metals, pesticides, and PCBs in vegetation were used at these three sites.

Terrestrial foodchain modeling was performed for SWMUs 4, 5, and 7; IRs 7 and 8; and AOC B but was not performed for IRs 1 and 3. Sufficient terrestrial habitat and potentially contaminated surface soil exist at SWMUs 4, 5, and 7; IRs 7 and 8; and AOC B, such that receptor use of the areas could potentially be long enough to result in significant contaminant exposure. However, IRs 1 and 3 do not contain significant terrestrial habitat, and hence, terrestrial receptor use of these areas is negligible. In addition, much of the contaminated surface soil at both of these sites was removed during interim remediation activities. As a result of this remediation, and because the sites contain only small areas of terrestrial habitat (which consists of mowed grass), subsequent exposure to contaminated surface soils would be insignificant. For these reasons, terrestrial foodchain modeling at IRs 1 and 3 was not performed.

Aquatic foodchain modeling utilized measured contaminant concentrations in minnows collected at SWMU 4, SWMU 5, and AOC B to estimate contaminant doses to the great blue heron from ingestion of fish. Measured contaminant concentrations in crabs collected at IR 7, IR 8, and AOC B (and estimated contaminant concentrations in crustaceans at SWMU 7) were utilized to estimate contaminant doses to the raccoon.

Criteria considered in the selection of representative terrestrial species used in the foodchain model included the relationship of the representative species to species or guilds associated with the site, consistency of potential exposure pathways with the species being selected, the recreational or aesthetic value of the species, and the probability that these representative species might be maximally exposed to site contaminants. As mentioned above, receptor species selected for foodchain modeling consisted of the Lower Keys marsh rabbit, cotton rat, raccoon, American kestrel, great blue heron. Table C.3-25 presents exposure parameters for each receptor used in the model.

The Lower Keys marsh rabbit was used as a receptor species for foodchain modeling at SWMUs 4, 5, and 7. This species is listed as endangered by the Florida Game and Fresh Water Fish Commission and the FWS, and a management plan to stabilize the rabbit's population is being implemented. Historically, marsh rabbits were found from Big Pine Key to Key West, encompassing a linear distance of approximately 30 miles (Layne, 1974; Hall, 1981). At present the marsh rabbit is found on 36 patches of habitat on Big Pine Key, Saddlebunch/Sugarloaf Key, and Boca Chica Key, and the total population numbers between 150 and 400 rabbits (FWS, 1994).

The home range of the Lower Keys marsh rabbit averages about 1.21 ha (FWS, 1994). The preferred habitat of this species is an ecotonal mixture of trees and shrubs known as the buttonwood transition zone, an area dominated by grasses and sedges, with buttonwood (*Conocarpus erectus*) the dominant

TABLE C.3-25

EXPOSURE PARAMETERS FOR ECOLOGICAL RECEPTORS
NAS KEY WEST

Receptor	Guild	Parameter	Value	Reference
Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*)	Herbivore	Body Weight	1,224 grams	FWS (1994)
		Food Ingestion	101.4 grams/day	Estimated from Nagy (1987)
		Soil Ingestion	6.3% of diet	Based on jackrabbit diet (EPA, 1993)
		Home range	1.21 ha	FWS (1994)
Cotton rat (*Sigmodon hispidus*)	Herbivore	Body Weight	103.4 grams	Average of males and females (Cothran et al., 1991)
		Food Ingestion	8.5 grams/day	Estimated from Nagy (1987)
		Soil Ingestion	2.8% of diet	EPA (1993)
		Home Range	0.75 ha	Average of males and females (Cothran et al., 1991)
American kestrel (*Falco sparverius*)	Carnivore (Avian)	Body Weight	138 grams	Migratory kestrels wintering in Florida (EPA, 1993)
		Food Ingestion	40.0 grams/day	Based on 0.29 g/g body weight/day EPA (1993)
		Soil Ingestion	NA	Sample and Suter (1994)
		Home Range	9.7 to 601 ha	EPA (1993)
Great blue heron (*Ardea herodias*)	Piscivore (Avian)	Body Weight	2,229 grams	EPA (1993)
		Food Ingestion	401 grams/day	Based on 0.18 g/g body weight/day (EPA, 1993)
		Soil Ingestion	NA	Sample and Suter (1994)
		Feeding Territory	0.6 to 8.4 ha	EPA (1993)
Raccoon (*Procyon lotor*)	Carnivore (Mammalian)	Body Weight	4,310 grams	EPA (1993)
		Food Ingestion	228.0 grams/day	Estimated from Nagy (1987)
		Soil Ingestion	9.4% of diet	EPA (1993)
		Home Range	39-65 ha	Home range for a Georgia coastal island (EPA, 1993)

NA = Not applicable since soil ingestion by raptors and great blue heron is assumed to be negligible (Sample and Suter, 1994).

tree. Other habitats, such as low marsh, mangrove-dominated areas, and beach berms are also utilized. Seashore dropseed (*Sporobolus virginicus* and *Sporobolus spartinae*) comprises the majority of the rabbit's diet, while white and red mangrove and sea oxeye daisy are also common food items (FWS, 1994). Rabbit scat was commonly observed by B&R Environmental biologists at SWMU 7, and to a lesser extent, in the marsh adjacent to SWMU 4. No signs of the marsh rabbit were observed at SWMU 5, but marsh rabbits have been observed approximately 500 feet northwest of the site (Schuetz, 1997). Since the marsh rabbit spends most of its life in close proximity to the ground and its home range is small, it could potentially spend a significant amount of time on SWMUs 4 and 7 and could be in contact with potentially contaminated surface soil. Marsh rabbits probably spend little time (if any) at SWMU 5 and in the vicinity, due to the overall lack of suitable habitat at and near the site. However, as a conservative measure due to their endangered status, they were used as representative herbivorous species in the foodchain modeling at SWMU 5. Since marsh rabbit habitat does not exist at the other five sites, foodchain modeling of this species was limited to SWMUs 4, 5, and 7.

The cotton rat, a small herbivore found throughout Florida and the southeastern U.S., was selected as a species representative of rodents at SWMUs 4, 5, 7, IRs 7 and 8, and AOC B. Cotton rats inhabit areas of tall grass and weeds, grassy ditches, and thickets. Their diet consists primarily of vegetation but also includes insects and the young of small mammals and birds. (Bee et al., 1981). Cotton rats would be expected to ingest soil and herbaceous plants which could expose them to soil contaminants. The cotton rat's range is relatively small, averaging 0.75 ha (Cothran et al., 1991). As a result, it may spend all of its lifetime on or near areas of localized contamination. The cotton rat is preyed upon by raptors and snakes in the Lower Keys.

Few native terrestrial carnivores occur in the Key West area. Avian predators that feed primarily on terrestrial species are largely absent from the Keys. For example, red-tailed hawks are rare migrants during the winter and are absent during the breeding season, and red-shouldered hawks are uncommon in the Keys (FNAI, 1994). The American kestrel was chosen as a representative avian carnivorous receptor in the foodchain modeling because it is one of the two most common avian predators at NAS Key West. Ospreys are also common, but they feed almost exclusively on fish. Although kestrels are not known to breed in the Keys, they are common from September through April and were frequently observed by B&R Environmental biologists during sampling activities. Kestrels are found in a variety of habitats and are more likely to use habitats near human activities than are most other raptors. Kestrels prey on small animals including insects, amphibians, reptiles, mammals and birds. In winter, small mammals and birds comprise most of the diet (EPA, 1993). The kestrel was selected as a species representative of avian carnivores at SWMUs 4, 5, 7, IRs 7 and 8, and AOC B.

The great blue heron was selected as a representative piscivorous receptor at SWMU 4, SWMU 5, and AOC B. This heron inhabits a variety of freshwater and marine areas throughout North America and is found in the Florida Keys throughout the year. Great blue herons in the Florida Keys often consist of a white color morph and are known locally as the "great white heron" (Kale and Maehr, 1990). Fish are the preferred prey, and fish usually comprise about 90 to 98 percent of the diet (EPA, 1993). However, these herons will occasionally eat insects, crustaceans, amphibians, reptiles, and small mammals. The feeding territory size shown in Table C.3-25 (0.6 to 8.4 ha) refers to the area that is defended by individual herons. However, herons in some areas do not defend specific territories and often lack fidelity to particular feeding sites (EPA, 1993). A home range size was not available in the literature.

No true native carnivorous mammals are present in the Key West area. The only true carnivorous mammals in the Key West area are non-native feral cats and the raccoon, which is omnivorous. Raccoons are opportunistic feeders and will forage on a wide variety of animal and plant matter (EPA, 1993). They are highly adapted to urban environments and frequently feed on garbage and other refuse. This is most likely the case in the Key West area, which is limited in size and relatively developed. However, in a conservative attempt to include all possible terrestrial guilds in the foodchain modeling, the raccoon was chosen as a mammalian carnivore. Since most of the sites evaluated in this ERA contain mostly aquatic habitats, the raccoon was conservatively assumed to forage exclusively on aquatic organisms. Raccoons are found in virtually any aquatic habitat, including mangroves and saltwater marshes (EPA, 1993).

Modeling of potential risks to the raccoon was performed at AOC B, IR 7, IR 8, and SWMU 7. These sites contain sufficient suitable habitat for the raccoon and had biomagnifiable contaminants in sediments or forage (mercury, PCBs, and organochlorine pesticides). Raccoons were conservatively assumed to forage exclusively on aquatic organisms from these three sites. Contaminant concentrations present in crabs from those sites, including mud crabs, stone crabs, spiny spider crabs, and blue crabs, were used as prey concentrations for the raccoon. Crustaceans are common forage items for raccoons in marine and estuarine environments while fish usually comprise less than 3 percent of the diet (EPA 1996b). The raccoon is the primary mammalian predator of the blue crab (Versar, Inc., 1992). However, no crab data or data from similar crustaceans or other food items were available for SWMU 7. Therefore, contaminant concentrations in sediment-associated organisms (crabs) were modeled at that site. Bioaccumulation factors for organics in crabs were calculated using the following formula (Markwell et al., 1989):

$$BAF = YL/(foc)(0.66)$$

where:

BAF	=	Bioacumulation Factor
YL	=	percent lipid
foc	=	fraction or organic carbon in sediments

For organics, a percent lipid value was not available for crabs. Hence, a percent lipid value for lobsters, a similar species, of 3 percent was obtained from the literature (Jorgenson et al., 1991). This was the most conservative lipid value available for this type of organism. No site-specific organic carbon data were available, so a default value of 1 percent was used, as recommended by EPA (EPA, 1996a). For mercury, a BAF for crabs was also unavailable, so a BAF of 129 for the lobster was used (EPA, 1985). The BAFs for all biomagnifiable contaminants were then multiplied by the site-specific sediment contaminant concentrations to obtain contaminant concentrations in raccoon prey (crabs).

For the terrestrial model utilized in this ERA, contaminant concentrations in vegetation were first estimated from soil contaminant concentrations (except at SWMUs 4, 5, and 7, where measured concentrations of metals, pesticides, and PCBs in vegetation were available). The concentration of a contaminant in vegetation is a function of both aerial deposition on the plant surfaces and the root uptake of contaminant from soil. Airborne contamination was not considered to be a factor on the station. Therefore, only concentrations of contaminants measured in soil were used to estimate plant contaminant concentrations. Maximum soil contaminant concentrations were used as conservative exposure point contaminant concentrations. However, since the use of maximum concentrations may tend to overestimate risk, mean measured concentrations in soil were also used to estimate plant contaminant concentrations to obtain a risk range.

Plant uptake of metals and selected organic compounds from soil was estimated. The organic compounds were limited to plant hormone-like substances such as 2,4-D and 2,4,5-T, which are absorbed by plants from soil. This decision was based on the dynamics of plant uptake, distribution, metabolism, and elimination of organic contaminants, as discussed below, and was approved by EPA (Wellman, 1997) and FDEP (Wolfe, 1997).

Soil-to-plant transfer of organic contaminants and distribution in plants is primarily a function of the solubility of the chemical in water (McFarlane, 1995). Other properties, including functional groups and molecular weight, appear to have little influence on systematic properties. There is no evidence of active uptake of anthropogenic chemicals in roots, indicating that uptake is a passive process, largely controlled by chemical solubility in water (McFarlane, 1995). Lipophilic compounds, or water-insoluble compounds, are unlikely to be appreciably translocated in plants (Bromilow and Chamberlain, 1995; Will and Suter, 1995b). Several PAH compounds, PCBs, and organochlorine pesticides have been detected in soils at the sites under investigation. These compounds generally have high octanol/water partition coefficients, indicating that they are lipophilic and are unlikely to be translocated into vegetation. In addition, these classes of organic contaminants have high organic carbon partitioning coefficients, and therefore, have a strong affinity for soil organic carbon. Thus, they will have a tendency to bind to soil organic carbon and not be available in the soil aqueous phase.

Although several VOCs, which are less lipophilic than the compounds mentioned above, were detected in soils at sites currently under investigation, it is also unlikely that they exist in appreciable levels in plant tissue. The rapid flux of water through plants tends to flush pollutants to areas where volatile chemicals may volatilize and leave the plant (McFarlane, 1995). Moreover, VOCs generally have high Henry's Law constants. Compounds with high Henry's Law constants also do not appreciably enter plants via the roots; they are usually taken up by plant foliage via the vapor phase (Bromilow and Chamberlain, 1995). This type of exposure is usually associated with pesticide applications and industrial spills. These scenarios are not relevant to the assessment of ecological risks at the sites under investigation. It is also widely known that plants possess a high metabolic capacity for a variety of polar and non-polar contaminants (Kamosa et al., 1995). As a result, they would be expected to readily metabolize simple, small molecules such as most VOCs. However, plant hormone-like chemicals, such as 2,4-D and 2,4,5-T, may be actively transported across root membranes. For these reasons, the organic compounds used in food chain modeling were limited to plant hormone-like substances such as 2,4-D and 2,4,5-T. Uptake of these compounds in plants and subsequent potential risks to herbivores was modeled when these compounds were detected in soil samples.

The concentration of a contaminant in vegetation due to root uptake is a function of the soil concentration and a contaminant-specific soil-to-plant biotransfer factor (partitioning coefficient). Soil-to-plant biotransfer factors were obtained from Baes et al. (1994). Methods developed by the California Air Pollution Control Officers' Association (CAPCOA, 1993) were adapted to calculate uptake of contamination by plants from soil through the following formula:

$$PC_{vegetation} = C_{soil} \times BF$$

where:

$PC_{vegetation}$	=	Predicted concentration in vegetation
C_{soil}	=	Concentration in soil
BF	=	Soil-to-plant Biotransfer Factor

Contaminant concentrations in vegetation predicted with these models were used to represent potential contaminants present in the food items of the Lower Keys marsh rabbit and the cotton rat. Subsequently, the modeled or measured concentrations of contaminants in plants and the measured concentrations in soil were multiplied by transfer factors obtained from Baes et al. (1984) to estimate the concentrations of contaminants in prey (small mammals) to which kestrels would be exposed. For the great-blue heron, measured concentrations in prey (minnows) were available for the sites where this piscivore was used as a representative receptor. Therefore, modeling of contaminant concentrations in prey was not necessary. Similarly for the raccoon, measured concentrations in prey (crabs) were available at SWMU 4, SWMU 5, and AOC B, where this mammal was used as a representative receptor. Therefore, modeling of contaminant concentrations in prey was not necessary at these three sites. The raccoon was used as a representative receptor at SWMU 7, where measured concentrations in prey were not available. The procedure used to estimate concentrations of contaminants in raccoon prey items at SWMU 7 is discussed in Section 3.3.2.1.2.1.

3.3.2.1.2.1 Dose Calculation for the Ingestion of Vegetation or Prey

The transport of contaminants through the foodchain for terrestrial ecological receptors is a potential concern at NAS Key West. The equation used to estimate contaminant intake from ingestion of contaminated food items is as follows:

$$PD_{ingestion\ of\ vegetation} = \frac{PC_{vegetation} * F * FV * FI * AF}{WR * CF}$$

$$PD_{ingestion\ of\ prey} = \frac{PC_{prey} * F * FA * FI * AF}{WR * CF}$$

where:

PD	=	Predicted dose from ingestion of food items (vegetation or prey; mg/kg/day)
PC	=	Predicted contaminant concentration (vegetation or prey; mg/kg)
F	=	Food consumed (mg/day)

FV = Vegetation as a percentage of diet

FA = Animals as a percentage of diet

FI = Fractional intake (percent of home range that overlaps impacted area; assumed to equal 100 percent)

AF = Absorption fraction (unitless)

WR = Weight of receptor (kg)

CF = Conversion factor (kg to mg)

An absorption fraction of 80 percent was used (i.e., 80 percent of the ingested contaminant was absorbed) for the dose calculations described for the intake of vegetation, prey, and soil. Actual absorption fractions range widely for most animal species (Bonaccorsi et al., 1984). Once ingested, the bioavailabilty of a contaminant depends upon a variety of factors, including physiochemical properties of the contaminant, the physiological characteristics of the organism, and other general factors such as age, sex, or disease state of the individual (Hrudey et al., 1996). Although limited, available data for oral exposure indicate that absorption of metals can be as low as 24 percent (arsenic; Freeman et al., 1993) and absorption of organics have been reported at levels of 48 percent for phenol (Capel et al., 1972) and 29 to 68 percent for TCDD (Bonaccorsi et al. 1984). Thus, based on available data, the absorption factor of 80 percent used in this assessment is still a conservative value for this parameter.

3.3.2.1.2.2 Dose Calculation for the Incidental Ingestion of Soil or Sediment

The estimation of intake of contaminants in soil or sediment was determined using the maximum and mean measured soil concentration of a given contaminant. Daily intake of contaminants as a result of ingestion of soil was determined using the following equation:

$$PD_{\text{ingestion of soil}} = \frac{PC_{soil} * FI * SA * AF * F}{WR * CF}$$

where:

PD = Predicted dose from ingestion of soil (mg/kg/day)

PC = Predicted contaminant concentration in soil (mg/kg)

FI = Fractional intake (percent of home range that overlaps impacted area; assumed to equal 100 percent)

SA = Percent of diet that equals soil

AF = Absorption fraction (unitless)

F = Food consumed (mg/kg)

WR = Body weight (kg)

CF = Conversion factor (kg to mg)

3.3.2.1.2.3 Calculating Dose Received from the Ingestion of Water

There is no freshwater at any of the eight sites under investigation except at SWMU 4, where a small ditch adjacent to Midway Avenue contains freshwater. Marsh rabbits are believed to need little freshwater to survive (FWS, 1994). Marsh rabbits are found on several isolated islands that consist of only mangroves and salt marsh areas, and have one of the highest urinary concentrating capabilities of all mammals found in the Florida Keys (Dunson and Lazell, 1982). Apparently, marsh rabbits and cotton rats can survive solely on dew and herbaceous water, and perhaps brackish water. A source of freshwater is not critical to kestrels, as they obtain an adequate supply of water from prey items (FGFWFC, 1993). These species, as well as the great blue heron and raccoon, are assumed to obtain their required water from sources other than the sites under investigation. Therefore, exposure to contaminants in surface water at the sites is assumed to be negligible, and the calculation of contaminant dose from the ingestion of water was not performed.

3.3.2.2 Risk Characterization

Risk characterization, the second step in the ecological risk assessment process, compares representative exposure point contaminant concentrations to thresholds and estimated contaminant intake doses to toxicity reference values, as well as an evaluation of tissue analyses. All of these data were used in a "weight-of-evidence" approach to determine potential ecological risks. Once this step was completed for this study, the results were reviewed to determine whether little or no ecological risk is associated with activities at the sites under investigation or additional information must be generated to verify that ecological receptors are at risk. The ratio of the exposure point contaminant concentration to the threshold value or the intake dose to the TRV is called the HQ, and is defined as follows:

$$HQ_i = EPC_i \text{ or } ID_i/BTV_i \text{ or } TRV_i$$

where:

HQ_i = Hazard Quotient for contaminant "i" (unitless)

EPC_i = Exposure Point Concentration for contaminant "i" (mg/L or mg/kg)

BTV_i = Threshold Toxicity Value for contaminant "i" (mg/L or mg/kg)

ID_i = Intake Dose for contaminant "i" (mg/kg/day)

TRV_i = Toxicity Reference Value for contaminant "i" (mg/kg/day)

When the ratio of the exposure point concentration to its respective threshold value exceeded 1.0, potential adverse impacts were considered possible, and the contaminant was retained as an COPC. The HQ value should not be construed as being probabilistic; rather, it is a numerical indicator of the extent to which an exposure point concentration exceeds or is less than a threshold. When HQ values exceed 1.0, it is an indication that ecological receptors are potentially at risk; additional evaluation or data may be necessary to confirm with greater certainty whether ecological receptors are actually at risk, especially since most thresholds are conservatively derived, as discussed in Section 3.3.1.2. Furthermore, other factors, such as low frequency of detection, may mitigate potential risks for a COPC with an elevated HQ value. As a result of the conservatism inherent in most threshold derivation, EPA Region III (1994d) has suggested that HQs greater than one are indicative of low to moderate potential risk; HQs greater than 10 are indicative of moderately high potential risk; and HQs greater than 100 are indicative of high potential risk. However, these designations are applied with caution, since not all threshold values were derived using the same endpoints.

The use of HQs is probably the most common method used for risk characterization in ERAs. Advantages of this method, according to Barnthouse et al. (1986), include the following:

- The HQ method is relatively easy to use, is generally accepted, and can be applied to any data.
- The method is useful when a large number of contaminants must be screened.

This method of risk characterization has some inherent limitations. One primary limitation is that it is a "no/maybe" method for relating exposure to toxicity. That is, it uses single values for exposure concentrations and threshold values and does not account for the variability in both these parameters nor for incremental or cumulative toxicity.

The comparisons described above are presented in site-specific screening tables to select COPCs in each individual site assessment section. Screening tables are presented for each applicable medium at each site. Sediment screening tables present most and less conservative threshold comparisons to exposure point concentrations if the most conservative value was exceeded and a less conservative value was available. As a result, two HQ values are presented in these instances. Due to the heavy conservatism in most thresholds initially utilized, contaminants were retained as COPCs if the most conservative threshold values were exceeded but, as mentioned above, a less conservative threshold (e.g., an ER-M for sediment) was provided for comparison, if available. When only one theshold was available, only one HQ is presented.

Background values are also presented for comparative purposes on screening tables. These values need to be taken into account when making risk management decisions since concentrations of inorganic contaminants can be naturally elevated and exceed screening values. In these instances toxic effects may be ameliorated by site-specific physical or chemical conditions. In this investigation, inorganic contaminants whose maximum detected concentration was less than twice the average background concentration were excluded as COPCs. This comparison was described in the workplan (ABB, 1995) and is recommended by EPA (EPA, 1996a) since concentrations of inorganics can be elevated naturally and not caused by site-related activities.

Hazard quotients for foodchain modeling were summed for all exposure routes for each contaminant. Contaminant-specific HQs were then summed to obtain an HI for the foodchain model receptor species. Quantitatively the HI can be interpreted in much the same manner as the HQ. Results of foodchain modeling are summarized on tables for each site that present the HI value and the five COPCs that contribute the most to the total HI. These tables also present the percentage of total dose received by each exposure route. EPA guidance states that HQs are not summed to provide an HI unless the modes of toxicities are similar (EPA, 1996a). The tables in this ERA that summarize the results of the food chain modeling provide a total HI only as a loose guide for cumulative toxicity. Thus, the total HI should be interpreted with caution. It is included primarily because where several contaminants are involved, modes of toxicity often encompass a "gray area" in which contaminants are similar in some aspects and different in others.

Some contaminants were present in some media for which no suitable benchmark values were available. In these instances, these contaminants were conservatively retained as COPCs and qualitatively assessed. Toxicity profiles describing the environmental fate, transport, and toxicities of COPCs in all media were developed, and are presented in Appendix B-3.

3.3.2.2.1 Tissue Analyses

Tissue analyses were conducted on fish and vegetation at SWMUs 4 and 5; vegetation at SWMU 7; lobsters, crabs, and vegetation at IR 7; lobsters, crabs, mollusks, and vegetation at IRs 1 and 8; and fish and crabs at AOC B (see Section 1.4 of this appendix). Results of the tissue analyses were compared to tissue concentrations in similar species collected from eight background sites in the Key West area, and to values considered to be protective of the organisms and to fish and wildlife consumers of those organisms (Table C.3-26).

TABLE C.3-26

CONTAMINANT CONCENTRATIONS IN FISH TISSUE PROTECTIVE OF FISH AND PISCIVOROUS RECEPTORS
NAS KEY WEST

Contaminant*	Contaminant Concentration	Source
INORGANICS (mg/kg WET WEIGHT)		
Cadmium	0.1	Conservative piscivorous fish and wildlife criterion (Eisler, 1985)
	0.2	Dietary protection criterion in piscivorous birds (Furness, 1996)
Chromium	1.0	Presumptive contamination in fish and wildlife (Eisler, 1986b)
Lead	2.0	Fish tissue concentration protective of marine animals (Maddock and Taylor, 1980)
Mercury	0.1	Fish concentration protective of piscivorous birds (Eisler, 1987)
	1.1	Fish concentration protective of piscivorous mammals (Eisler, 1987)
	3.0	Fish protection criterion (Weiner and Spry, 1996)
Selenium	0.75	Foodchain organisms - toxic effects threshold for piscivorous fish and wildlife (Lemly, 1996)
	1.0	Fish tissue concentration - toxic effects threshold (Lemly, 1996)
PESTICIDES/PCBs (µg/kg WET WEIGHT)		
4,4'-DDD	200	Criterion for protection of sensitive wildlife species (Newell et al., 1987)
4,4'-DDE	200	Criterion for protection of sensitive wildlife species (Newell et al., 1987)
4,4'-DDT	200	Criterion for protection of sensitive wildlife species (Newell et al., 1987)
Aldrin	120	Non-carcinogenic piscivorous wildlife criterion (Newell et al., 1987)
	22	1 in 100 cancer risk level for piscivorous wildlife (Newell et al., 1987)
Dieldrin	120	Non-carcinogenic piscivorous wildlife criterion (Newell et al., 1987)
	22	1 in 100 cancer risk level for piscivorous wildlife (Newell et al., 1987)
Endrin	25	Non-carcinogenic piscivorous wildlife criterion (Newell et al., 1987)
BHC (alpha, beta, delta, and gamma isomers)	100	Non-carcinogenic piscivorous wildlife criterion (Newell et al., 1987)
	510	1 in 100 cancer risk level for piscivorous wildlife (Newell et al., 1987)
Heptachlor	200	Non-carcinogenic piscivorous wildlife criterion (Newell et al., 1987)
	210	1 in 100 cancer risk level for piscivorous wildlife (Newell et al., 1987)
Heptachlor epoxide	200	Non-carcinogenic piscivorous wildlife criterion (Newell et al., 1987)
	210	1 in 100 cancer risk level for piscivorous wildlife (Newell et al., 1987)
PCBs	100	Total PCB criteria for piscivorous birds and mammals (IJCUSC, 1988)
	130	Non-carcinogenic piscivorous wildlife criterion (Newell et al., 1987)
	110	1 in 100 cancer risk level for piscivorous wildlife (Newell et al., 1987)
	400	Fish protection criterion (Eisler, 1986)
	3000	Fish concentration protective of piscivorous birds (Eisler, 1986)

*Detected in at least one fish, crab, mollusk, or lobster tissue sample collected from RCRA/CERCLA sites.

3.3.3 Uncertainty Analysis

Uncertainty is associated with all aspects of the ERA process. This section provides a summary of the uncertainties involved in this ERA, with a discussion of how they may affect the final risk results and conclusions. Once an ERA is complete, the results must be reviewed and evaluated to identify the types and magnitudes of uncertainties involved. Relying on results from a risk assessment without consideration of uncertainties, limitations, and assumptions inherent in the process can be misleading. If numerous conservative assumptions are combined in the ERA process, the resulting calculations will propagate the uncertainties associated with each of those assumptions. The resulting bias is toward overpredicting risks. Thus, both the results of the risk assessment and the uncertainties associated with those results must be considered when making risk management decisions.

Generally, risk assessments carry two types of uncertainty: measurement and informational. Measurement uncertainty refers to the variability inherent in measured data. The risk assessment reflects the accumulated variances of the individual values used for several different parameters. Informational uncertainty stems from the limited availability of necessary information. Often the gap between what is needed and what is available is significant; information regarding the effects of some contaminants on wildlife receptors, the biological mechanism of a contaminant, the impact of physiological differences on exposure pathways, or the behavior of a contaminant in various environmental media is often absent. Uncertainty is associated with each of the steps of the risk assessment process:

- Uncertainty in preliminary problem formulation can result from limited information regarding contaminant sources, release mechanisms, and exposure routes.

- Uncertainty in the ecological effects characterization arises from the quality of the existing threshold values and toxicity data to support a determination of potential adverse impacts to ecological receptors.

- Uncertainty associated with the exposure assessment includes the methods used and the assumptions made to determine exposure point concentrations and calculate contaminant intake doses.

- Uncertainty in risk characterization includes that associated with the potential effects of exposure to multiple contaminants and the cumulative uncertainty from combining conservative assumptions made in earlier activities.

3.3.3.1 Uncertainty in the Preliminary Problem Formulation

Some of the sites investigated in this ERA receive contaminant inputs from more than one source, although initially contaminants are assumed to stem directly from site-related activities. Since contaminant concentrations may reflect inputs from many sources, uncertainties exist regarding whether risk characterized at a discrete site stems from site-related contaminants. This was of particular importance while assessing impacts to IR 1, 7, and 8. These sites are located adjacent to ocean water. As a result, contaminants detected in surface water, sediment, and aquatic biota at these sites may stem from non-Navy sources. Similarly, aquatic habitats at SWMUs 4 and 5 probably receive contaminants from highway traffic and various aircraft maintenance activities.

Uncertainty also arises when different release mechanisms are present. Contaminants at some of the sites may be released from their sources only during specific events (e.g., certain contaminants may be released from SWMU 5 soils only after becoming inundated with surface water). As a result, risks may be over- or under-estimated if the information regarding these parameters is scarce or unknown. Also, different sites and their contaminants may possess different contaminant exposure routes for ecological receptors. Difficulties and limitations exist in trying to obtain exposure routes for individual sites for individual receptors. Since exposure routes may be quite different for different species, risk may be over- or under-estimated if this information is not known.

3.3.3.2 Uncertainty in the Ecological Effects Characterization

A great deal of uncertainty in this risk assessment arises from the nature and quality of the available toxicity data used to derive threshold values and reference doses. This uncertainty is reduced when similar effects are observed across species, strain, sex, and exposure route; when the magnitude of the response is clearly dose related; when postulated mechanisms of toxicity are similar for laboratory and wildlife species; and when the COC is structurally similar to other contaminants for which the toxicity is more completely characterized. Most threshold values are based on the most conservative assumptions possible. As such, though an inherent level of conservatism is needed in an ERA to ensure that the most sensitive receptors are protected, these screening levels may grossly overestimate potential risks and the resulting HQ values may be misleading. As discussed earlier, both AWQC and most sediment screening values used in this assessment are based on laboratory studies that do not take into account mitigating physical and chemical properties in the environment. Therefore, uncertainty is introduced into the assessment, and the results tend to overestimate potential risks. To account for this, less conservative sediment threshold values are presented (when available) with the most conservative thresholds, but they cannot fully reduce the associated uncertainty.

In addition, ERAs, unlike human health risk assessments, must consider risks to many different species. However, calculation of risk values for each potential receptor species is not possible. For this ERA, conservative screening values protective of a wide range of ecological receptors were sought. The underlying assumption associated with the use of these benchmarks is that contaminant concentrations in excess of these screening levels are indicative of potential impacts to actual receptors inhabiting the area. However, species-specific physiological differences that may influence an organism's response to a contaminant or subtle behavioral differences that may increase/decrease a receptor's contact with a contaminant are seldom known. Also, some contaminants were present in some media for which no suitable screening levels were available. This was especially true for terrestrial plant thresholds for organic contaminants. Although plants do not generally translocate organics to the extent that they translocate metals, terrestrial plant thresholds were only available for a few contaminants, and hence, the potential risks to plants from organics in soils could not be fully assessed. Threshold contaminant concentrations in fish that are protective of piscivorous birds and mammals were also used in this assessment. These types of thresholds are scarce and must be gathered from several sources in the primary literature. Most of the thresholds that were available were based on one or a few studies, and are generally conservatively derived. For these reasons, the use of threshold screening values, while necessary, will introduce error into the results of an assessment.

For TRV derivation, as described earlier, all available data were gathered for calculating doses for all contaminants to which the representative receptor species (Lower Keys marsh rabbit, cotton rat, raccoon, kestrel, great blue heron) may be exposed. However, toxicological data for these species are scarce. As a result, extrapolations were made using toxicity data from studies which used other small mammals and birds as test species. Extrapolations from acute toxicity tests were also made to derive chronic toxic doses, and LOAELs were used (if necessary) to estimate NOAELs. For some parameters, uncertainty factors were employed to generate a sufficient level of conservatism in the foodchain model. In some of these instances, the resulting HIs were increased by a factor of 100. Therefore, the increased risk estimates may be due more to a lack of toxicity data than to potential risks, and potential risks may be overestimated.

3.3.3.3 Uncertainty in the Exposure Assessment

Uncertainty in the exposure assessment arises mainly in the methods used to obtain exposure point concentrations. The maximum detected contaminant concentration was used to represent contaminant concentrations to which ecological receptors might be exposed. If the samples evaluated in this ERA are representative of contaminant concentrations associated with the station, then this approach is conservative and should overestimate potential risks to ecological receptors. The maximum concentration of a contaminant in a given medium may have been collected in a "hot spot" of contamination, and may be much higher than the remaining values in the data set. This was the case for contaminants in various media at some sites. Again, although use of maximum values is appropriate for screening in an ERA, they may overpredict potential risks.

Uncertainties also exist in the calculation of contaminant intake doses for the representative receptor species. To help reduce some of these uncertainties, the food chain model was run using both maximum and mean soil contaminant concentrations. However, only single values could be used for several of the input parameters used in the model. Specifically, it was assumed that the receptor species absorbed 80 percent of all contaminants ingested. Data do not exist regarding absorption rates of most contaminants for wildlife receptor species. The value of 80 percent for all contaminants is assumed to be sufficiently conservative based on a review of available literature, but absorption of different contaminants may vary greatly, and varies between species. Several of the contaminants used in the model may have absorption rates much less than 80 percent, which would result in an overprediction of risks. The receptor species were also conservatively assumed to forage 100 percent of the time on the contaminated areas at the sites under investigation. Since portions of the sites contain little or marginal habitat, and since some sites are small in areal extent, it is highly unlikely that the receptor species spends 100 percent of their time foraging on the sites. This tends to overpredict risk.

3.3.3.4 Uncertainty in the Risk Characterization

Section 3.3.2.2 describes uncertainty in the risk characterization as affected by all aspects of the ERA process. Uncertainty in risk characterization also stems, in part, from the fact that this process does not consider antagonistic or synergistic effects. Little or no information is available to determine the potential for antagonism or synergism for the contaminants evaluated. For food chain modeling, HQs were summed to generate HIs, which were used to interpret total potential risk. However, the HI is only a linear, arithmetic measure of total potential risk. Additive risks may actually increase, or even decrease, geometrically based on synergistic or antagonistic effects. Additionally, contaminants that account for a large percentage of risk may be mitigated by several factors, including a low frequency of detection. For these reasons, the HI can be used a rough estimate to total risk, but contains uncertainty and must be interpreted with caution.

3.3.4 Ecological Risk Assessment Approach Summary

IT Corporation conducted screening-level ERAs at SWMUs 4, 5, and 7, and at IRs 1, 3, 7, and 8. Based on the results of those ERAs, additional RFI/RI Phase II ecological risk assessment was performed for these seven sites, along with AOC B. As part of Phase II investigations, the maximum exposure point concentrations for contaminants in surface water, groundwater, sediment, and surface soil were compared to ecological screening values that are protective of ecological receptors to assess potential risk to aquatic and terrestrial organisms. Analytes were retained as COPCs if exposure point contaminant concentrations exceeded screening values, and the ratio of the two values is defined as the hazard quotient. In addition, modeling of contaminants in the foodchain was conducted for SWMUs 4, 5, 7, AOC B, and IRS 7 and 8. Biological sampling was performed at all sites except IR 3. Results are summarized for each site in each individual site-specific sections. Interpretation of the results and recommendations for remedial action, further ecological study, or no further study or remediation based on ecological risk concerns are also presented in those sections. A weight-of-evidence approach was used to determine the potential for risk at each site using all of the analyses described above, with weighting dependent on the best use of the data, the apparent quality of the data, and the nature and magnitude of associated uncertainties.

References

ABB (ABB Environmental Services, Inc.), 1995. *Facility and Remedial Investigation NAS Key West, Workplan - Volume 1 and Sampling and Analysis Plan - Volume 2*, prepared for SOUTHNAVFACENGCOM, Tampa, Florida, June.

ATSDR (Agency for Toxic Substances and Disease Registry), 1990. Draft Toxicological Profile for Lindane. Atlanta, Georgia, October.

ATSDR (Agency for Toxic Substances and Disease Registry), 1991. Draft Toxicological Profile for Cobalt. Atlanta, Georgia, October.

B & R Environmental (Brown & Root Environmental), 1997. Draft Supplemental RCRA Facility Investigation and Remedial Investigation Report for NAS Key West High-Priority Sites, prepared for Department of Navy, Southern Division, Naval Facilities Engineering Command, Aiken, South Carolina, Revision 2, March 1997.

Baes, C. F., R. D. Sharp, A. L. Sjoreen, and R. W. Shor, 1984. A review of parameters for assessing transport of environmentally released radionuclides through agriculture. Oak Ridge National Laboratory.

Barnthouse, L. W., G. W. Suter, S. M. Bartell, J. J. Beauchamp, R. H. Gardner, E. Linder, R. V. O'Neill, and A. E. Rosen, 1986. *User's Manual for Ecological Risk Assessment*, No. 2679, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Baudo, R., J. Geisy, and H. Muntau (eds.), 1990. *Sediments: Chemistry and Toxicity of In-Place Pollutants*. Lewis Publishers, Inc., Ann Arbor, Michigan.

Bee, J. W., G. E. Glass, R. S. Hoffman, and R. R. Patterson, 1981. *Mammals in Kansas*. University of Kansas, Lawrence, Kansas.

Bonaccorsi, A., A. di Domenico, R. Fanelli, F. Merli, R. Vanzati, and G. A. Zapponi, 1984. "The influence of soil particle adsorption on 2,3,7,8-TCDD biological uptake in the rabbit," *Archives of Toxicology Supplement* 7:431, in *Bioavailability in Environmental Risk Assessment*, Hrudey, S. E., W. Chen, and C. G. Rousseaux, 1996, Lewis Publishers, Boca Raton, Florida.

Bromilow, R. H., and K. Chamberlain, 1995. Principals Governing Uptake and Transport of Chemicals, in Trapp, S. and J. C. McFarlane, 1995, Plant Contamination, Lewis Publishers, Boca Raton, Florida.

Calabrese, E. J. and L. A. Baldwin, 1993. *Performing Ecological Risk Assessments*, Lewis Publishers, Chelsea, Michigan.

CAPCOA (California Air Pollution Control Officers Association), 1993. *Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines*, Cameron Park, California.

Capel, I. D., M. R. French, P. Millborn, R. L. Smith, and R. T. Williams, 1972. "The fate of phenol in various species" *Xenobiotica*, 2:25, in *Bioavailability in Environmental Risk Assessment*, Hrudey, S. E., W. Chen, and C. G. Rousseaux, 1996, Lewis Publishers, Boca Raton, Florida.

Caspary, J., 1997. Meeting with Florida Department of Environmental Protection, Brown & Root Environmental, and Navy Southern Division, Naval Facilities Engineering Command, Tallahassee, Florida, April 24.

Cothran, E. G., M. H. Smith, J. O. Wolff, and J. B. Gentry, 1991. *Mammals of the Savannah River Site*, SRO-NERP-21, Savannah River Ecology Laboratory, Aiken, South Carolina.

Cowherd, C., G. E. Muleski, P. J. Englehart, and D. A. Gillette, 1985. *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites*, EPA/600/8-85/002, U.S. EPA Office of Health and Environmental Assessment, Washington, D.C.

Direction des Substances Dangereuses, 1988. *Contaminated Sites Rehabilitation Policy*.

Doull, J., C. D. Klaassen, and M. O. Amdur, 1986. *Casarett and Doull's Toxicology: The Basic Science of Poisons*, third edition, Macmillan Publishing Company, New York, New York.

Dragun, J., 1988. *The Soil Chemistry of Hazardous Materials*, Hazardous Materials Control Research Institute, Silver Spring, Maryland.

Dunson, W. A. and J. D. Lazell, 1982. "Urinary concentrating capacity of *Rattus rattus* and other mammals from the Lower Florida Key," *Comparative Biochemistry and Physiology* 71A:17-21.

Eisler, R., 1985. Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Report No. 2. Patuxent Wildlife Research Center. Laurel, Maryland.

Eisler, R., 1986a. Polychlorinated Biphenyl Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Services Biological Report 85 (1.7). 72 pp.

Eisler, R., 1986b. Chromium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic review. U.S. Fish and Wildlife Services Biological Report. 85 (1.6). 60 pp.

EPA (U.S. Environmental Protection Agency), 1979. "Water-Related Environmental Fate of 129 Priority Pollutants," EPA 440/4-79/029, Washington, D.C., December.

EPA (U.S. Environmental Protection Agency), 1982. "Aquatic Fate Process Data for Organic Priority Pollutants," EPA 440/4-81/014, Office of Drinking Water Regulations and Standards, Washington D.C., December.

EPA (U.S. Environmental Protection Agency). 1985. Ambient Water Quality Criteria for Mercury - 1984, EPA 440/5-84-026, Office of Water Regulations, Criteria and Standards Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1986a. "Air Quality Criteria for Lead," EPA 600/8-83/028, Environmental Criteria and Assessment Office, Research Triangle Park, North Carolina.

EPA (U.S. Environmental Protection Agency), 1986b. "Guidelines for the Health Risk Assessment of Chemical Mixtures," 51 *Federal Register* 185, 34014 et seq. September 24.

EPA (U.S. Environmental Protection Agency), 1986c. "Test Methods for Evaluating Solid Wastes, Physical and Chemical Methods," EPA/SW-846, third edition, Revision 2.

EPA (U.S. Environmental Protection Agency), 1988. "Superfund Exposure Assessment Manual," EPA 540//1-88/001, April.

EPA (U.S. Environmental Protection Agency), 1989a. "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)," EPA 540/1-89/002, Office of Emergency and Remedial Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1989b. "Guidance Document on the Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities," Interim Final Guidance, EPA 530/SW-89-026, Office of Solid Waste, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1991a. "Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors," Office of Solid Waste and Emergency Response, (OSWER), Directive 9285.6-03, OSWER, Toxics Integration Branch, Washington, D.C., March 25.

EPA (U.S. Environmental Protection Agency), 1991b. "Exposure Point Concentrations in Groundwater," EPA Region III Technical Guidance Manual, EPA/903/8-91/002.

EPA (U.S. Environmental Protection Agency), 1991c. "Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper," Final Rule, 56 *Federal Register* 26460-26564, June 7.

EPA (U.S. Environmental Protection Agency), 1991d. "Standard Operating Procedures and Quality Assurance Manual," EPA Region IV, Quality Assurance Branch.

EPA (U.S. Environmental Protection Agency), 1991e. Water Quality Criteria Summary, Office of Science and Technology, Washington, D.C. , May.

EPA (U.S. Environmental Protection Agency), 1992a. "Dermal Exposure Assessment: Principles and Applications, Interim Report," EPA 600/8-91/011/B, Office of Health and Environmental Assessment, Washington, D.C., January.

EPA (U.S. Environmental Protection Agency), 1992b. "Framework for Ecological Risk Assessment," EPA/630/R-92/001, February.

EPA (U.S. Environmental Protection Agency), 1992c. "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities; Addendum to Interim Final Guidance," Office of Solid Waste Permits and State Programs Division, Washington, D.C., July.

EPA (U.S. Environmental Protection Agency), 1992d. "National Primary Drinking Water Regulations; Final Rule." 56 *Federal Register* 30265-30281, July 17.

EPA (U.S. Environmental Protection Agency), 1992e. Statistical Training Course for Groundwater Monitoring Data, EPA 530/R-93-003.

EPA (U.S. Environmental Protection Agency), 1993. "Wildlife Exposure Factors Handbook: Volumes I and II," EPA/600/R-93/187, U.S. EPA Office of Research and Development, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1994a. "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities," Office of Solid Waste and Emergency Response, Directive 9355.4-12.

EPA (U.S. Environmental Protection Agency), 1994b. "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses," EPA/540/R-94/013.

EPA (U.S. Environmental Protection Agency), 1994c. "Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children," EPA 540/R-93/081, Office of Emergency and Remedial Response, Washington, D.C., February.

EPA (U.S. Environmental Protection Agency), 1994d. "Region III Interim Ecological Risk Assessment Guidance," Philadelphia, Pennsylvania.

EPA (U.S. Environmental Protection Agency), 1994e. "Amended Guidance of Preliminary Risk Evaluations (PREs) for the purpose of reaching a Finding of Suitability to Lease (FOSL)," December 20.

EPA (U.S. Environmental Protection Agency), 1994f. "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses," EPA/540/R-94/012.

EPA (U.S. Environmental Protection Agency), 1995a. "Interim Supplemental Guidance to RAGs: Region 4 Bulletins, Human Health Risk Assessment."

EPA (U.S. Environmental Protection Agency), 1995b. "Integrated Risk Information System (IRIS)," Computer Database, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1995c. *Health Effects Assessment Summary Tables (HEAST), Annual Update FY 1995*, EPA 540-R-95-036, prepared by the Office of Health and Environmental Assessment for the Office of Solid Waste and Emergency Response and the Office of Water, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1995d. "Assessing Dermal Exposure from Soil," Region III Technical Guidance Manual for Risk Assessment, December.

EPA (U.S. Environmental Protection Agency), 1995e. "Supplemental Guidance to RAGS: Region 4 Bulletins - Ecological Risk Assessment," Waste Management Division, Atlanta, Georgia.

EPA (U.S. Environmental Protection Agency), 1995f. "EPA Region III BTAG Screening Levels," Philadelphia, Pennsylvania.

EPA (U.S. Environmental Protection Agency), 1996a. "ECO Update," EPA 540/F-95/038, Office of Solid Waste and Emergency Response.

EPA (U.S. Environmental Protection Agency), 1996b. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. " USEPA Environmental Response Team. Edison, New Jersey.

EPA (U.S. Environmental Protection Agency), 1996c. Drinking Water Regulations and Health Advisories, Office of Water, Washington D.C., October.

EPA (U.S. Environmental Protection Agency), 1997. "Risk-Based Concentration Table" Region III EPA. March.

FDEP (Florida Department of Environmental Protection), 1994. *Approach to the Assessment of Sediment Quality in Florida Coastal Waters: Volume 1 - Development and Evaluation of Sediment Quality Assessment Guidelines,* Tallahassee, Florida.

FDEP (Florida Department of Environmental Protection), 1994b. Groundwater Guidance Concentrations, Bureau of Drinking Water and Ground Water Resources, June.

FDEP (Florida Department of Environmental Protection), 1995b. Soil Cleanup Goals for Florida, Memorandum from John M. Ruddell to District Directors, September.

FDEP (Florida Department of Environmental Protection), 1995c. Drinking Water Standards, Monitoring and Reporting, Chapter 62-550.

FDEP (Florida Department of Environmental Protection), 1995, "Surface Water Quality Standards," Chapter 62-302.

FDEP (Florida Department of Environmental Protection), 1996. Applicability of Soil Cleanup Goals for Florida, Memorandum from John M. Ruddell to District Directors, January.

Federal Register, 1990. Section 264.521(a)(2)-(i-iv), Proposed RCRA Action Levels.

FGFWFC (Florida Game and Fresh Water Fish Commission), 1993. *Ecology and Habitat Protection Needs of the Southeastern American Kestrel (Falco Sparverius Paulus) on Large-Scale Development Sites in Florida*, Non-game Wildlife Technical Report No. 13, Office of Environmental Services, Tallahassee, Florida.

FNAI (Florida Natural Areas Inventory/The Nature Conservancy), 1994. *Ecological Survey of U.S. Navy Property in the Lower Florida Keys, Monroe County, Florida*, Florida Natural Areas Inventory, Tallahassee, Florida.

Fourqueen, J., 1996. Florida International University, Tampa, Florida, personal communication with M. L. Whitten, Brown and Root Environmental, Aiken, South Carolina, July 30.

Freeman, G. B., J. D. Johnson, J. M. Killinger, S. C. Liao, A. O. Davis, M. V. Ruby, R. L. Chaney, S. C. Lover, and P. D. Bergstrom, 1993. "Bioavailability of arsenic in soil impacted by smelter activities following oral administration in rabbits," *Fundamentals of Applied Toxicology 21:83*, in *Bioavailability in Environmental Risk Assessment*, Hrudey, S. E., W. Chen, and C. G. Rousseaux, 1996, Lewis Publishers, Boca Raton, Florida.

Furness, R. W., 1996, "Cadmium in Birds," in Beyer, W. N., G. H. Heinz, and A. W. Redmond-Norwood, 1996. Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations. CRC Press, Boca Raton, Florida. pp. 389-404.

FWS (U.S. Fish and Wildlife Service), 1994. "Recovery Plan: Lower Keys Marsh Rabbit (*Sylvilagus palustris hemeri*)." U.S. Department of the Interior, Atlanta, Georgia.

Gass, T. E., 1988. "Monitoring Well Filter Pack and Screen Slot Selection," *Water Well Journal*.

Gass, T. E., 1989. "Monitoring Wells in Non-Aquifer Formations," *Water Well Journal*.

Gibbons, J. A. and M. Alexander, 1989. "Microbial Degradation of Sparingly Soluble Organic Chemicals: Phthalate Esters," *Environmental Toxicology and Chemistry*, Volume 8, pp. 283-291.

Gilbert, R. O., 1987. *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand and Reinhold, New York, New York.

Ginn, T. C., and R. A. Pastorak, 1992. Assessment and Management of Contaminated Sediments in Puget Sound, pp. 371-401 in *Sediment Toxicity Assessment*, G. A. , Jr. (ed.). Lewis Publishers, Boca Raton, Florida.

Hall, E. R., 1981. *The Mammals of North America*, Wiley and Sons, New York.

Hrudey, S. E., W. Chen, and C. G. Rousseaux, 1996. *Bioavailability in Environmental Risk Assessment*, Lewis Publishers, Boca Raton, Florida.

Hull, R. N., and G. W. Suter, 1994. "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-associated Biota," Oak Ridge National Laboratory, Oak Ridge, Tennessee.

IJCUSC (International Joint Commission United States and Canada), 1988. *Great Lakes Water Quality Agreement*. Amended by protocol signed November 18, 1987. Ottawa, Canada. Cited in Irwin, R. J., 1988. *Impacts of Toxic Chemicals on Trinity River Fish and Wildlife*. U.S. Wildl. Serv. Contaminants Report. Fort Worth Field Office, November 1988. 82 pp.

IRIS (Integrated Risk Information System), 1990. "Integrated Risk Information System: On-Line Database."

IRIS (Integrated Risk Information System), 1995. "Integrated Risk Information System: On-Line Database."

IT Corporation, 1993. *RCRA Facility Investigation/Remedial Investigation, Final Workplan and Sampling and Analysis Plan, NAS Key West, Key West, Florida*, prepared for SOUTHNAVFACENGCOM, Tampa, Florida, March.

IT Corporation, 1994. *RCRA Facility Investigation/Remedial Investigation, Final Report, NAS Key West, Key West, Florida*, prepared for SOUTHNAVFACENGCOM, Tampa, Florida, June.

Jones, D. S., R. N. Hull, and G. W. Suter, 1996. "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1996 Revision," Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Jorgensen, S. E., S. N. Nielsen, and L. A. Jorgensen. 1991. *Handbook of Ecological Parameters and Ecotoxicology*. Elsevier Press, Amsterdam.

Kale, H. W. and D. S. Maehr, 1990. *Florida's Birds*, Pineapple Press, Sarasota, Florida, 288 pp.

Kamosa, D., C. Langebartels, and H. Sandermann, Jr., 1995. Metabolic Processes for Organic Chemicals in Plants, in Trapp, S. and J. C. McFarlane, 1995, Plant Contamination, Lewis Publishers, Boca Raton, Florida.

Kaplan, E. H., 1988. *Southeastern and Carribean Seashores*, Houghton Mifflin Company, New York, New York.

Layne, J. N., 1974. "The land mammals of South Florida," *Memoranda of Miami Geological Society*, 2:386-413.

Lemly, A. D., 1996. "Selenium in Aquatic Organisms." In Beyer, W. N., G. H. Heinz, and A. W. Redmond-Norwood, 1996. *Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations*. CRC Press, Boca Raton, Florida. 494 pp.

Long, E. R. and L. G. Morgan, 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program," *NOAA Technical Memorandum NOS OMA 52*, National Oceanographic and Atmospheric Administration, Seattle, Washington.

Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder, 1995. "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments," *Environmental Management*, 19:81-97.

Lyman, W. J., W. F. Reehi, and D. H. Rosenblatt, 1990. *Handbook of Chemical Property Estimation Methods*, American Chemical Society.

Maddock, P. G. and D. Taylor, 1980. "The Acute Toxicity and Bioaccumulation of Some Lead Alkyl Compounds in Marine Animals," in M. Branica and Z. Konrad (eds.), *Lead in the Marine Environment*, Pergammon Press, Oxford, England.

Markwell, R. D., D. W. Connell, and A. J. Gabric. 1989. Bioaccumulation of lipophilic compounds from sediments by oligochaetes. Wat. Res. 23:1443-1450.

Marx, J. M. and W.F. Herrnkind, 1986. *Spiny Lobster*, U.S. Fish and Wildlife Service Biological Report 82(11.61), U.S. Army Corps of Engineers, TR EL-82-4. 21 pp.

McFarlane, J. C., 1995. Anatomy and Physiology of Plant Conductive Systems, in Trapp, S. and J. C. McFarlane, 1995, Plant Contamination, Lewis Publishers, Boca Raton, Florida.

Nagy, K. A., 1987. "Field metabolic rate and food requirement scaling in mammals and birds," *Ecological. Monographs*, 57:111-128.

Newell, A. J., D. W. Johnson, and L. K. Allen, 1987. *Niagara River Biota Contamination Project: Fish Flesh Criteria for Piscivorous Wildlife.* New York State Department of Environmental Conservation. Technical Report 87-3. 181 pp.

OME (Ontario Ministry of the Environment), 1992. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*, Ontario, Canada.

Opresko, D. M., B. E. Sample, and G. W. Suter, 1994. *Toxicological Benchmarks for Wildlife, 1994 Revision*, ES/ER/TM-86/R1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B. E. and G. W. Suter, 1994. Estimating Exposure of Terrestrial Wildlife to Contaminants, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B. E., D. M. Opresko, and G. W. Suter, 1996. Toxicological Benchmarks for Wildlife: 1996 Revision, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Schuetz, A., 1997. Naval Air Station Key West, Florida, personal communication with M. L. Whitten, Brown and Root Environmental, Aiken, South Carolina, April 2.

Suter, G. W, 1993. *Ecological Risk Assessment*, Lewis Publishers, Boca Raton, Florida.

Suter, G. W. and C. L. Tsao, 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision, Prepared for the U.S. Department of Energy by Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, Tennessee. ES/ER/TM-96/R2.

Talmage, S. S. and D. M. Opresko, 1995. Ecological Criteria Document for 2,4,6-Trinitrotoluene. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Versar, Inc., 1992. Synthesis of Basic Life Histories of Tampa Bay Species. Tampa Bay National Estuary Program, St. Petersburg, Florida. PB93-196012.

Weiner, J. G. and D. J. Spry, 1996. "Toxicological Significance of Mercury in Freshwater Fish" in Beyer, W. N. , G. H. Heinz, and A. W. Redmond-Norwood, 1996. *Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations*, CRC Press, Boca Raton, Florida.

Wellman, L. (U.S. Environmental Protection Agency), 1997. Personal communication with M. L. Whitten, Brown and Root Environmental, Aiken, South Carolina, April 16.

Wentsel, R. S., R. T. Checkai, T. LaPoint, M. Simini, and L. Brewer, 1994. "Procedural Guidelines for Ecological Risk Assessments at U.S. Army Sites." ERDEC-TR-221.

Will, M. E., and G. W. Suter, 1995a. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil Litter Invertebrates and Heterotrophic Process," Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Will, M. E., and G. W. Suter, 1995b. "Toxicological Benchmarks for Screening Potential Contaminants of Potential Concern for Effects on Terrestrial Plants: 1995 Revision," Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Wolfe, S. (Florida Department of Environmental Protection), 1997. E-mail to M. L. Whitten, Brown and Root Environmental, Aiken, South Carolina, April 9.

APPENDIX D

WORKPLAN AMENDMENTS AND DEVIATIONS

APPENDIX D. WORKPLAN AMENDMENTS AND DEVIATIONS NAS KEY WEST SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

The Supplemental RFI/RI field investigation for eight Modification 01 sites at the Naval Air Station (NAS) Key West was conducted August to October 1996 in accordance with the Supplemental RFI/RI Sampling and Analysis Plan (SAP) prepared by ABB in 1995. Those sites included one Area of Concern (AOC) site AOC-B; three RCRA Solid Waste Management Units (SWMUs) sites, SWMUs- 4, -5, and -7; and Installation Restoration (IR) sites IR-1, -3, -7, and -8. In several instances, the plan either did not detail information required to conduct the sampling, the plan contained discrepancies regarding sampling or analyses, or the plan required changes based on existing field conditions/technical decisions. These amendments or deviations are described below.

On July 8, 1996, telephone conference call between Dudley Patrick (SouthDiv), Jorge Caspary (FDEP), Martha Berry (EPA), and B&R Environmental was conducted to discuss issues related to the NAS Key West RFI/RI SAP prior to conducting field activities. A number of the deviations discussed below are a result of this conference call. On August 21,1996, the conclusions of the conference call relating to the deviations in the SAP were placed in a letter to each participant.

1. Well Purge Rate

Section 2.2.4.2 Monitoring Well Sampling states that the purge rate for the monitoring wells being sampled by the peristaltic pump be 100 milliliter per minute.

On July 8, 1996, B&R Environmental proposed that the purge rate be change to 300 milliliter per minute because of the technical inability of the peristaltic pump to maintain a 100 milliliter per minute pumping rate and the extensive amount of time that would be spent purging wells. The regulators verbally agreed.

2. Herbicide Analyses

Herbicides are included in the Appendix IX list of parameters specified in the workplan; however, the RFI/RI SAP did not list herbicide methods of analysis. For completeness, herbicide sample volumes were collected for all samples when pesticide/PCB analyses were specified in the SAP.

3. Groundwater Samples

Section 2.2.4.2 states that dedicated precleaned Teflon bailers are to be used to collect all groundwater samples except metals. Metals are to be collected with the peristaltic pump and dedicated Teflon tubing. Based on field observations, B&R Environmental determined that higher quality sample could be taken with the peristaltic pump and dedicated Teflon tubing for those wells sampled for non-volatile and semi-volatile parameters. The Teflon bailers were used in the monitoring wells that required VOC and SVOC analyses.

4. Decontamination of Drilling Equipment

Section 2.2.1 of the RFI/RI SAP refers to the 1993 IT SAP for the decontamination procedures of drilling equipment. The IT SAP states the all down hole equipment will be decontaminated with soap, tapwater rinse, deionized water rinse, alcohol rinse, and allowed to air dry. The practice of using the deionized water and alcohol rinse was discontinued by B&R Environmental because no benefit was realized from the practice since no soil samples were being taken during drilling activities.

5. Background Surface Soil Analyses

Section 3.1.2 of the RFI/RI SAP text states that only pesticide/PCB and TAL metal analyses were to be performed on soil samples from background sites; however, Table 3-2 listed all analytical parameters for background soil samples. All background surface soil samples were therefore analyzed for all analytical parameters. The Truman Annex background sites were analyzed by EPA Methods 602 and 610 for VOCs and SVOCs because they are non-RCRA sites.

6. Field, Rinsate and Trip Blank Analyses

According to Table 3-2, the analytical methodology for the projects volatile and semi-volatile samples varied according to the designation of a site as RCRA (i.e., SWMU-4, -5, and -7) and non-RCRA (i.e., IR-1, -3, -7, -8, and AOC-B). The methods include RCRA Appendix IX Methods 8260 and 8270 and EPA Methods 602 and 610 for VOCs and SVOCs, respectively. Typically, the quality assurance samples follow the analytical methods of the samples taken on any given day as discuss in Section 4.8 of the SAP. However, in this case the RCRA methods encompass the analytical parameters of the EPA methods. Therefore, B&R Environmental chose to use the RCRA Appendix IX analyses of the field, rinsate, and trip blanks as a more conservative approach.

7. IR-1, -7, and -8 Surface Water Sampling

Sections 3.2.8, 3.2.10, and 3.2.11 of the RFI/RI SAP discuss the sampling of surface water at IR-1, -7, and -8, respectively. The total number of surface water samples by site are IR-1 (7 locations), IR-7 (9 locations), and IR-8 (10 locations).

On July 8, 1996, B&R Environmental proposed that the surface water samples not be taken at these sites because the surface water is open ocean water. B&R Environmental believed the sampling of the ocean water was unnecessary because it would not add any useful evidence for the conclusion of risk or contaminant migration from the sites. The regulators verbally agreed and surface water sampling at these sites was not conducted. Refer to the attached Figures 3-22, 3-27, and 3-30 for the location of these samples.

8. IR-1 Monitoring Well Installation

The text in Section 3.2.8 of the RFI/RI SAP states that five additional monitoring wells will be installed at the IR-1 site. However, the text and Figure 3-23 contradict this statement and indicate the installation of two new monitoring wells.

On July 8, 1996, B&R Environmental proposed to install only two additional monitoring wells, and to move the location of the wells upgradient and to the northwest of its original position. The regulators verbally agreed and the two wells were installed as proposed. Refer to the attached Figure 3-10 for the location of these wells.

9. IR-3 Surface Soil Samples

Section 3.2.9 of the RFI/RI SAP states that six offsite samples were to be taken to the north and east of IR-3 to assess the areal extent of pesticide contamination and if existing surface soil may reflect background conditions.

On July 8, 1996, B&R Environmental proposed the four offsite samples to the north of Fort Street be omitted since previous sampling of the area confirmed that there is no contamination in the area. The regulators verbally agreed and the four samples were omitted from the sampling activities. Refer to the attached Figure 3-24 to view the surface samples that were omitted.

10. IR-3 Surface Soil Samples

Section 3.2.9 of the RFI/RI SAP states that each of the surface soil and subsurface soil samples will be taken from 0 to 1 foot below the ground. B&R Environmental reviewed the SAP text and determined that subsurface soil samples were not intended to be taken. Therefore, two surface soil samples 0 to 1 foot were taken at IR-3. Refer to the attached Figure 3-24 for the locations of the two soil samples.

11. IR-3 Well Locations

Section 3.2.9 of the RFI/RI SAP states that four monitoring wells will be installed at IR-3 (one upgradient and three downgradient of the site). In addition, the four new wells and two existing wells will be sampled. On August 9, 1996, a B&R Environmental search for the two existing wells concluded that none of the wells were present at the site. As a result, a fifth new monitoring well was installed in the center of the site. Refer to the attached Figure 3-25 for the location of the fifth well.

12. IR-3 Groundwater Sampling

Section 3.2.9 of the RFI/RI SAP states that four new monitoring wells and two existing wells will be sampled. Since the two existing wells could not be found, B&R Environmental installed a fifth well at IR-3 and subsequently sampled the five new monitoring wells. Refer to the attached Figure 3-25 for the location of each of the five wells.

13. IR-7 Sediment Analyses

Section 3.2.10 of the RFI/RI SAP states that Pesticide/PCB analyses be performed on the sediment samples (Surface water samples were not taken at IR-7 because it was ocean water. Refer to Deviation 6.). B&R Environmental also performed herbicides, metals, and cyanide analyses of the sediment samples because those were contaminants of concern for the groundwater.

14. IR-7 Groundwater Analyses

Section 3.2.10 of the RFI/RI SAP states that groundwater samples will be taken to confirm previously detected metals, cyanide, and pesticide concentration. The proposed sample breakdown for groundwater media lists pesticide and PCBs analyses. B&R Environmental performed pesticide/PCB, herbicides, metals, and cyanide analyses of the IR-7 groundwater samples.

15. IR-8 Sediment Analyses

Section 3.2.11 of the RFI/RI SAP states that Pesticide/PCB analyses be performed on the sediment samples (Surface water samples were not taken at IR-8 because it was ocean water. Refer to Deviation 6.). B&R Environmental also performed herbicides and metals analyses of the sediment samples because those were contaminants of concern for the groundwater.

16. IR-8 Groundwater Analyses

Section 3.2.11 of the RFI/RI SAP states that groundwater samples will be taken to confirm previously detected metals concentration. The proposed sample breakdown for the groundwater media lists pesticide and PCBs analyses. B&R Environmental performed pesticide/PCB, herbicides, and metals analyses of the IR-8 groundwater samples.

17. AOC-B Permanent Wells

Section 3.2.13 of the RFI/RI SAP states that three temporary monitoring wells will be installed at AOC-B. On July 8, 1996, B&R Environmental proposed making the three temporary well permanent wells because of the potential need for future monitoring. The regulators verbally agreed and the wells in AOC-B were permanently installed.

18. SWMU-4 Background Soil Samples

Section 3.2.4 of the RFI/RI SAP states that two background location soil samples will be taken at the site. The locations are depicted in Figure 3-10 of the SAP.

On July 8, 1996, B&R Environmental proposed moving the sample locations because they were viewed to be too close to one of the sources of contamination at the site. Based on the location of the samples, B&R Environmental determined on field observations that one of the samples was intended to be for background use and the other samples, near the source of contamination was intended to evaluate any remaining contamination. B&R Environmental moved the sample locations and the depth of the sample near the tank was changed to a vertical composite from 6 to 18 inches. Refer to the attached Figure 3-10 for the revised sample locations.

19. SWMU-4 Groundwater Analyses

Section 3.2.4 of the RFI/RI SAP states that groundwater samples will be analyzed for VOCs and cyanide. B&R Environmental performed VOC, SVOC, TAL metals, and cyanide analyses on groundwater samples based on the constituents of concern for the site and to parallel the analyses indicated in the SAP for the surface soil, sediment, and surface water samples.

20. SWMU-5 Location of Sediment and Surface Water Samples

Section 3.2.5 of the RFI/RI SAP states that two of the four sediment and surface water samples are to be located in the concrete-lined ditch behind Buildings 989 through 992 at SWMU-5.

On July 8, 1996, B&R Environmental proposed the two sediment and surface water samples be moved to the soil area and pond to the east as depicted in Figure 3-14 where the concrete-lined ditch flows. The move was prompted because the ditch had no sediments or surface water. The regulators verbally agreed and the two samples were taken in between the ditch and the pond and in the body of water to the south of the pond. The pond overflows to the body of water through a culvert under the roadway.

21. Shipping Samples

Section 4.4.3 states that samples will be shipped to the laboratory within 24 hours of sample collection. Due to nature of field operations (i.e., weather and technical delays and productivity), sampling was conducted during the weekend periods and samples were not always shipped within the 24-hour timeframe. However, B&R Environmental had refrigeration available in its field office keep the samples refrigerated to the time they were shipped. Often solid sample matrixes were scheduled for sample on weekend as opposed to aqueous matrixes.

Due to an oversight during the sample analysis process, SDG GA1725 was analyzed for the shorter list of 600 series organic compounds, rather than the longer 8,000 series specified for RCRA sites in the SAP. This SDG includes 4 background soil samples, 2 background sediment samples, and 5 soil samples from SWMU-7.

APPENDIX E

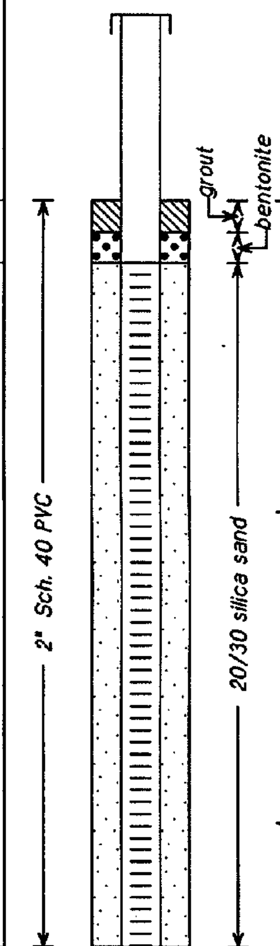
BORING LOGS

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING ABMW-1	*Page 1 of 1*

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/20/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *1.64 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Ingersoll Rand A-300*	GEOLOGIST: *Paul Calligan*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	PID (ppm) B. Zone	PID (ppm) Borehole	PID (ppm) Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		5							Sand, tan to brown, fine to med-grained, poorly sorted, loose, silty, dry
			ND						
		8							
		33							
5			1						Limestone, oolitic, Tan to white, sandy, coarse-grained, some shell fragments, friable, intergranular to moldic porosity, highly weathered
		50							
10									Same as above, hard, well consolidated *spoon refusal, augers jumping, decreased penetration rate* moderately weathered, saturated
		24							
			1						
		50							
									Boring terminated in this strata TD = 12.0 ft bls
15									

WELL DIAGRAM



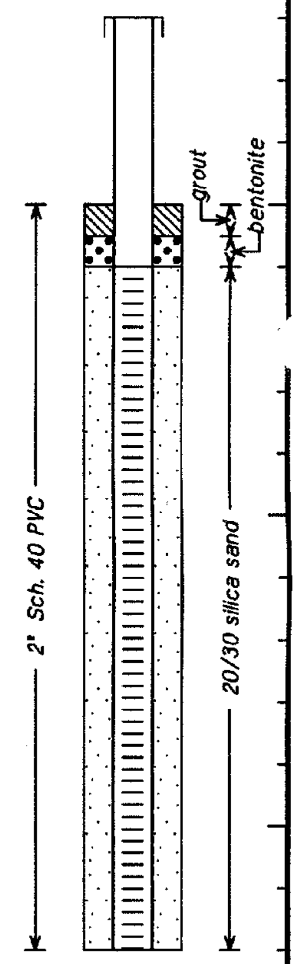
BROWN & ROOT ENVIRONMENTAL

LOG OF BORING ABMW-2

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/20/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *1.55 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Ingersoll Rand A-300*	GEOLOGIST: *Paul Calligan*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		4							Clay/lime mud, light gray, sandy, very soft, moist
			ND						
		6							
									Limestone, oolitic, Tan, sandy, saturated coarse-grained, some shell fragments, friable, intergranular to moldic porosity, highly weathered
		30							
5			ND						
		50							
									Same as above, hard, well consolidated *(Spoon refusal, augers jumping, decreased penetration rate)* moderately weathered, saturated
10									
		23							
			1						Same as above, cream color, friable, moderately consolidated
		34							
									Boring terminated in this strata TD = 12.0 ft bls
15									

WELL DIAGRAM

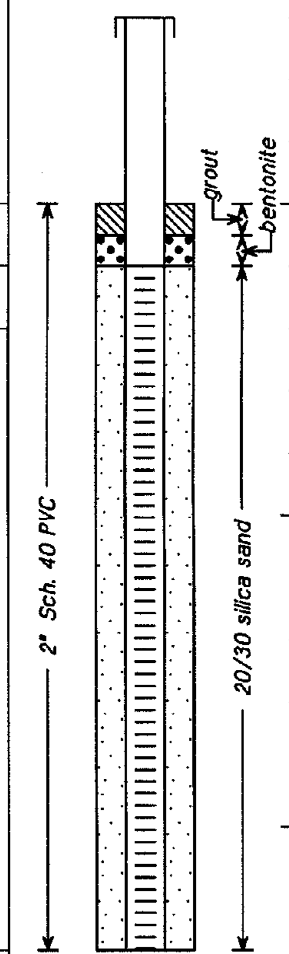


BROWN & ROOT ENVIRONMENTAL	LOG OF BORING ABMW-3	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/20/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *1.07 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Ingersoll Rand A-300*	GEOLOGIST: *Paul Calligan*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		2							Sand, fine to med.-grained, silty, tan to light brown, loose, poorly sorted, well rounded, saturated
			ND						
		2							Mud and silt, black, abundant organic material
									Limestone, oolitic, Tan, sandy, saturated coarse-grained, some shell fragments, friable, intergranular to moldic porosity, highly weathered
		29							Same as above, becomes harder, well consolidated *(Spoon refusal, augers jumping, decreased penetration rate)* moderately weathered, saturated
5			ND						
		50							
10									
			ND						Same as above
									Boring terminated in this strata TD = 12.0 ft bls
15									

WELL DIAGRAM



BROWN & ROOT ENVIRONMENTAL	LOG OF BORING I1MW-6	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/7/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *11.24 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Failing F-2*	GEOLOGIST: *Gary Braganza*

Columns: DEPTH feet | SAMPLE NUMBER | BLOWS/FT. | PID (ppm): Sample, B. Zone, Borehole, Drill B. Z. | GRAPHIC LOG | USCS/RQD | GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color | WELL DIAGRAM

Depth scale: 0, 5, 10, 15, 20

BLOWS/FT.	PID Sample (ppm)
	ND
50	
18	
	ND
11	
14	
	ND
17	
30	
13	
9	
6	
34	
	10
21	
79	
59	
16	
	2
17	
19	
	ND
19	

GEOLOGIC DESCRIPTION

Fill material, brown to light brown, coarse grained sand, poorly sorted, abundant roots, vegitation

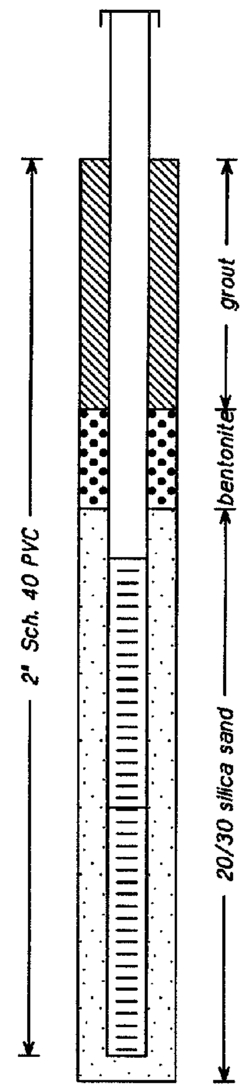
Limestone, oolitic, gray brown, coarse sand, minor clay, poorly consolidated, sandy, light brown, coarse grained, some pebbles & cobbles, few shells

Fill material, sand, gray brown, pebbles, cobbles, and boulders, loosely consolidated, sandy limestone, gray brown, coarse-grained sand, poorly sorted

black tar/asphalt

Limestone, oolitic, well consolidated beige to brown, micritic, coarse sand and shell fragments

Boring terminated in this strata
TD=18.5 ft bls

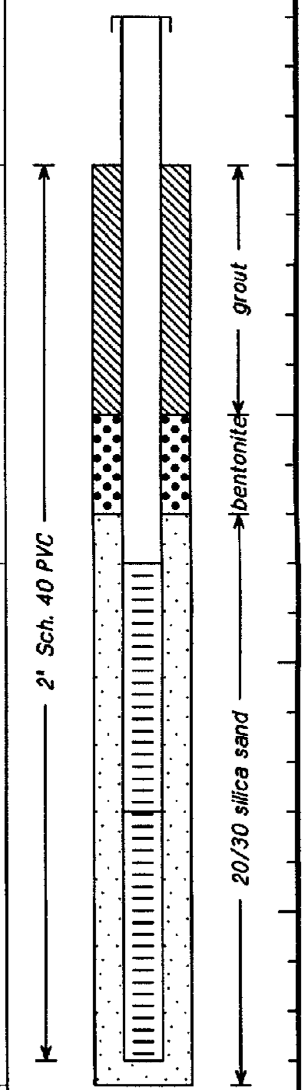


BROWN & ROOT ENVIRONMENTAL	LOG OF BORING I1MW-7	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/7/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *9.43 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Failing F-2*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		60							
		40							
		18							Fill material, poorly sorted pebbles, cobbles and boulders, and coarse sand
		19							
5		10							
		10							
		25							*increases resistance, probably a boulder?*
		64							
		78							
10		70							
		72							Limestone, oolitic, well consolidated, coarse sand and shell fragments in matrix
		81							
		61							
		75							same as above
15		17							same as above, larger shell fragments (brachiopods)
		16							
		18							same as above
		23							
									Boring terminated in this strata TD=18.5 ft bls
20									

WELL DIAGRAM

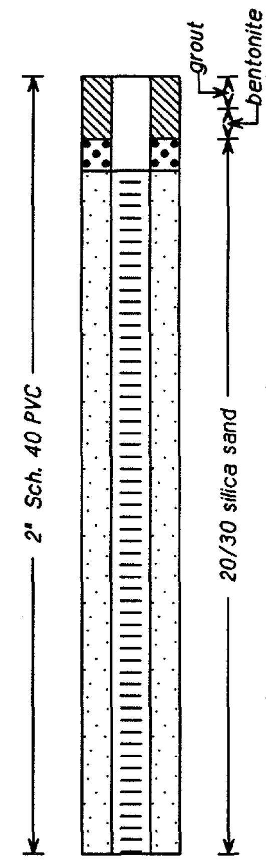


BROWN & ROOT ENVIRONMENTAL	LOG OF BORING I3MW-3	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *9/19/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *5.78 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Ingersoll Rand A-300*	GEOLOGIST: *Paul Calligan*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0									Grass, top soil
			ND						Fill material, crushed limestone, coarse sand and shell, brown, poorly sorted
			ND						
5			ND						Limestone, oolitic, Light brown to beige, sandy, coarse-grained, some shell fragments, hard, moderately consolidated, moderately weathered intergranular to moldic porosity, saturated
			ND						
			ND						
10			ND						
			ND						*Boring terminated in this strata TD=12.5 ft bls*
15									

WELL DIAGRAM



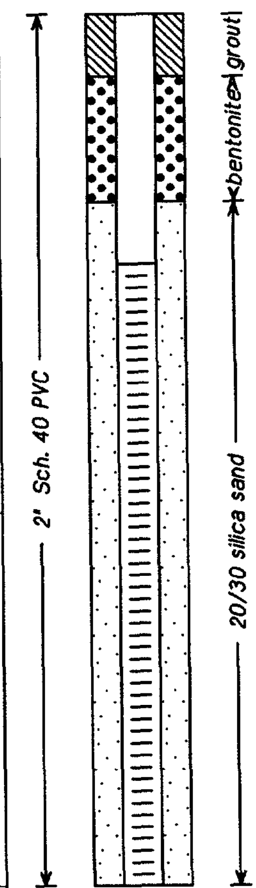
JOB NUMBER: HK 7046

BROWN & ROOT ENVIRONMENTAL	LOG OF BORING I3MW-4	Page 1 of 1

PROJECT NO: HK 7046	PROJECT NAME: Naval Air Station Key West
PROJECT LOCATION: Key West, Florida	DATE DRILLED: 8/9/96
DRILLING COMPANY: Gulf Atlantic Drilling	SURFACE ELEVATION: 7.22 Feet
DRILLING METHOD: Hollow Stem Auger	BORING DIAMETER: 8.25 Inches
DRILLING RIG: Failing F-2	GEOLOGIST: Gary Braganza

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		45							Fill material, coarse sand, cobbles, gray to brown
			ND						
		50							Sand, med. to coarse-grained, quartzose, light brown to beige, well sorted
			ND						
		91							
5			ND						Limestone, oolitic, light brown to beige, coarse sand, minor shell fragments in matrix, moderately consolidated
		50							
		82							
			ND						
		65							
		66							Oolitic limestone, with minor lenses of clay approximately 6 inches in thickness
			ND						
		71							
10		65							
			ND						
		76							
		55							
			ND						
		55							
									Boring terminated in this strata *TD=14.0 ft bls*
15									

WELL DIAGRAM



JOB NUMBER: HK 7046

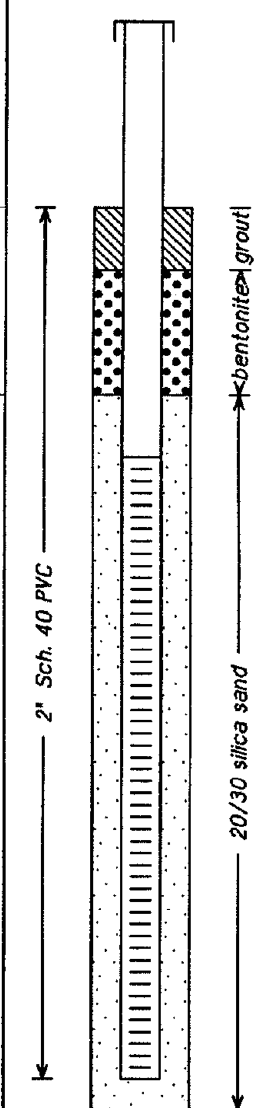
BROWN & ROOT ENVIRONMENTAL

LOG OF BORING I3MW-5

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/8/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *6.87 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Failing F-2*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		20							
			ND						Sand and gravel, dark brown, fill type material, pebbles and cobbles, few shell fragments, poorly sorted
		55							
		76							
			ND						
		92							
		86							
5			ND						
		52							
			ND						
		44							Limestone, oolitic, beige to light brown, coarse sand, shell fragments, friable, moderately consolidated
		51							
			ND						
10		50							
		51							
			ND						
		50							
		73							
			ND						
		89							
15									*Boring terminated in this strata* *TD=14.5 ft bls*

WELL DIAGRAM

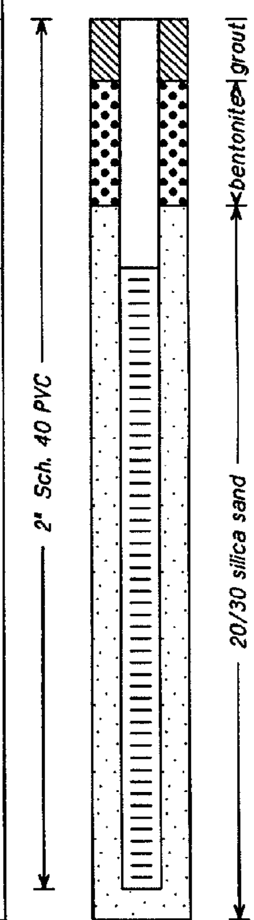


BROWN & ROOT ENVIRONMENTAL	LOG OF BORING I3MW-6	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/9/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *7.12 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Failing F-2*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0–4		30, 37	ND, ND						Fill material, brown to dark brown, coarse sand, pebbles, cobbles, and boulders, poorly sorted
4–14.5		44, 47, 38, 57, 44, 75, 65, 40, 52, 50	ND, ND, ND, ND, ND						Limestone, oolitic, light brown to beige, coarse sand, shell fragments in matrix, moderately consolidated
14.5									*Boring terminated in this strata TD=14.5 ft bls*

WELL DIAGRAM



JOB NUMBER: HK 7046

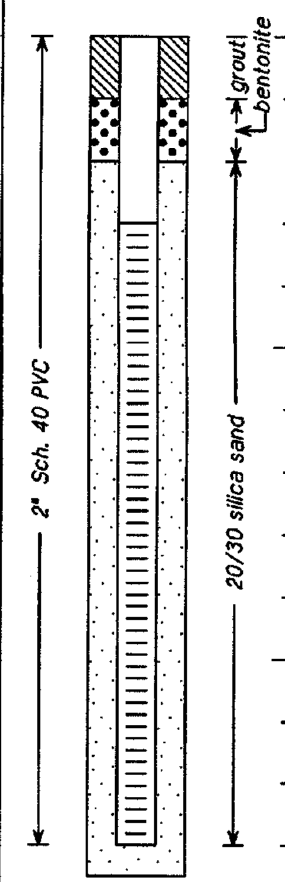
BROWN & ROOT ENVIRONMENTAL

LOG OF BORING I3MW-7

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/20/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *7.15 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Ingersoll Rand A-300*	GEOLOGIST: *Paul Calligan*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	PID (ppm) B. Zone	PID (ppm) Borehole	PID (ppm) Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0									Grass, top soil
		46	ND						
		50							Fill material, crushed limestone, light brown coarse sand and shell, gray, poorly sorted, dry
		22							
5		40	ND						
10									Limestone, oolitic, light brown to beige, coarse sand, some shell fragments, hard moderately consolidated, moderately weathered intergranular to moldic porosity, saturated
		38	ND						
		65							
									Boring terminated in this strata *TD=13.5 ft bls*
15									

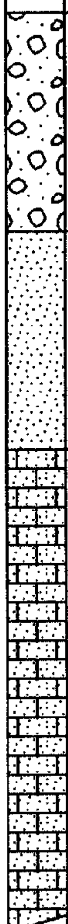
WELL DIAGRAM



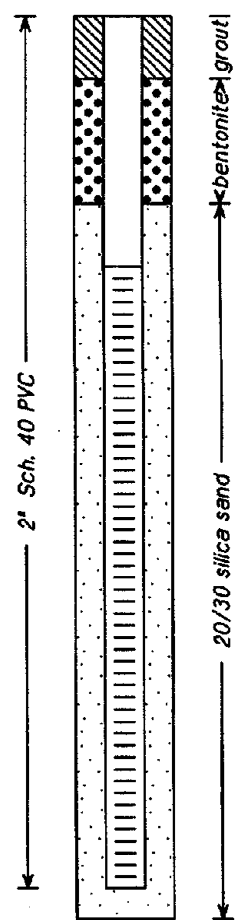
BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S4MW-4	Page 1 of 1

PROJECT NO: HK 7046	PROJECT NAME: Naval Air Station Key West
PROJECT LOCATION: Key West, Florida	DATE DRILLED: 8/10/96
DRILLING COMPANY: Gulf Atlantic Drilling	SURFACE ELEVATION: 5.54 Feet
DRILLING METHOD: Hollow Stem Auger	BORING DIAMETER: 8.25 Inches
DRILLING RIG: Failing F-2	GEOLOGIST: Gary Braganza

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		48	ND						Fill material, crushed limestone, pebbles, cobbles, boulders, and coarse sand poorly sorted, poorly consolidated
		25							
		7	ND						
		4							
5			ND						Clay with minor coarse sand, gray white, well consolidated, stiff, dense
		9	30						Limestone, oolitic, abundant shell fragments and coarse sand in matrix, well consolidated
		29							
		39	ND						
		77							
10		36	ND						
		61							
		57	ND						
		77							
		50	ND						
15									*Boring terminated in this strata TD=14.5 ft bls*



WELL DIAGRAM



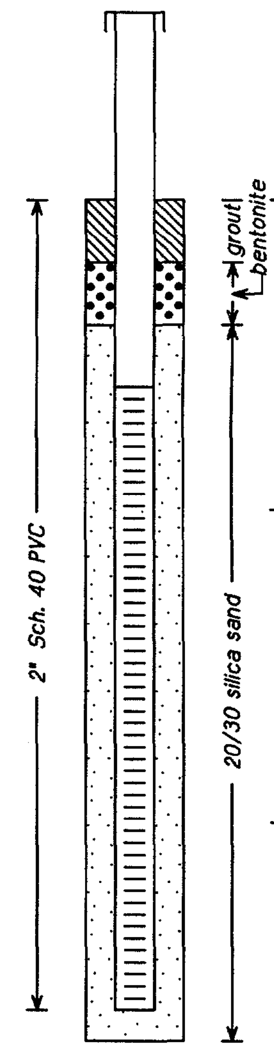
BROWN & ROOT ENVIRONMENTAL

LOG OF BORING S4MW-5

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/10/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *4.71 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Failing F-2*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		56							
			ND						Fill material, coarse sand, pebbles, boulders, and cobbles, beige to light brown, poorly sorted
		28							
		38							
			ND						
		28							Limestone, oolitic, beige to light brown, coarse sand and few shell fragments in matrix
		22							
5			ND						
		31							Same as above, becomes more clayey (20%)
		33							
			5						
		84							
		52							
			2						
		50							
10									Same as above, becomes well consolidated 5% clay, larger shell fragments
		50							
			ND						
		50							
		56	ND						
									Boring terminated in this strata TD=13.5 ft bls
15									

WELL DIAGRAM

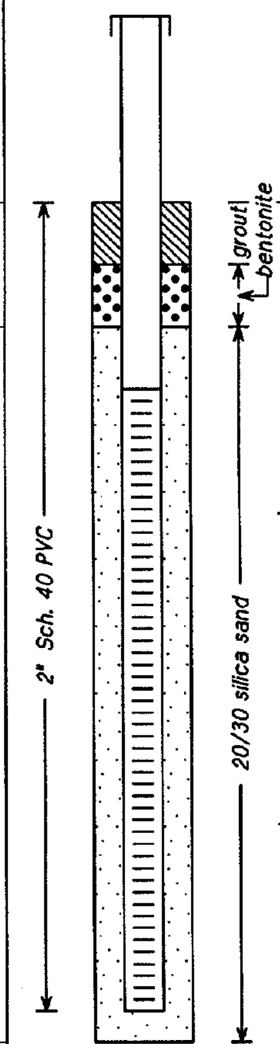


BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S4MW-6	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/10/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *5.21 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Failing F-2*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		40							Fill material, crushed limestone, coarse sand pebbles, cobbles, poorly sorted
			ND						
		26							
		21							Limestone, oolitic, beige to light brown, coarse sand and few shell fragments in matrix, well consolidated
			ND						
		29							
		23							
5			ND						
		11							
		39							
			ND						
		83							
		68							
			ND						
		50							
10									
		65							
			ND						
		70							
		57							
									Boring terminated in this strata TD=13.5 ft bls
15									

WELL DIAGRAM

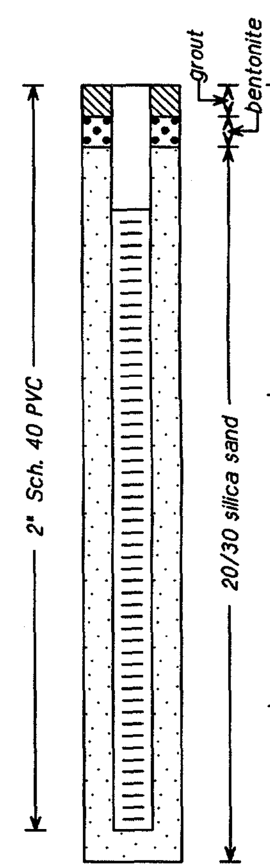


BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S4MW-7	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/19/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *5.38 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Ingersoll Rand A-300*	GEOLOGIST: *Paul Calligan*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0									Asphalt
			ND						Sand, fine to med.-grained, tan to light brown, poorly sorted, dry
			ND						
5			ND						Limestone, oolitic, tan to white, sandy, some shell fragments, friable moderately conslolidated, intergranular to moldic porosity, moderately weathered
			ND						becomes harder and well consolidated
			ND						
10			ND						
									Boring terminated in this strata TD=12.5 ft bls
15									

WELL DIAGRAM

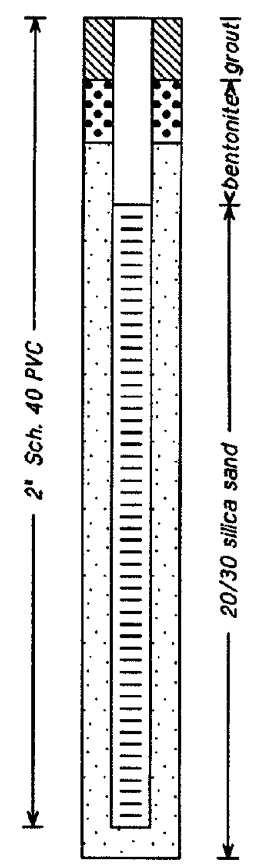


BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S5MW-4	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/11/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *3.85 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Failing F-2*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0									
			ND						Concrete
		32							Fill material, coarse sand, pebbles & cobbles poorly sorted
			ND						
		50							
		26							
5			2						
		40							
		44							
			ND						
		50							
		61							Limestone, oolitic coarse sand & shell fragments in matrix, minor clay, well consolidated
			2						
		68							
10									
		62							
			ND						
		64							
			ND						
		50							
									Boring terminated in this strata *TD=13.5 ft bls*
15									

WELL DIAGRAM



BROWN & ROOT ENVIRONMENTAL	LOG OF BORING S5MW-5	Page 1 of 1

PROJECT NO: *HK 7046*	PROJECT NAME: *Naval Air Station Key West*
PROJECT LOCATION: *Key West, Florida*	DATE DRILLED: *8/11/96*
DRILLING COMPANY: *Gulf Atlantic Drilling*	SURFACE ELEVATION: *4.0 Feet*
DRILLING METHOD: *Hollow Stem Auger*	BORING DIAMETER: *8.25 Inches*
DRILLING RIG: *Failing F-2*	GEOLOGIST: *Gary Braganza*

DEPTH feet	SAMPLE NUMBER	BLOWS/FT.	PID (ppm) Sample	B. Zone	Borehole	Drill B. Z.	GRAPHIC LOG	USCS/RQD	GEOLOGIC DESCRIPTION Density/Consistency, Hardness, Color
0		38							
			ND						
		26							
		9							
			2						
		15							
		32							
5			2						
		47							Limestone, oolitic, beige to light brown, coarse sand and shell fragments in matrix, minor clay, well consolidated
		52							
			ND						
		40							
		40							
			ND						
		72							
10		65							
			ND						
		57							
		76	ND						
									Boring terminated in this strata TD=13.5 ft bls
15									

WELL DIAGRAM