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Formerly Utilized Sites Remedial Action Program (FUSRAP)

# ADMINISTRATIVE RECORD

## for Maywood, New Jersey

U.S. Department of Energy

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**FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM (FUSRAP)**
**CONTRACT NO. DE-AC05-91OR21950**

# BASELINE RISK ASSESSMENT FOR THE MAYWOOD SITE

## VOLUME I

**MAYWOOD, NEW JERSEY**


Prepared by:
Former Sites Restoration Division
U.S. DEPARTMENT OF ENERGY

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## LIST OF ACRONYMS

| | |
|---|---|
| ACGIH | American Conference of Governmental Industrial Hygienists |
| AEC | Atomic Energy Commission |
| ALARA | as low as reasonably achievable |
| ANL | Argonne National Laboratory |
| ARARs | applicable or relevant and appropriate requirements |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BEIR | Committee on the Biological Effects of Ionizing Radiation, National Research Council |
| BG | background |
| BGS | Below Ground Surface |
| BNAE | base/neutral and acid extractable |
| BNI | Bechtel National, Incorporated |
| BRA | baseline risk assessment |
| CEDE | committed effective dose equivalent |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended |
| CFR | Code of Federal Regulations |
| $CHCL_3$ | chloroform |
| COC | contaminant of concern |
| CLP | contract laboratory program |
| CRDL | Contract Required Detection Limit |
| DCE | dichloroethene |
| DCF | dose conversion factor |
| DCG | derived concentration guides |
| DL | Detection Limit |
| DREF | dose rate effectiveness factor |
| DOE | Department of Energy |
| EIS | Environmental Impact Statement |
| EPA | U.S. Environmental Protection Agency |
| EQ | Ecological Quotient |
| ERA | ecological risk assessment |
| ETF | environmental transport factor |
| FFA | Federal Facilities Agreement |
| FS | feasibility study |
| FUSRAP | Formerly Utilized Sites Remedial Action Program |
| HEAST | Health Effects Assessment Summary Tables |
| HI | Hazard Index |
| HQ | Hazard Quotient |
| HVO | halogenated volatile organic |
| ICRP | International Commission on Radiological Protection |
| IDL | Instrument Detection Limit |
| IRIS | Integrated Risk Information System |
| LET | linear energy transfer |
| MCW | Maywood Chemical Works |
| MED | Manhattan Engineer District |
| MISS | Maywood Interim Storage Site |
| MSL | Mean Sea Level |
| NA | not available or not applicable |
| NAS | National Academy of Sciences |

## LIST OF ACRONYMS (continued)

| | |
|---|---|
| NCRP | National Council on Radiation Protection |
| ND | not detected |
| NEPA | National Environmental Policy Act |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| NIOSH | National Institute for Occupational Safety and Health |
| NJ | New Jersey |
| NJDEP | New Jersey Department of Environmental Protection |
| NPL | National Priorities List |
| NRC | Nuclear Regulatory Commission |
| NYSWRR | New York, Susquehanna and Western Railroad |
| OSWER | Office of Solid Waste and Emergency Response |
| OU | operable unit |
| PAH | Polycyclic aromatic hydrocarbons |
| PCE | tetrachloroethylene |
| QL | Quantitation Limit |
| RAGS | Risk Assessment Guidance for Superfund |
| RBAL | risk - based action level |
| RBCL | risk - based cleanup level |
| REM | roentgen equivalent man - unit of dose equivalent |
| RESRAD | RESidual RADioactivity computer code |
| RfD | Reference Dose |
| RI | Remedial Investigation |
| RI/FS | Remedial Investigation/Feasibility Study |
| RME | reasonable maximum exposure |
| ROD | Record of Decision |
| SARA | Superfund Amendments and Reauthorization Act |
| SF | slope factor |
| SHRTSC-ECAO | Superfund Health Risk Technical Support Center - Environmental Criteria and Assessment Office |
| TCE | trichloroethylene |
| TCL | Target Compound List |
| TLV-STEL | Threshold limit value - short-term exposure limit |
| TLV-TWA | Threshold limit value - time-weighted average |
| UCL | upper confidence limit |
| UNSCEAR | United Nations Scientific Committee on the Effects of Atomic Radiation |
| $UL_{95}$ | 95% upper confidence limit |
| VC | vinyl chloride |
| VOCs | volatile organic compounds |
| WLM | working-level month |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| Ac | actinium |
| Bq/g | becquerel per gram |
| $Bq/m^2/s$ | becquerel per square meter per second |
| Bq/L | becquerel per liter |
| cfs | cubic feet per second |
| cm | centimeter |
| $cm^2$ | square centimeter |
| cpm | counts per minute |
| °C | degrees Celsius (Centigrade) |
| d/yr | day per year |
| dpm | disintegrations per minute |
| $dpm/cm^2$ | disintegration(s) per minute per square centimeter |
| °F | degrees Fahrenheit |
| ft | foot |
| ft/y | feet per year |
| g | gram |
| gal | gallon |
| $g/cm^3$ | gram per cubic centimeter |
| gpm | gallons per minute |
| h | hour |
| ha | hectare |
| in | inch |
| $in^2$ | square inch |
| K | potassium |
| keV | kilo electron volts |
| kg | kilogram |
| km | kilometer |
| km/h | kilometer per hour |
| $km^2$ | square kilometers |
| L | liter |
| L/s | liters per second |
| L/min | liters per minute |
| lb | pound |
| m | meter |
| MeV | million electron volts |
| mg/d | milligram per day |
| m/y | meters per year |
| $m^3$ | cubic meter |
| µCi/ml | microcuries per milliliter |
| µCi/pCi | microcuries per picocurie |
| µg | microgram |
| µg/kg | micrograms per kilogram |
| µg/L | micrograms per liter |
| $µg/m^3$ | micrograms per cubic meter |
| µmhos/cm | micromhos per centimeter |
| µR/h | microroentgen per hour |
| mg | milligram |
| mg/kg | milligram per kilogram |

## LIST OF ABBREVIATIONS (continued)

| | |
|---|---|
| mi | mile |
| $mi^2$ | square miles |
| min | minute |
| mph | miles per hour |
| µR | microroentgen |
| mrad | millirad |
| mR/hr | milliroentgen per hour |
| mrem/yr | millirem per year |
| O.D. | outside diameter |
| Pa | protactinium |
| Pb | lead |
| ppb | parts per billion |
| ppm | parts per million |
| pCi | picoCurie |
| $pCi/cm^3$ | picoCurie per cubic centimeter |
| $pCi/m^3/hr$ | picoCurie per cubic meter per hour |
| $pCi/m^3/s$ | picoCuries per cubic meter per second |
| pCi/g | picoCuries per gram |
| pCi/L | picoCuries per liter |
| $pCi/m^2/s$ | picocuries per square meter per second |
| Po | polonium |
| Ra | radium |
| Rn | radon |
| Th | thorium |
| Tl | thallium |
| U | uranium |
| yd | yard |
| $yd^3$ | cubic yards |

# EXECUTIVE SUMMARY

## 1. BACKGROUND INFORMATION

The U.S. Department of Energy (DOE) is conducting a comprehensive review and analysis to evaluate potential remedial actions for a set of properties in and near Maywood, New Jersey, collectively referred to as the Maywood site. Contamination at these properties is attributed in part to thorium processing operations conducted at Maywood Chemical Works (MCW) beginning in 1916. Remedial action is being taken under DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP). Responsibility for the Maywood site was assigned to DOE as a decontamination research and development project by the U.S. Congress through the Energy and Water Development Appropriations Act of 1984.

To determine remedial action needs and establish appropriate cleanup goals for the Maywood site, DOE is currently preparing a remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS). This type of document is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, and incorporates the requirements of the National Environmental Policy Act (NEPA) of 1969. Details of the RI/FS-EIS process are described in the project work plan (ANL and BNI 1992). As part of the ongoing analysis at the Maywood site, this baseline risk assessment (BRA) has been prepared to evaluate risk to human health and the environment from the radioactive and chemical contaminants in the absence of remedial action. As such, this BRA serves as a baseline for evaluating available remedies. This baseline is consistent with CERCLA and does not assume future control by DOE; for purposes of the future scenarios evaluation, current institutional controls are not expected to remain in place.

The Maywood site is located in northern New Jersey in a highly developed area approximately 20 km (12 mi) north-northwest of New York City and 21 km (13 mi) northeast of Newark, New Jersey. More than 80 vicinity properties became contaminated with radiological materials. These properties are distributed in an area approximately 2.5 km (1.5 mi) long by 1 km (0.5 mi) wide in a neighborhood with intermixed residential, commercial, and industrial properties and an average population density of about 5,000 to 10,000 persons per square mile. This area also lies across several major transportation corridors, including NJ Route 17, U.S. Route 46, and Interstate 80.

Ecological resources include terrestrial vegetation and wildlife commonly found in regional residential/commercial properties similar to Maywood. Freshwater wetlands of intermediate or ordinary value cover approximately 4.1 acres of the study area. No endangered or threatened plant or animal species inhabit the area. Aquatic habitats include drainageways, small temporary ponds, and limited portions of Westerly and Lodi Brooks. The Saddle River and its floodplain constitute the most productive habitat in the site vicinity.

In the RI report (BNI 1992), the properties comprising the Maywood site were grouped into four operable units based on land use. These are the Maywood Interim Storage Site (MISS), the Stepan Company property, commercial/government properties, and residential properties including municipal parks. With such widely distributed properties, average contaminant levels and the risks estimated from them would be meaningless. Therefore, for risk assessment purposes several smaller property units were defined. A complete listing of all the Maywood site properties showing the operable units and property units in which they have been grouped and their current status is given in Appendix A.

In September 1983, the Maywood site was placed on the National Priorities List (NPL) by the U.S. Environmental Protection Agency (EPA). A Federal Facilities Agreement (FFA) between DOE and EPA now governs the remedial program and specifies DOE cleanup responsibilities. Under the FFA, DOE is responsible for cleanup of "FUSRAP waste," which is specifically limited to the following:

- all radioactive and chemical contamination occurring on or migrating from MISS;
- all radioactive contamination exceeding DOE action levels and related to thorium processing at MCW, occurring on vicinity properties; and
- any chemical or nonradiological contamination on vicinity properties that would fulfill either of the following requirements:
  - the contamination originated at MISS or was associated with specific thorium manufacturing or processing activities at MCW that resulted in the radioactive contamination; or
  - the chemical or nonradiological contaminants that were mixed or commingled with radiological contamination above DOE action levels.

The Maywood BRA focuses primarily on radionuclide contamination due to the more extensive database on radiological contaminants and the expectation that these are the primary contaminants from MCW operations. However, chemical contamination at the site also is evaluated using available data. The BRA presents estimates of the mean and reasonable maximum exposure

(RME) incremental risk levels for human receptors in current and future land use scenarios. The relative risks to ecological receptors is assessed using ecological quotients (EQs). The approach used for the Maywood BRA is based on the EPA Risk Assessment Guidance for Superfund (RAGS) (EPA 1989b and 1991c) and related guidance (EPA 1992a).

## 2. CONTAMINANTS OF CONCERN

Numerous radiation surveys and site characterization studies have been conducted at MISS and the vicinity properties. Data from these studies and the RI report (BNI 1992) were reviewed and used to select contaminants of concern (COC) for detailed evaluation in the subsequent exposure assessment and risk characterization. The geographic distribution of properties and the history of numerous characterization studies have produced two distinct data collections, one for radiological and one for chemical contaminants; this is reflected in the organization and presentation of data and results in this report.

Data sets were compiled for each of the property units and statistical analyses were performed on the aggregated soil radionuclide data. The data sets were examined to identify and group properties with similar contaminant levels. Radionuclides were selected as COCs if the range of detected concentration exceeded twice the average of background concentrations. The radiological COCs selected for this risk assessment are Thorium (Th)-232, Uranium (U)-235, U-238, Radium (Ra)-226 and their associated decay products.

Chemical contaminant sampling data for the MISS and Stepan operable units and two adjoining properties were used in the risk assessment. Chemical data were evaluated in accordance with EPA guidance (EPA 1989b). Chemicals were selected as COCs if the frequency of detection warranted inclusion under the COC screening criteria and for chemicals which are found naturally if the detected average concentrations exceeded twice the average background concentrations. Chemical data were aggregated by operable unit, medium, and location of sample within each medium before screening. The final list of COCs for the risk assessment is comprised of those chemicals that remained after application of the screening criteria and for which appropriate toxicity factors were available. The chemical COCs retained for evaluation in the quantitative risk assessment included the following:

| Medium | Contaminant | | | |
|---|---|---|---|---|
| | Metals | VOCs* | BNAEs** | Pesticides |
| Soil | 7 | 6 | 23 | 0 |
| Groundwater | 13 | 13 | 5 | 1 |
| Surface water | 2 | 3 | 0 | 0 |
| Sediment | 2 | 0 | 0 | 0 |

* VOC - volatile organic compounds

** BNAE - base/neutral and acid extractable

## 3. EXPOSURE ASSESSMENT

In the exposure assessment, a detailed evaluation of each of the property units was completed in order to identify and characterize contaminant sources and release mechanisms, transport media, exposure points, exposure routes, and human receptors. Human receptors include residents, transients, and employees. Two categories of exposure scenarios were considered: current land use and hypothetical future use. In the future use scenario, land use could remain as it is now or could change, such as a light commercial area converting to residential use in the future, with a resident who is assumed to grow a portion of his own food onsite.

Conceptual site models were developed for these exposure scenarios. Exposure pathways and receptors were identified for use in the risk assessment. Exposure point concentrations were determined based on measured contaminant concentrations in environmental media of concern (particularly surface and subsurface soils) and modeling procedures.

Radiological exposure rates and doses were calculated using the RESidual RADioactivity (RESRAD) computer code. Where measured radon data were not available, inhalation of radon progeny was estimated using United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) methodology. Annual dose estimates are presented in tabular format and also in maps prepared to correspond to DOE guidelines. The annual dose ranges shown in these maps are <10 mrem/yr, 10-25 mrem/yr, 25-100 mrem/yr, 100-500 mrem/yr, and >500 mrem/yr. The rationale for selection of these ranges is given in Section 3.

Chemical intake estimates are based on EPA methodology presented in RAGS (EPA 1989b) and related guidance (EPA 1991b). All estimated intakes are summarized in Appendix E. For the MISS and Stepan property units, estimated intakes for incidental soil ingestion were calculated for

the current and future employee and transients. Inhalation exposure estimates included inhalation of airborne contaminated particulates and radon, where appropriate. Surface soil statistical data were utilized to calculate exposure point concentrations for all scenarios.

Average and RME groundwater intakes were estimated for the resident and the future employee utilizing the combined alluvial groundwater data from MISS, Stepan, and Ballod. It was conservatively assumed that 100 percent of the total water intake is derived from the contaminated source.

Average and RME surface water intakes and sediment ingestion were estimated for the future child resident wading and playing in Westerly Brook and Lodi Brook. A 50 mL/event contact rate was conservatively assumed based on EPA's recommended contact rate for surface water ingestion while swimming.

For residential properties, exposure to contaminated soils, sediments, and structures may occur via complete pathways for inhalation, direct radiation, and incidental soil ingestion for all scenarios and receptors.

There are no current residents at municipal parks, but transients, particularly children, may spend extended periods in contact with soil. The present and future use exposure pathways for municipal parks include inhalation, direct radiation, and incidental soil ingestion. No complete pathways exist for surface water or groundwater at the municipal park property units under current use conditions. Complete pathways may exist in the future if these properties are converted to residential use.

## 4. TOXICITY ASSESSMENT

Cancer and chemical toxicity are the two general endpoints for health effects from exposure to site contaminants. Cancer induction is the primary health effect associated with radionuclides at the site, and 21 of the chemical contaminants at the Maywood site are classified by EPA as potential carcinogens. Four of the 21 are classified as Group A carcinogens, for which strong evidence exists for human carcinogenicity. A number of toxic effects are linked with exposure to carcinogenic and noncarcinogenic contaminants.

Potential carcinogenic risks from exposure to radiation were estimated by using scientifically accepted values to convert estimated doses (in mrem) to the likelihood of cancer induction. The

potential for carcinogenic and noncarcinogenic effects of human exposure to chemicals was quantified using standard EPA slope factors and reference doses.

## 5. RISK CHARACTERIZATION

Risk estimates were developed for reasonable current use and hypothetical future use scenarios for human receptors at the Maywood site. Human receptors include residents, employees, and transients (visitors, customers, trespassers, commuters). Radiological risks and chemical risks are estimated separately.

For the radiological assessment, risk is defined as the lifetime probability of cancer morbidity and does not include genetic or noncarcinogenic effects. For the chemical COCs, cancer risk estimates and hazard index (HI) estimates are presented, as appropriate, where toxicity values are available.

Cancer risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of pathway-specific exposure to carcinogenic contaminants. EPA has identified a target range of acceptability of $10^{-4}$ to $10^{-6}$ for the incremental cancer risk to an individual from exposures at NPL sites. The potential for noncarcinogenic effects from chemicals is evaluated by summing the ratios of intake to chronic reference dose values. This ratio of exposure is called a hazard quotient (HQ). HQs for each COC are then summed to obtain an HI for the specific pathway. When the HI exceeds unity, there may be concern for adverse noncarcinogenic health effects from exposures.

### 5.1 Radiological Risk

The radiological health risks are limited to induction of cancer. Risk from exposure to radioactive contaminants was estimated following EPA (EPA 1989d), BEIR IV (NRC 1988), and BEIR V (NRC 1990) recommendations. A population-weighted average excess cancer risk of $6 \times 10^{-7}$ per mrem was assumed.

For the current use scenario, reasonable maximum risk estimates exceed the target range for residents at the I-80 South right-of-way and Long Valley Road (Residential, Property Unit 1); for transients at the field on MISS property, in front of Building 76 (MISS, Property Unit 6H); and current employees at Stepan (Stepan, Property Units 3 and 3H), MISS (MISS, Property Unit 6), and Sears/DeSaussure (Commercial/Government, Property Unit 7H).

For the hypothetical future use scenario, estimated radiological risks for RME receptors at all property units, except for future residents on Branca Court and Redstone Lane (Property Unit 2), exceed the EPA target risk range. Dominant exposure pathway risks in the future use scenarios are similar to those in the current use scenario with direct gamma irradiation and radon contributing most of the radiological risk to the resident and employee receptors and direct gamma irradiation contributing most of the radiological risk to transients.

The projected excess cancer rate for the total population within 80 km (50 mi) around the Maywood site is approximately 600 cancers per 10 million people. This constitutes less than 1 percent of the total local cancer incidence rate attributable to background radiation (100,000 cancers per 10 million people).

## 5.2 Chemical Risk

Chemical cancer risk and health hazard were estimated for chemicals of concern based on EPA risk assessment guidance (EPA 1989b, 1992d). The cancer risk from exposure to contaminants is expressed as the increased probability of developing cancer over a 70-year lifetime. The potential for adverse noncarcinogenic health effects is expressed as an HI, the sum of chemical-specific HQs.

Under the current use scenario, none of the estimated cancer risks exceeded the EPA target risk range for employees or transients at MISS or Stepan. The principal contributors to risk from soil ingestion were arsenic and polyaromatic hydrocarbons (PAHs) at both properties. For airborne particulate inhalation, chromium was the sole contributor to risk at MISS as was arsenic at Stepan; however, risks could not be calculated for PAHs because no inhalation slope factors were available for PAHs.

The HIs for current employees and transients at MISS and Stepan were less than one, indicating no concern for potential adverse noncancer health effects. Chromium, lithium, and uranium were the principal contributors to the health hazard at MISS with arsenic and uranium the principal contributors at Stepan.

For the hypothetical future use scenario, none of the estimated cancer risk exceeded the EPA target range, except for groundwater ingestion. Groundwater contamination was considered as a continuum; therefore, separate risks were not calculated for individual properties. The risk

attributable to ingestion of bedrock groundwater was less than that projected for the shallow (alluvium) groundwater.

The cancer risk from soil ingestion and particulate inhalation for future employees and transients at MISS and Stepan are the same as the current use scenario and did not exceed the EPA target risk range. The estimated cancer risk for a future resident child ingesting surface water while playing in Westerly Brook was $2 \times 10^{-7}$. There are no slope factors for estimating exposure through sediment ingestion from Lodi Brook.

The principal noncancer health hazard under the hypothetical future scenario is groundwater ingestion. No other complete pathways for which HIs could be calculated exceeded the concern threshold of one. In shallow (alluvium) groundwater, arsenic, chromium, lithium, and manganese contributed principally to the HI.

### 5.3 Overall Health Risk

To lend perspective for overall site risk, radiological and chemical carcinogenic risks for current and hypothetical future receptor scenarios were summed. Since insufficient data are available to calculate chemical risks for all property units, the summation encompasses only the MISS and Stepan properties. Aggregate cancer risk is $6 \times 10^{-3}$ for employee RME exposure at MISS. The aggregate exposure is less for Stepan employees. For current and future scenarios, potential radiological risks are generally higher than chemical risks except for groundwater ingestion.

### 5.4 Uncertainties Related to Risk Estimates

Uncertainties attributable to the numerous assumptions incorporated in the risk estimations are inherent in each step of the risk assessment process. These uncertainties are discussed in detail in Section 5. A key factor affecting the exact identification of COCs for the Maywood site is associated with the limitations imposed by the available database, especially the limited data available for chemical contaminants. In addition, the COCs identified for the BRA might include chemicals that contribute to overall site risk but are not necessarily attributable to past thorium processing activities at the site.

Uncertainty is associated with each step of the risk assessment process. For example, sampling locations are preferentially selected where higher contamination is expected, not all

analytes are sampled for all locations and media, a wide variation in future exposure pathways could be considered, and some toxicity data are not available. Although several procedures used and the limitations in available information will, in some cases, result in under estimates, the conservative assumptions used in this BRA tend to over estimate potential risks. Therefore, actual risks may be lower than those presented in this assessment.

Because of the inherent uncertainties in the risk assessment process, the results of the human health assessment presented in this BRA do not represent absolute risk. Rather, estimated risks should be considered to represent the most important sources of potential risk at the site, which, once identified, might be evaluated in more detail and remedied, as appropriate, during the remedial action process.

## 6. ECOLOGICAL ASSESSMENT

The Maywood site, located in an urban and industrialized area, nonetheless contains ecological resources including aquatic, terrestrial, and wetland ecosystems. No threatened or endangered species identified by the U.S. Fish and Wildlife Service (FWS) are known to inhabit the site. Habitats and biota occurring at the Maywood site are not viewed as unique or unusual, or necessary for continued propagation of key species. The significance of the Maywood site with regard to local ecological resources may be minimal, and intensive field studies for possible impacts to biota from site contaminants may not be warranted when literature findings could be sufficient.

Sixty-two chemicals were recognized as potential ecological COCs. Most of these chemicals were found above background levels in the surface soils at MISS, Stepan, commercial/government and residential vicinity properties, alluvial groundwater at the MISS/Stepan/Ballod property, and surface water and sediments in Westerly and Lodi Brooks. Calcium, potassium, and sodium were eliminated from the risk characterization because they are essential biological minerals. There are no readily available terrestrial wildlife toxicity data for radium, thorium, and uranium (or their isotopes) at the Maywood site. The risk assessment for metals and other elements and volatile and semivolatile organic chemicals relies on aquatic and oral toxicity data for laboratory animals that were gathered from compendia of published studies, e.g., Long and Morgan (1990), AQUIRE (1992). When the observed environmental concentrations and physical-chemical parameters of COCs were compared to toxicity, mobility and persistence thresholds, 40 of these emerged as the contaminants of ecological concern. The ecological quotients (EQs) for those contaminants exceeding their toxicity thresholds ranged from 2.1 to 98 (mean) and 2.1 to 15,053 (RME). Ratios which exceed 1 by a significant margin are of concern. The ecological COCs consist of radium,

thorium, and uranium (and their isotopes), 14 elements (metals and rare earths), 22 volatile and BNAE organic chemicals, and one organic pesticide.

Chromium, barium, lead, and copper had the highest EQs at Maywood operable units. Barium and lead exceeded 1,000 in soils at commercial/government properties as did hexavalent chromium in MISS soil, and lead in residential vicinity property soils. The EQs of copper and hexavalent chrome exceeded 100 in commercial/government property soils, as did copper and lead in MISS soils. Lead's EQ exceeded 100 in Stepan soils. Arsenic, chromium, copper, and lead in groundwater at the MISS/Stepan/Ballod property had EQs between 10 and 100. Zinc and phenanthrene had EQs between one and 10 in MISS/Stepan/Ballod groundwater and Stepan soils, respectively. EQs for the other organic COCs and lithium in MISS, Stepan, commercial/government vicinity property soils, MISS/Stepan/Ballod groundwater, and Westerly Brook surface water were not calculated.

The relative risks of Maywood COCs to ecological receptors exposed via different modes and pathways are assessed using exposure quotients (XQs) which are the ratio of exposure concentrations (i.e., the environmental concentration corrected for exposure) to the toxicity threshold concentration. When hypothetical exposure is considered, the heavy metals with many XQs > $10^4$ present the greatest ecological risk to both onsite and offsite terrestrial receptors. Terrestrial organisms exposed onsite via direct contact with contaminated media or trophic pathways are subject to the greatest risk from arsenic and chromium in MISS/Stepan/Ballod groundwater, lead in soils at all sites, and chromium in MISS soil (all XQs > $10^2$ except that for arsenic). Terrestrial organisms are exposed to an unknown degree of risk from the organics. All COCs pose a lower relative risk to offsite terrestrial predators because offsite receptors are hypothesized to experience no less than a tenth of this exposure.

The numerous COCs with large EQs and XQs strongly indicate that, in the absence of remediation, both onsite and offsite terrestrial organisms and populations at Maywood properties will continue to be at risk of adverse ecological effects.

# 1. INTRODUCTION

The U.S. Department of Energy (DOE) is preparing a remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS) for a group of properties in and near Maywood, New Jersey, collectively referred to as the Maywood site. These properties were contaminated beginning in 1916, primarily as a result of thorium processing. DOE is responsible for cleanup activities at this site under its Formerly Utilized Site Remedial Action Program (FUSRAP).

The U.S. Atomic Energy Commission (AEC), a predecessor agency of DOE, established FUSRAP in 1974 to identify and decontaminate sites where radioactive contamination remained from activities carried out under contract to the Manhattan Engineer District (MED) and AEC. Responsibility for the Maywood site was assigned to DOE as a decontamination research and development project under FUSRAP by the U.S. Congress through the Energy and Water Development Appropriations Act of 1984.

As part of the ongoing analysis at the Maywood site, this baseline risk assessment (BRA) has been prepared to evaluate risk to human health and the environment from the radioactive and chemical contaminants at the site. This BRA will be used to support future decisions on remedial activities to be implemented at the site.

This section presents a brief description of the overall site and its background. Section 1 also advances the objectives and scope of this study, followed by an overview of report organization.

## 1.1 RESPONSIBILITIES AND OBJECTIVES

DOE is a responsible party for cleanup activities at the site under FUSRAP. The primary goal of FUSRAP is to mitigate potential hazards to human health and the environment. To determine and establish cleanup goals for the Maywood site, DOE is preparing an RI/FS-EIS, as required by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, and the National Environmental Policy Act of 1969 (NEPA). Details of the RI/FS-EIS process are described in the project work plan (ANL and BNI 1992). The Maywood BRA is a component of the process. It addresses potential risks to human health and the environment associated with contamination present at the various properties comprising the Maywood site in the absence of remedial action.

### 1.1.1 Environmental Compliance Process

The assessment of potential baseline health risks and environmental impacts associated with a contaminated site is an important component of the RI/FS process, which is the framework the U.S. Environmental Protection Agency (EPA) developed to evaluate remedial alternatives for hazardous waste sites under CERCLA. DOE is incorporating NEPA values into its CERCLA process, so that all the environmental consequences of a proposed action will be considered as part of the decision-making process for that action. Hence, the primary evaluation documents of an RI/FS under CERCLA have been supplemented to incorporate elements of an EIS under NEPA. The resultant document is, therefore, referred to as the RI/FS-EIS. In integrating NEPA values into CERCLA documentation, the RI generally incorporates the affected environment portion of an EIS; the BRA provides information for evaluation of the no-action alternative, and the FS provides the detailed evaluation of the alternatives. The environmental compliance documents for the Maywood site are being developed in coordination with EPA Region II and the state of New Jersey.

The results of the RI/FS-EIS documents will be summarized in a proposed plan, which identifies the preferred alternative for site remediation. The documents will be issued for public comment. Public involvement is considered an important component of the decision-making process for site remediation. Responses to public comments on the RI/FS-EIS and proposed plan will be incorporated into a responsiveness summary and a record of decision (ROD). Following this decision, remedial design and remedial action activities will be planned and implemented at the site.

### 1.1.2 Objectives of the BRA

There is the potential for uncontrolled releases of contaminants to the environment from exposed surface and subsurface disposal areas and contaminated soils at the Maywood site. Contaminants could be released from these sources via infiltration and percolation, surface runoff, and particulate or gaseous emissions. Direct external radiation exposure or dermal exposure at the site is also a possibility. If not properly controlled, exposures to the contaminants could be increased by natural or anthropogenic disturbances.

The goal of the risk assessment process is to focus on providing the information necessary to justify remedial action at a site and to facilitate selection of the best remedy for the site. The specific objective of this BRA is to assess the potential impacts on human health and the

environment that may result from releases of, or exposure to, radiological and chemical contaminants under current and future average and reasonable maximum exposure (RME) conditions for the various Maywood scenarios and receptors.

This BRA identifies the primary sources/release mechanisms, environmental transport media, principal exposure points and principal exposure routes/receptors at Maywood properties. The potential health risks and ecological impacts will be documented for the current and future land uses in the absence of remedial action. It, therefore, also satisfies CERCLA/NEPA requirements to complete a detailed no-action alternative analysis. This analysis, together with the RI report (BNI 1992), will serve as the primary means of documentation of the no-action alternative. Further, the information from the BRA will aid in the development of FS activities and focus development of remedial alternatives.

## 1.2 SITE BACKGROUND

### 1.2.1 General Site Description – Operable Units and Property Units

The Maywood site is located in northern New Jersey in a highly developed (industrial and residential) area approximately 20 km (12 mi) north-northwest of New York City and 21 km (13 mi) northeast of Newark, New Jersey. Politically, it is located in the boroughs of Maywood and Lodi, and the township of Rochelle Park, all of which are in Bergen County, New Jersey (Figure 1-1). The Maywood site became contaminated primarily as a result of thorium processing operations conducted for 40 years at Maywood Chemical Works (MCW) (Figure 1-2). More than 80 vicinity properties became contaminated with radiological materials as a result of waste disposal operations, construction activities, and surface water movement.

The RI report groups the vicinity properties into four operable units based on land use. These are represented as follows: (1) MISS, (2) the Stepan Company property, (3) commercial/government properties, and residential properties and municipal parks. For risk assessment purposes, a further division into smaller units is necessary because with such widely distributed properties, average contaminant levels and the risks estimated from them would be meaningless. Therefore, several small units were defined in which there are one or more properties with similar contamination histories and land use. These are designated "property units" and are shown as numbered units in Figure 1-2.

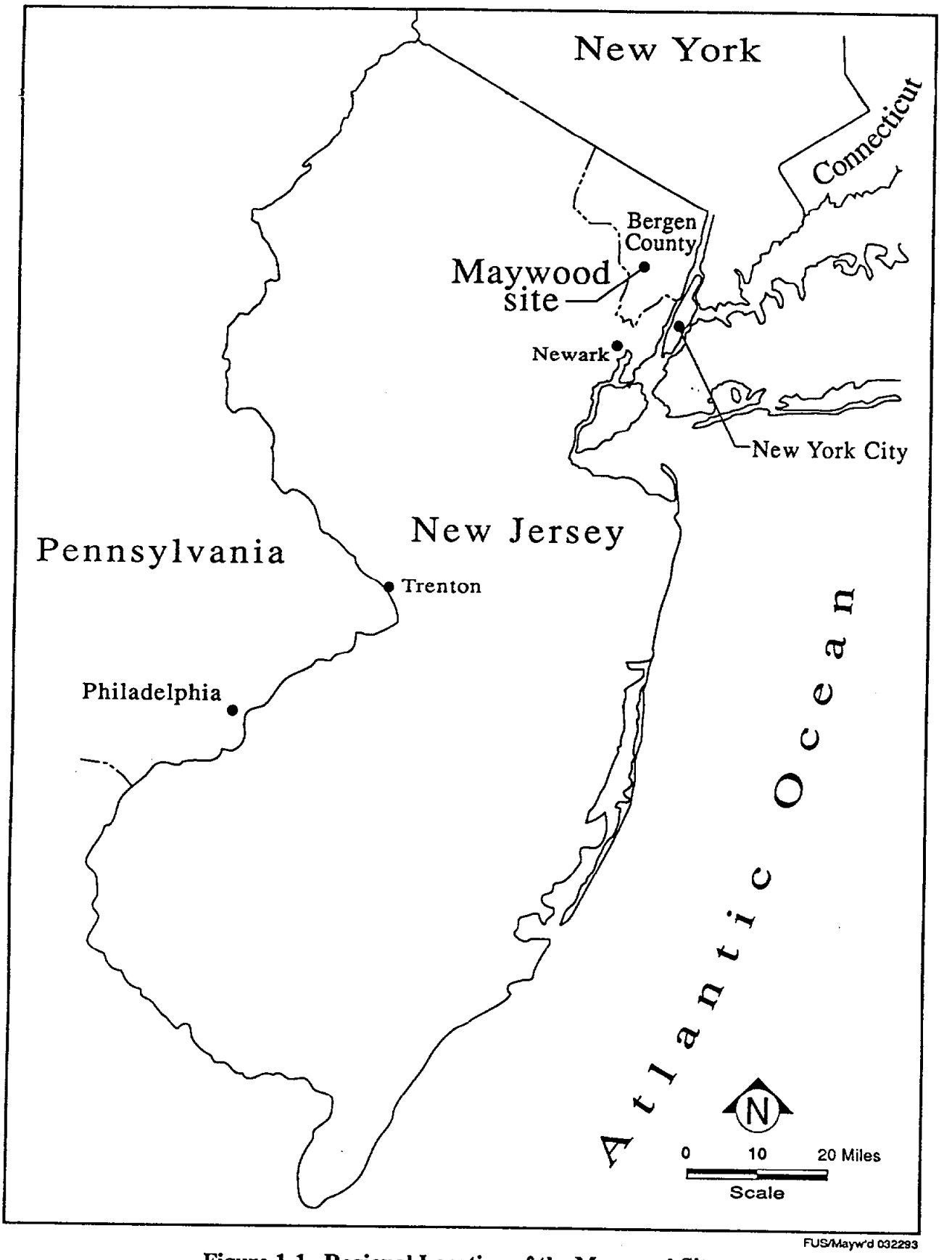


**Figure 1-1. Regional Location of the Maywood Site**

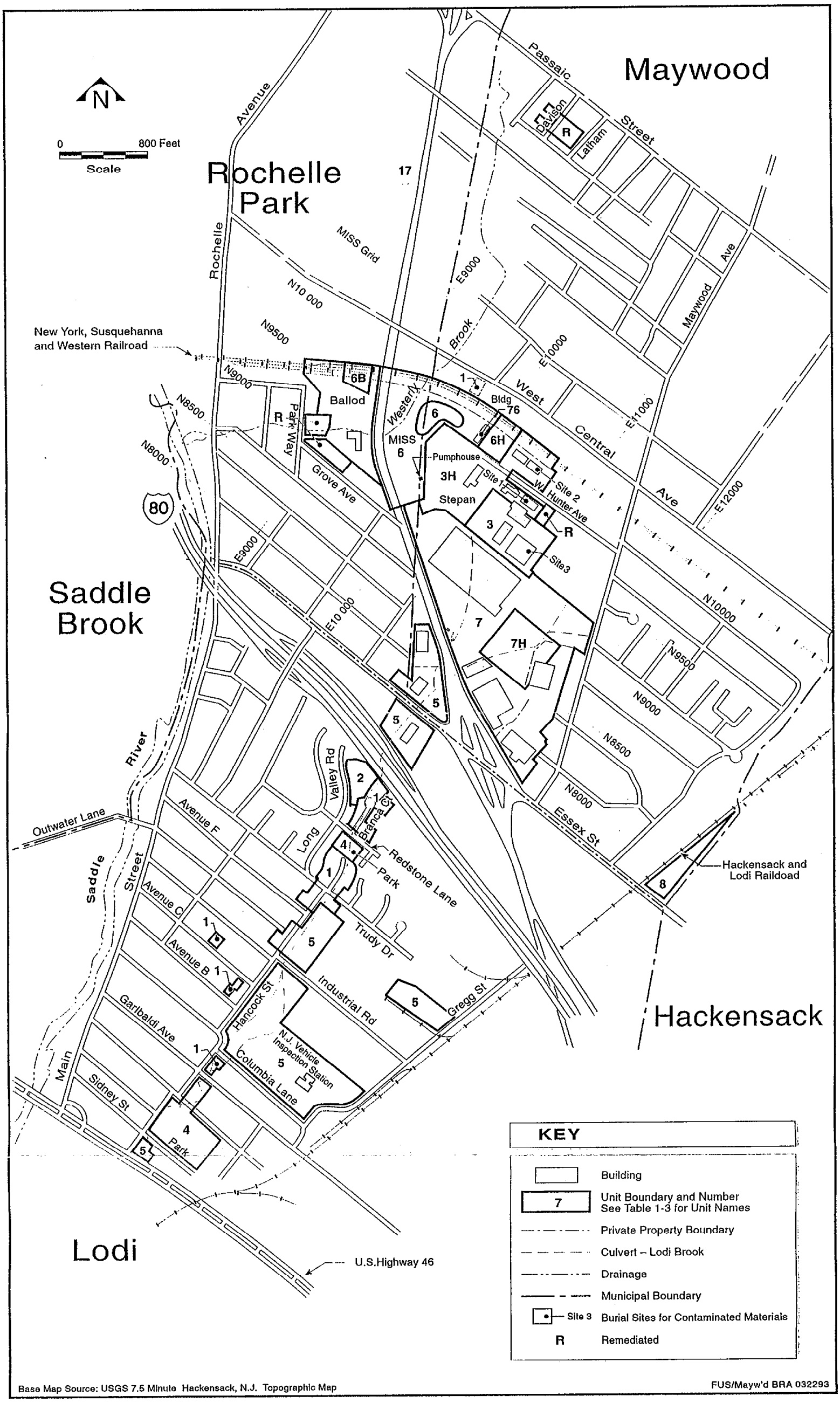


**Figure 1-2. The Maywood Site, Showing Unit Designations and Numbers**

The radiological data were aggregated by land use and radionuclide concentration. A proxy value referred to as the average contaminant level was created to account for the presence of multiple radionuclides within a single sample. Radionuclide concentration ratios were developed by dividing the measured Radon(Rn)-226, Thorium(Th)-232, and Uranium(U)-238 concentrations for each sample by their respective DOE soil guidelines [5 pCi/g of Radium(Ra)-226 and Th-232 in surficial soils (0 to 15 cm), 15 pCi/g in subsurface soils (>15 cm)]. U-238 guideline concentration estimates are shown in Table 1-1. An estimated U-238 guideline of 60 pCi/g was used for all soil horizons. This value was taken from site-specific guidelines developed by DOE for a site with similar contamination and land use. The average contaminant level of a sample is defined as the sum of the radionuclide concentration ratios for each analyte within the sample. An average contaminant level above one indicates that the sample exceeds the DOE soil criteria. Average contaminant levels for individual sample locations were calculated from all of the samples collected at that location. Average contaminant levels by property were then determined using all of the samples collected at each property. The properties within each operable unit were ranked according to average contaminant level; results are shown in Table 1-2. Properties with average contaminant levels below the DOE soil criteria were segregated by operable unit. Properties with average contaminant levels above the criteria were investigated by plotting contaminant concentration by individual borehole. The plots were reviewed to identify contiguous areas where sample location contaminant levels exceeded the DOE criteria by more than an order of magnitude. These contiguous areas of anomalous contamination were aggregated separately.

Table 1-3 provides the correlation of operable units and property units. Numbering of the property units is arbitrary and is not in any specific sequence. However, in order to maintain the correlation of property units used in this BRA with operable units used in the RI report (BNI 1992), both are presented in a consistent order in the following sections of this report. Appendix A lists all the Maywood site properties showing the operable units and property units in which they have been grouped and their current status.

MISS is a 4.7-ha (11.7-acre) fenced lot on the northwestern corner of what was originally a 12.1-ha (29.9-acre) property owned by the Stepan Company. The site contains a waste storage pile consisting of about 27,000 $m^3$ (35,000 $yd^3$) of contaminated materials, two buildings (Building 76 and a pumphouse), a reservoir, and two rail spurs (Figure 1-3). The lot is bounded on the west by Route 17; on the north by the New York, Susquehanna, and Western Railroad line; and on the south and east by commercial and industrial areas. MISS is the only property at the Maywood site that DOE owns and directly controls. Residential units are located north of the railroad line and within 100 m (328 ft) to the west of MISS.

**Table 1-1. U-238 Guideline Concentration Estimates**

| Receptor | Exposure | Unit Dose per pCi/g (2) | | 100 mrem/yr equals (3) | |
|---|---|---|---|---|---|
| | | Current (1) (mrem/yr) | Future (1) (mrem/yr) | Current (pCi/g) | Future (pCi/g) |
| Transient | RME | 1.6E-03 | 1.6E-03 | 62,000 | 62,000 |
| Transient | mean | 1.3E-03 | 1.3E-03 | 79,000 | 79,000 |
| Employee | RME | 4.1E-02 | 5.2E-02 | 2,500 | 1,900 |
| Employee | mean | 3.6E-02 | 4.2E-02 | 2,800 | 2,400 |
| Adult Resident | mean | 1.1E-01 | 1.5E-01 | 900 | 700 |
| Child Resident | mean | 1.1E-01 | 1.5E-01 | 900 | 700 |
| Adult Resident | Default (4) | 4.3E-01 | 2.0E+00 | 200 | 50 |

1) Exposure scenarios defined in Section 3.
2) Assuming a 2m thick source containing 1 pCi/g of U-238+Decay Products and U-234, and 0.05 pCi/g of U-235+Decay Products.
3) Concentration of U-238 that would produce 100 mrem/yr.
4) RESRAD default resident farmer scenario.

**Table 1-2. Average Radionuclide Contaminant Levels(1)**

| Property | Ratio |
|---|---|
| ***Residential Properties*** | |
| 19 Redstone Lane | 0.03 |
| 70 West Hunter | 0.13 |
| 99 Garibaldi Avenue | 0.19 |
| 4 Branca Court | 0.19 |
| 106 Columbia Lane | 0.20 |
| 14 Long Valley Road | 0.21 |
| 62 Trudy Drive | 0.24 |
| 2 Branca Court | 0.27 |
| 11 Branca Court | 0.27 |
| 4 Hancock Street | 0.27 |
| 108 Avenue East | 0.28 |
| 113 Avenue East | 0.29 |
| 17 Redstone Lane | 0.30 |
| 5 Hancock Street | 0.31 |
| 9 Hancock Street | 0.33 |
| 24 Long Valley Road | 0.35 |
| 6 Branca Court | 0.36 |
| 7 Hancock Street | 0.38 |
| Interstate 80 East | 0.53 |
| 8 Hancock Street | 0.53 |
| 79 Avenue B | 0.56 |
| 10 Hancock Street | 0.57 |
| 90 Avenue C | 0.60 |
| 112 Avenue East | 0.67 |
| 136 West Central | 0.68 |
| 7 Branca Court | 0.70 |
| 6 Hancock Street | 0.86 |
| 26 Long Valley Road | 0.96 |
| 16 Long Valley Road | 1.04 |
| 11 Redstone Lane | 1.15 |
| 18 Long Valley Road | 1.28 |

**Table 1-2. (continued)**

| Property | Ratio |
|---|---|
| 22 Long Valley Road | 1.54 |
| 20 Long Valley Road | 1.71 |
| ***Stepan Property*** | |
| Stepan | 2.60 |
| ***Commercial/Government Properties*** | |
| 72 Sydney Street | 0.02 |
| 100 Hancock Street | 0.07 |
| 160/174 Essex Street | 0.10 |
| 80 Hancock Street | 0.11 |
| 1-80 North | 0.13 |
| 205 Maywood (Myron) | 0.16 |
| 80 Industrial Road | 0.18 |
| 113 Essex - NCB | 0.19 |
| 200 Route 17 | 0.23 |
| Muscarelle | 0.27 |
| Bergen Cable | 0.82 |
| NJ Vehicle Inspection Station | 0.90 |
| Gulf Station | 1.01 |
| Sunoco Station | 1.04 |
| Federal Express | 1.40 |
| Hunter Douglas | 3.35 |
| Scanel Properties | 4.14 |
| Sears Property | 4.56 |
| Ballod Property | 5.20 |
| DeSaussure Property | 10.59 |
| ***MISS Properties*** | |
| NJ Route 17 | 0.87 |
| MISS Pile | 1.50 |
| MISS Onsite | 7.47 |

**Table 1-2. (continued)**

| Property | Ratio |
|---|---|
| ***Parks*** | |
| J.F. Kennedy Park | 0.22 |
| Lodi Fire Station | 0.23 |

1) Average contaminant level is the sum of the radionuclide concentration ratios for each analyte within the sample, averaged over all samples collected at each property.

**Table 1-3. Property Unit Designations**

| Property Unit | |
|---|---|
| Number | Name |
| **MISS OPERABLE UNIT** | |
| 6 | MISS Property<br>NJ Route 17<br>New York, Susquehanna, and Western Railroad<br>MISS Pile |
| **STEPAN OPERABLE UNIT** | |
| 3 | Stepan Property |
| 3H | Elevated Contamination Area |
| **COMMERCIAL/GOVERNMENT OPERABLE UNIT** | |
| 5 | National Community Bank<br>I-80 North (Westbound Right-of-Way)<br>Sidney Street Auto Salvage<br>Muscarelle Associates<br>Flint Ink<br>NJ Vehicle Inspection Station<br>Bergen Cable<br>Sears Small Truck Repair |
| 7 | Sears Property<br>Desaussure Property<br>Federal Express<br>Gulf Station<br>Hunter Douglas<br>Sunoco Station |
| 7H | Elevated Contamination Area |
| 8 | Scanel Properties |
| 6B | Ballod Properties |
| 6H | Elevated Contamination Area |

**Table 1-3. Property Unit Designations (continued)**

| | |
|---|---|
| **RESIDENTIAL OPERABLE UNIT** | |
| 1 | Long Valley Road (14, 24)<br>Interstate 80 (East Bound Right-of-Way)<br>Branca Court<br>Hancock Street<br>Columbia Lane<br>Avenue E<br>West Central<br>Redstone Lane (18, 19)<br>Trudy Drive<br>West Hunter, Avenue B<br>Avenue C<br>Garibaldi Avenue |
| 2 | Redstone Lane (11)<br>Long Valley Road (16, 18, 20, 22, 26) |
| **RESIDENTIAL (MUNICIPAL PARK) OPERABLE UNIT** | |
| 4 | Lodi Municipal Park<br>Lodi Fire Station<br>J.F. Kennedy Park<br>Fireman's Memorial Park |

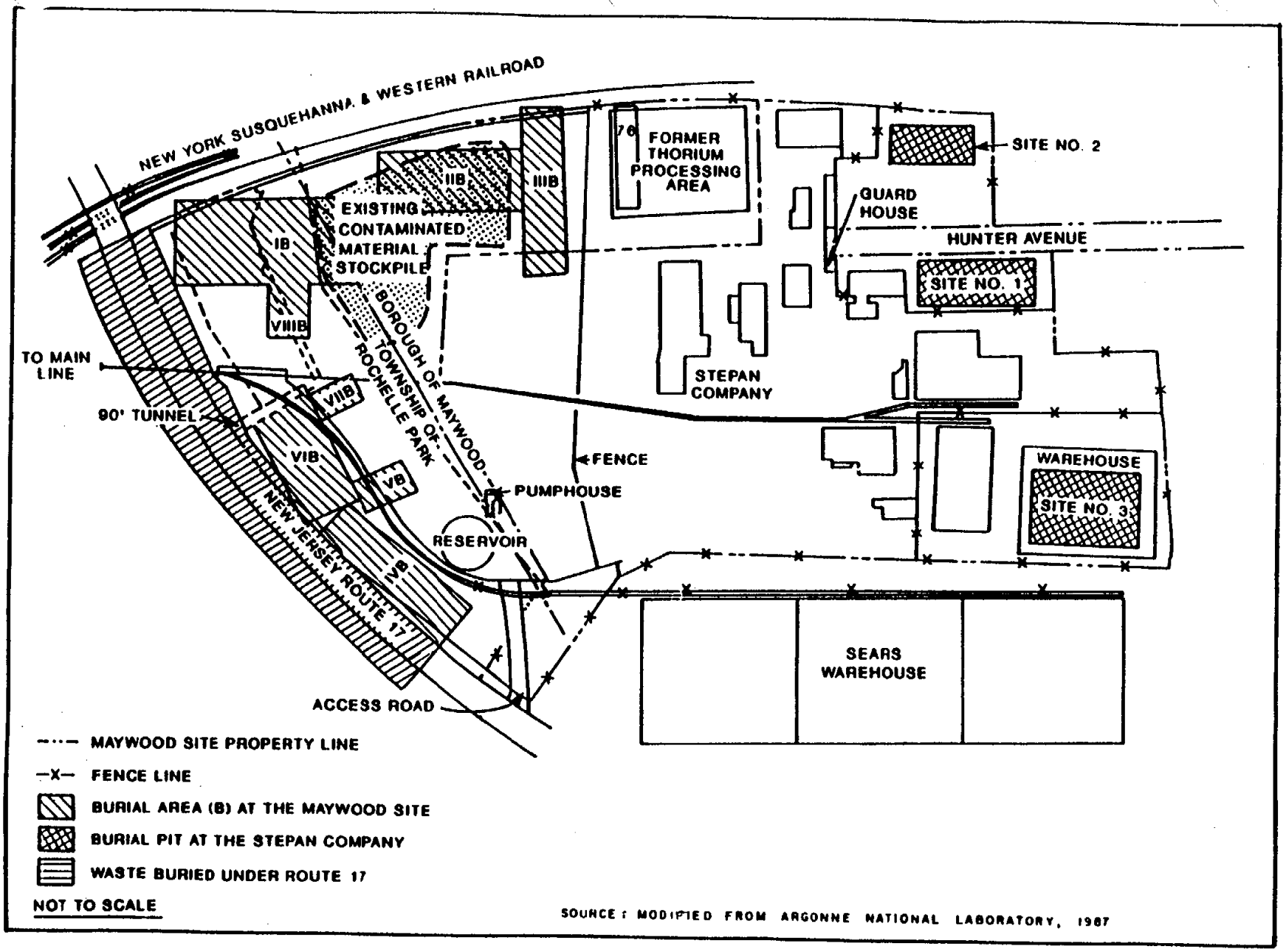


**Figure 1-3. The MISS and Stepan Company Properties**

The more-than-80 contaminated vicinity properties are distributed in an area approximately 2.5 x 1 km (1.5 x 0.5 mi) in a neighborhood with an average population density of about 5,000 to 10,000 persons per square mile. This area also lies across several major transportation corridors, including NJ Route 17, U.S. Route 46, and Interstate 80. In Rochelle Park, the contaminated properties include the Ballod property and nine residential units on Grove Avenue and Park Way. In Maywood, they include the Stepan Company property, eight residential properties on Davison and Latham Streets, one residential property on West Central Avenue, part of Route 17, the Scanel property (vacant), the Sears warehouse, the Sears small truck repair shop, and eight other commercial properties. In Lodi, they include 50 residential, commercial, and governmental properties on Trudy Drive, Hancock Street, Branca Court, Long Valley Road, Essex Street, Redstone Lane, Columbia Lane, Garibaldi Street, Sidney Street, and Avenues B, C, E, and F. Twenty-five of the 82 designated properties are fully decontaminated, and one is partially decontaminated. The remaining properties were grouped into 12 smaller property units for this BRA on the basis of similarity of contamination. Appendix A gives the status of all of the individual site properties.

### 1.2.2 Site History

MCW was founded in 1895. In 1916, the company began extracting thorium and rare earths from monazite sand for use in manufacturing industrial products such as mantles for gas lanterns. The manufacturing process involved the production of mantle-grade thorium nitrate. MCW also produced lithium compounds such as lithium hydroxide and lithium chloride, detergents, alkaloids, and essential oils. In 1954, AEC licensed MCW to possess, process, manufacture, and distribute radioactive materials under the Atomic Energy Act of 1954. Thorium extraction stopped in 1956, but MCW continued processing stockpiled material until 1959.

Process wastes from manufacturing operations were pumped to two areas surrounded by earthen dikes on property west of the plant. Some of the contaminated wastes appear to have migrated onto adjacent properties along Grove Avenue and Park Way. In 1932, Route 17 was built through the MCW property over the earthen dikes, separating the property into two areas. Several tunnels were constructed under Route 17, apparently to allow continued access between the two areas.

Contaminated materials also were dispersed from MCW to vicinity properties in the form of fill. Although the fill consisted primarily of tea and coca leaves, it was mixed with thorium-processing wastes from the plant. In 1928, wastes were brought to several nearby areas for use as

mulch and fill. During 1944-46, wastes were transported to a vacant lot at 464 Davison Street for surface grading and for filling a ditch that extended across several lots between Davison and Latham Streets (see Figure 1-2). Residents incorporated some of the fill on the 464 Davison Street lot into the lawns and gardens of nearby properties. A house was constructed on the vacant lot in 1967.

Additional contaminated materials migrated from the site through the stream channel. Old photographs and maps indicate that the course of a previously existing stream (Lodi Brook), whose headwaters originate near MCW, closely coincides with the distribution of contaminated materials (see Figure 1-2) in the Borough of Lodi (Mata 1984). Most of the original stream channel has since been replaced by a subsurface storm drain system.

Before 1984 radioactive contaminated wastes were buried at eight locations on the MCW/Stepan Property. The eight burial areas on the Maywood site (Areas IB-VIIIB on Figure 1-3), along with two areas on the Ballod Associates property and a portion of Route 17, cover much of the previously diked areas mentioned above (ANL 1984).

The Stepan Chemical Company (now called the Stepan Company) purchased MCW in 1959. Although the Stepan Company itself was never involved in the manufacture or processing of any radioactive materials, the company in 1961 was issued an AEC radioactive materials storage license because of the contaminated wastes buried on site.

In 1963 the Stepan Company began performing several remedial actions onsite. Between 1966 and 1968, contaminated material from west of Route 17 was removed and buried on Stepan Company property at Burial Sites 1, 2, and 3 (see Figure 1-3). Several radiological surveys of the Stepan Company site and vicinity were conducted to identify the locations of radioactive contamination resulting from past manufacturing and processing activities. Limited chemical sampling was also performed.

In December 1982, EPA proposed to include the Maywood site, designated as the "Maywood Chemical Company Site," on its National Priority List (NPL). This listing occurred on September 8, 1983.

DOE was authorized to undertake a decontamination research and development project at the Maywood site by the Energy and Water Appropriations Act of 1984, and the site was assigned to FUSRAP. In 1985 DOE negotiated access to a 4.7-ha (11.7-acre) portion of the Stepan Company

property to use as a storage facility for contaminated materials in order to expedite cleanup of the vicinity properties. This area on the Stepan Company property was designated as MISS. Subsequently, DOE began a program of removal actions at the vicinity properties and environmental monitoring at MISS. In September 1985, ownership of MISS was transferred to DOE.

Removal actions at vicinity properties began in 1984. During this time, approximately 27,000 $m^3$ (35,000 $yd^3$) of contaminated materials were removed from the Ballod property and from 17 vicinity properties located on Davison Avenue, Latham Street, Grove Avenue, and Park Way in Maywood and Rochelle Park. These materials were stored in an interim storage cell at MISS. During 1985, an additional 380 $m^3$ (500 $yd^3$) of contaminated materials were removed from eight vicinity properties located on Avenue C, Avenue F, Hancock Street, and Trudy Drive in Lodi and another portion of the Ballod property in Rochelle Park. These materials were added to the storage cell on MISS. An additional removal action was undertaken in 1991. Radiologically contaminated waste that was removed from a residential property in Lodi is being stored in Building 76 on MISS. Environmental monitoring of MISS and surveying of the vicinity properties continue.

### 1.2.3 Summary of Site Contamination

Numerous investigations have been performed on the Maywood site. Information on the most recent sampling and analyses is presented in the RI report (BNI 1992). Surface soils, subsurface soils, groundwater, surface water, and sediments have all been sampled and analyzed for radiological and chemical contamination. Structures and air have also been sampled and analyzed for radionuclides.

Lead agency responsibility for cleanup of FUSRAP waste and chemical contamination lies with DOE and EPA, respectively, at the Maywood Chemical Company NPL site. DOE's lead agency responsibility and EPA's oversight role for cleanup of FUSRAP waste (and chemical contamination that meets the definition of FUSRAP waste) is set forth in the Federal Facility Agreement (FFA) between DOE and EPA Region II. As defined in the FFA, "FUSRAP waste" is specifically limited to:

- all radioactive and chemical contamination, whether commingled or not, occurring on MISS;

- all radioactive contamination exceeding DOE action levels and related to thorium processing at MCW, occurring on vicinity properties; and

- any chemical and nonradioactive contamination on vicinity properties that would fulfill either of the following conditions:

  - the contamination is mixed or commingled with radioactive contamination exceeding DOE action levels; or

  - the contamination originated at MISS or was associated with specific thorium manufacturing or processing activities at MCW that resulted in the radioactive contamination.

The BRA examines both radioactive and chemical contamination occurring on MISS, whether or not they are commingled. The radiological and chemical COCs are discussed in Section 2. The actual onsite or offsite origins of chemical contaminants in groundwater have proved indeterminate. Based on the results of the RI, the extent of chemical contamination in groundwater currently can not be determined. A groundwater sampling plan has been developed and approved. Ongoing studies by the Stepan Company under the direction of EPA Region II also may provide additional information concerning chemical contaminants.

## 1.3 SCOPE OF THE BRA

Remedial and removal actions conducted by DOE at the Maywood site are being coordinated with EPA Region II under CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA). In addition, all DOE activities must comply with NEPA, which requires that the environmental consequences of a proposed action be considered as part of the decision-making process for that action. The activities and environmental compliance documents for the Maywood site are being developed in coordination with EPA Region II and the state of New Jersey. These documents will be issued for public comment. The assessment of potential baseline health risks and ecological impacts associated with a contaminated site is an important component of the RI/FS process. This BRA includes the determination of mean (i.e., central tendency value) and reasonable maximum individual human risks potentially resulting from exposure to contaminants at each property unit comprising the operable units (OUs) designated in Table 1-3, as well as an estimate of human population risk and an ecological risk assessment (ERA). The approach used for the Maywood BRA is based on EPA Risk Assessment Guidance for Superfund (RAGS) (EPA 1989b, 1992d).

The scope of the study is to use site-specific data to the extent necessary to isolate localized areas of elevated contaminant concentrations and to evaluate risk. The data in the RI report and those found in previous reports (references listed in Appendix A) were used to identify and screen potential COCs for risk evaluation. That evaluation focused primarily on the comparison of site concentrations to background concentrations, as described in Section 2, and evaluation of sample quantitation limits, as well as consideration of detection frequency. Exposure point concentrations were estimated for the COCs, and were used to estimate potential exposure and lifetime risk for various combinations of locations, receptors and exposure scenarios. These are compared with DOE and EPA guidelines for exposure and risk. The determination of final cleanup criteria is beyond the scope of the BRA and will be addressed in the FS-EIS, proposed plan, and ROD for the site.

### 1.3.1 Time Period

Because DOE is responsible for the cleanup of this site and is committed to pursuing a timely response, the time period considered as the hypothetical future in this assessment of risks for the no-action alternative is the immediate future (i.e., the next 100 years). Thus, further dispersal of contaminants that would occur over very long time periods has not been considered in the BRA. Current contaminant concentrations in the environmental media identified for this site are assumed for each scenario evaluated, including the future scenarios. The RESRAD computer code, Version 4.6, used in this analysis can estimate doses at specified future times. However, the ability of this or any currently available model to accurately predict contaminant fate and transport and resultant exposure and risk at distant future times is highly uncertain. The estimated doses for each future scenario were conservatively assumed to be the maximum annual doses within a 1,000-year time span. These doses typically were found at either the present (i.e., for areas with predominantly surface soil contamination) or at approximately 150 years in the future (i.e., for areas with predominantly subsurface soil contamination). For the radiological COCs at least, this assumption yields the maximum estimates of dose and risk.

### 1.3.2 Exposure Scenarios

Under the CERCLA process, a BRA typically considers impacts that could occur if remedial action was not performed at a site. It assesses impacts for reasonable exposure scenarios under both current conditions and projected future conditions. Under the NEPA process, the impact assessment for the no-action alternative typically addresses the status quo at the site, which includes the retention of existing institutional controls (e.g., access restrictions and monitoring) up

to the next 100 years. This risk assessment assumes that the heavy industrial property land use does not change. The exposure assessments presented in Section 3 of this document address, in detail, the potential receptors and locations selected to assess baseline impacts for the Maywood site.

## 1.4 REPORT ORGANIZATION

This report was organized according to the suggested EPA RAGS outline (EPA 1989b) with minor modifications to address NEPA considerations and DOE programmatic guidance.

Section 2, Identification of Contaminants of Concern, reviews existing radiological and chemical data collected from the site and surrounding area and identifies the data and contaminants of concern used in this risk assessment.

Section 3, Exposure Assessment, briefly describes those physical features of the Maywood site that affect the risk assessment, especially in terms of fate and transport of hazardous substances present at the site. Also, Section 3 summarizes site characteristics pertinent to the exposure assessment, develops exposure point concentrations, identifies potentially exposed populations, and defines primary exposure pathways. Exposure point concentrations are estimated for each selected exposure pathway and property.

Section 4, Toxicity Assessment, discusses human health effects of each category of COC and presents quantitative toxicity values for those contaminants.

Section 5, Risk Characterization, presents estimates of incremental risk from each selected COC and exposure pathway for designated property units, which comprise the OUs, for each receptor identified in Section 3.

Section 6, Ecological Assessment, presents a framework for evaluating potential effects on biota from the contamination at the Maywood site.

# 2. IDENTIFICATION OF CONTAMINANTS OF CONCERN

## 2.1 SOURCES, TYPES, AND DISTRIBUTION OF CONTAMINANTS

The purpose of this section is to describe the process of identifying COCs and to present a summary of those selected for modeling exposure and risk. An important part of the process is evaluating not only the types and sources of contamination, but also the sampling, analysis, and modeling procedures used to estimate contaminant concentrations and distribution relative to the properties, media, and receptors that comprise the Maywood site.

The geographic distribution of properties over a large area and the history of numerous characterization studies have produced two distinct data collections, reflected in the organization and presentation of data and results. One is for radiological contaminants, and one is for chemical contaminants.

### 2.1.1 Radiological Contaminants

Radiological contamination data have been collected in many surveys and characterization studies conducted since 1980. These are discussed in the RI report (BNI 1992) and the work plan for the Maywood site (ANL and BNI 1992). The Nuclear Regulatory Commission (NRC) requested a comprehensive survey of the area following reports in 1980 of radioactive materials in the vicinity of the Stepan Company plant. Aerial and drive-by surveys located properties with elevated radiation levels. These surveys were followed with near-surface gamma radiation surveys using cone-shielded detectors to more accurately define areas of radioactivity. Soil samples collected in areas where gamma radiation exceeded two times background were analyzed using gamma spectroscopy to determine Th-232, Ra-226, and U-238 concentrations. More than 130 reports resulted from these studies, and data obtained from them and the RI report were used to create an electronic data base that supported risk assessment calculations. The reports pertaining to individual properties are shown in Appendix A. An independent RI/FS is being conducted for the Stepan Property. Results of this investigation were not available for consideration in this BRA.

The validation and verification of RI report data are addressed in the RI report review process; therefore, the data are assumed acceptable for this evaluation. The historical data were collected under several quality assurance programs by various contractors over many years. Direct validation and verification of all these data were not done. However, for many sites these are the

only data available. Thus, the historical data are used where RI report data are unavailable. Therefore, the results in this document for these sites contain a higher level of uncertainty.

Almost all the data used in the radiological risk assessment are from soil radionuclide analyses. Radon sampling results (55 measurements) obtained for the residential properties were in reasonable agreement with the radon concentrations calculated from soils data as discussed in Section 3.

### 2.1.2 Chemical Contaminants

Characterization studies of chemical contamination at the Maywood site are more recent than most of the radiological studies. They have been conducted primarily for the MISS and Stepan operable units and a limited number of residential and commercial/government properties. Chemical contamination sources are described in the RI report and include the burial pits of Stepan, former waste retention ponds at MISS, the interim storage pile at MISS, and other areas that may have been contaminated due to release or transport of waste materials.

The chemical contaminants include rare earth metals and heavy metals that were present in the monazite sands from which thorium was extracted, volatile organic compounds, semivolatile organic compounds, pesticides, and polychlorinated biphenyls (PCBs). In this BRA, all chemical contaminants detected at the Maywood site are evaluated as potential COCs and retained, if applicable, regardless of whether they are within the definition of FUSRAP wastes.

The chemical data are organized according to operable unit and medium. All the groundwater data are from the MISS and Stepan operable units and two adjoining properties that are in the same hydrogeologic system. Surface water and sediment data are evaluated for Westerly Brook and Lodi Brook, but only the data from the Westerly Brook basin were adequate for risk assessment. The data from the Lodi Brook basin were from a single sampling point, and only a single COC was retained after screening. Surface and subsurface soils data were available for MISS, Stepan, and the three properties in each of the residential and commercial/government operable units. The three residential properties for which chemical data were available were 90 Avenue C (property unit 6), 113 Avenue E (property unit 5), and 62 Trudy Drive (property unit 4). Commercial/ government properties for which chemical data were available were 113 Essex Street, 200 Route 17, and 205 Maywood Avenue. These were grouped into four data sets for chemical risk assessment.

The procedures for selecting radiological and chemical COCs are described in the following sections, and the results are presented in tables.

## 2.2 RADIOLOGICAL DATA EVALUATION

Radionuclides known or suspected to be present at the Maywood site relate to the processing of the mineral monazite (monazite sands). Monazite sands contain natural thorium at concentrations of 3 to 10 percent (NJDEPE 1983), significantly higher than natural background levels. Concentrations of uranium are also higher than natural background levels. Thorium and its progeny are the dominant contributors to the radioactive contamination of the site, although some enhanced uranium contamination is also present.

### 2.2.1 Rationale and Criteria for Selection of COCs

The radionuclides in the U-238, Th-232, and U-235 decay series (Figures 2-1, 2-2, and 2-3) that are expected to significantly contribute to site risk can be identified in a preliminary screening. However, for completeness, all radionuclides in these three decay series were considered in the risk assessment for this BRA. A source term analysis indicates that the radiological hazards of the various radionuclides in the U-238 decay series can be determined from the activity concentrations of U-238 and Ra-226. Activities of radionuclides from U-238 through U-234 and Th-230 were assumed to be in secular equilibrium. Also, the activity of each individual radionuclide from Ra-226 through Polonium (Po)-210 were assumed to be equal to that of Ra-226. The activity of U-235 (and progeny) was assumed to be equal to 5 percent of the U-238 activity.

The goal of the data evaluation is to identify a set of radiological COCs that are likely site-related and then select those COCs that are valid for use in the quantitative risk characterization. Radiological sample analyses for the RI were performed by TMA/Eberline in accordance with approved protocols. The detailed analytical results are contained in appendices to the RI report (BNI 1992). Data quality objectives and QA/QC procedures are discussed in Appendix I of the RI report. The quality assessment procedure for radiological data is presented in the *Quality Assurance Project Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the Maywood Interim Storage Site, Maywood New Jersey.* (BNI 1990).

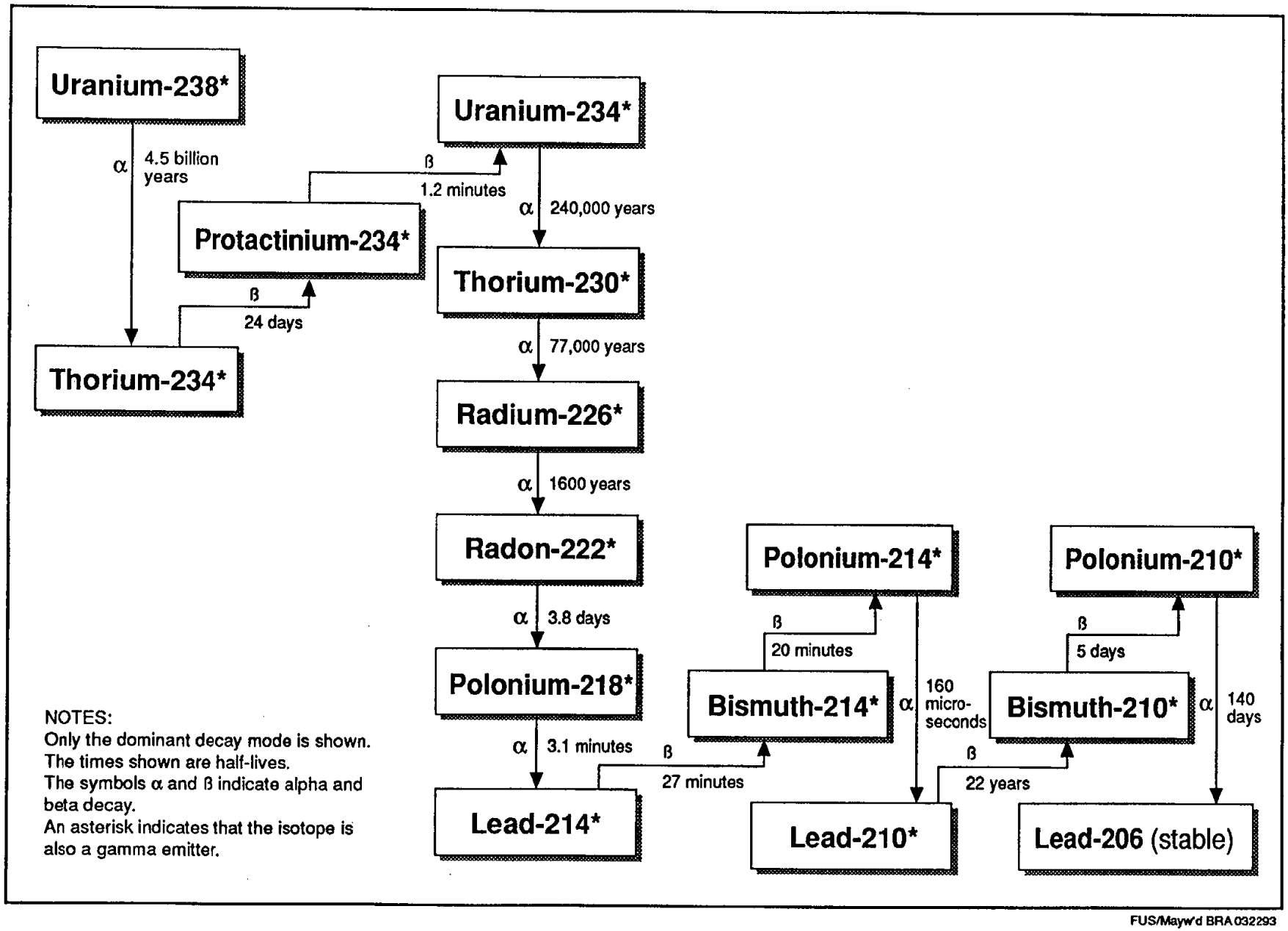


**Figure 2-1. Uranium-238 Radioactive Decay Series**

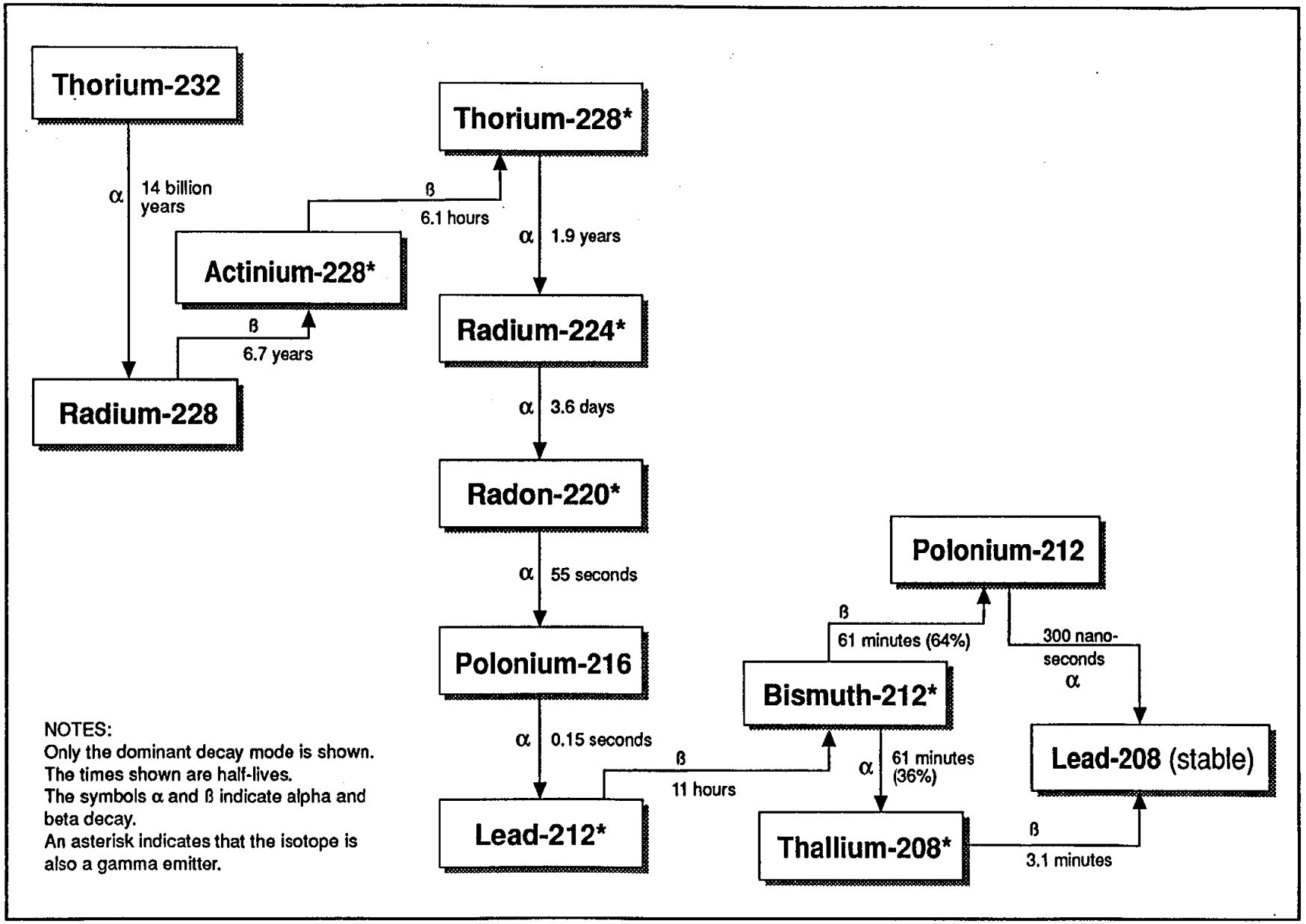


**Figure 2-2. Thorium-232 Radioactive Decay Series**

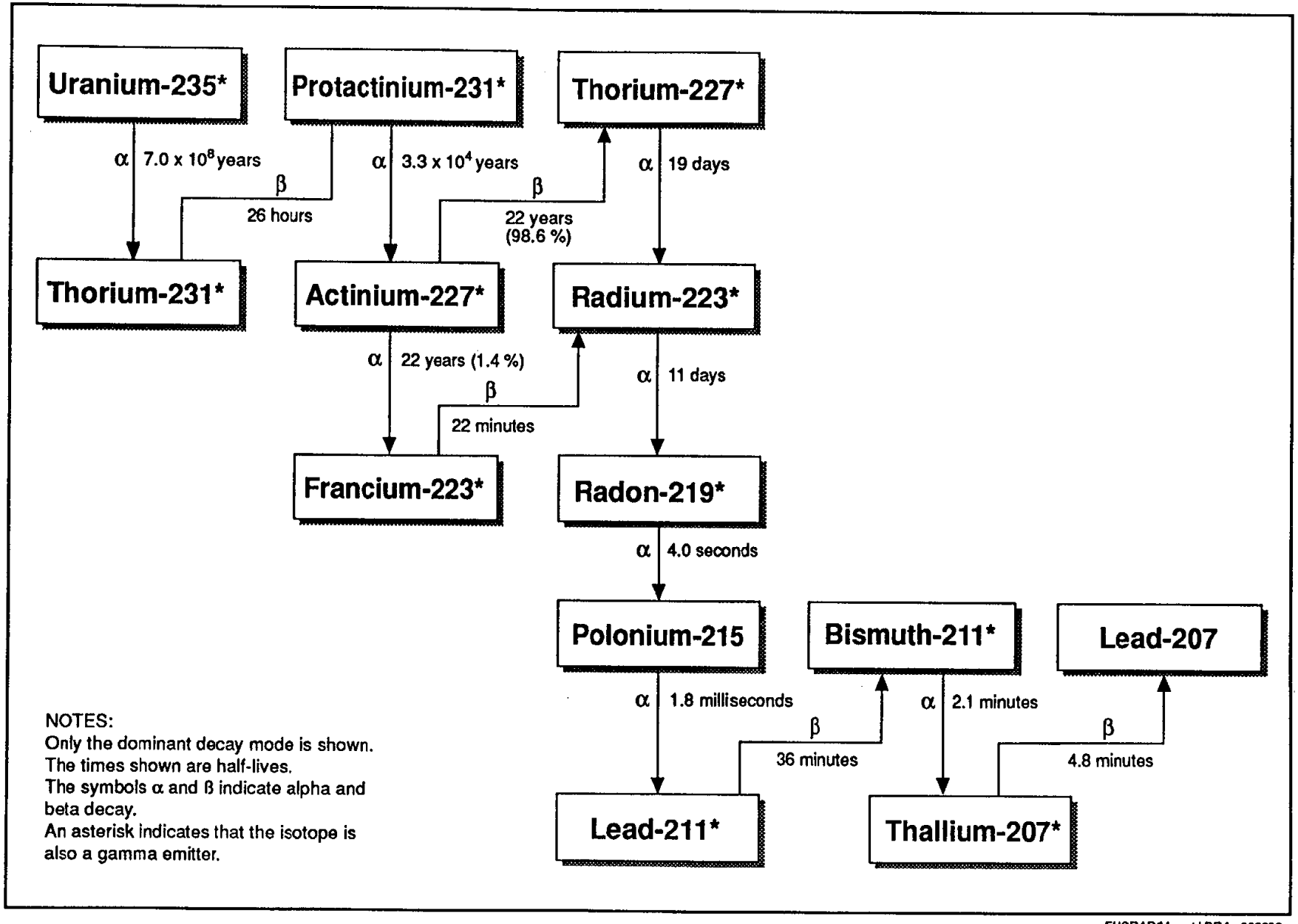


**Figure 2-3. Uranium-235 Radioactive Decay Series**

### 2.2.2 Radiological Data Evaluation

Radiological data were aggregated by depth: surficial (0 to 2 ft depth) and subsurface (2 to 16.5 ft maximum depth). Because of limited data, sediment data were aggregated with surficial soil data. Groundwater data were aggregated as a single unit by aquifer (shallow alluvium and bedrock) for MISS, Stepan, and Ballod properties based on data review and hydrology. Groundwater data were not available for the residential and commercial/governmental vicinity properties. Surface water data were aggregated by drainage for Westerly Brook and Lodi Brook. Statistical analysis was performed on the aggregated data sets to identify mean concentrations for each contaminant in these media.

### 2.2.3 Background

Background samples for each medium were used to identify naturally occurring levels of radionuclides and ambient concentrations attributable to non-site sources. Radionuclides were selected as COCs if the mean of detected concentrations exceeded twice the mean background concentration.

#### 2.2.3.1 Soil

Background levels of naturally occurring radionuclides in soil in the vicinity of the Maywood site were determined by sampling at locations that were considered to be nonindustrialized, undisturbed, and located within reasonable proximity of the site. Locations within Foschini Park, Rochelle Park, and the Borough Park-Maywood were selected as representative of typical background radionuclide levels (Figure 2-4). A summary of the results is presented in Table 2-1.

#### 2.2.3.2 Groundwater

Groundwater background data were obtained from two monitoring wells, B38W02D and B38W05B (Figure 2-5). These wells are considered to be hydrologically upgradient from source areas. Background samples were analyzed for total uranium, Ra-226, and Th-232. Average background concentrations of total uranium were 3.0 pCi/L; Ra-226 concentrations were 0.8 pCi/L, and Th-232 concentrations were 0.4 pCi/L. Results of groundwater analyses are presented in Section 4.3.1 of the RI report (BNI 1992).

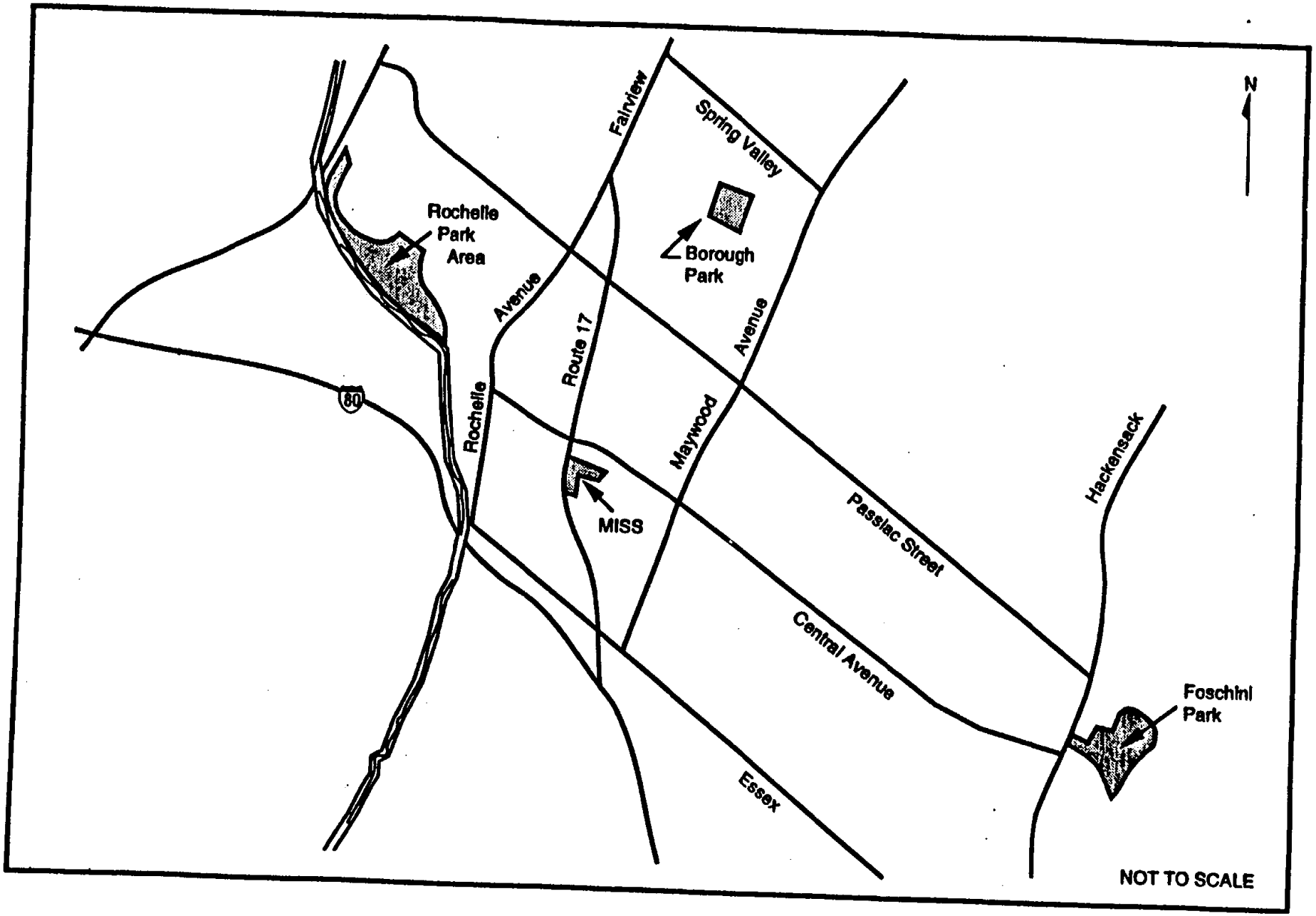


**Figure 2-4. Background Sample Areas in Relation to MISS**

**Table 2-1. Analytical Results for Background Radionuclide Concentrations in Soil**
(pCi/g)

| Locaton | U-238 | Ra-226 | Th-232 |
|---|---|---|---|
| Foschini Park | <3.5 | <0.8 | <1.1 |
| Rochelle Park | <2.4 | <0.5 | <0.9 |
| Borough Park-Maywood | <2.9 | <0.7 | <0.9 |
| Average | <2.9 | <0.7 | <1.0 |

Source: BNI 1992

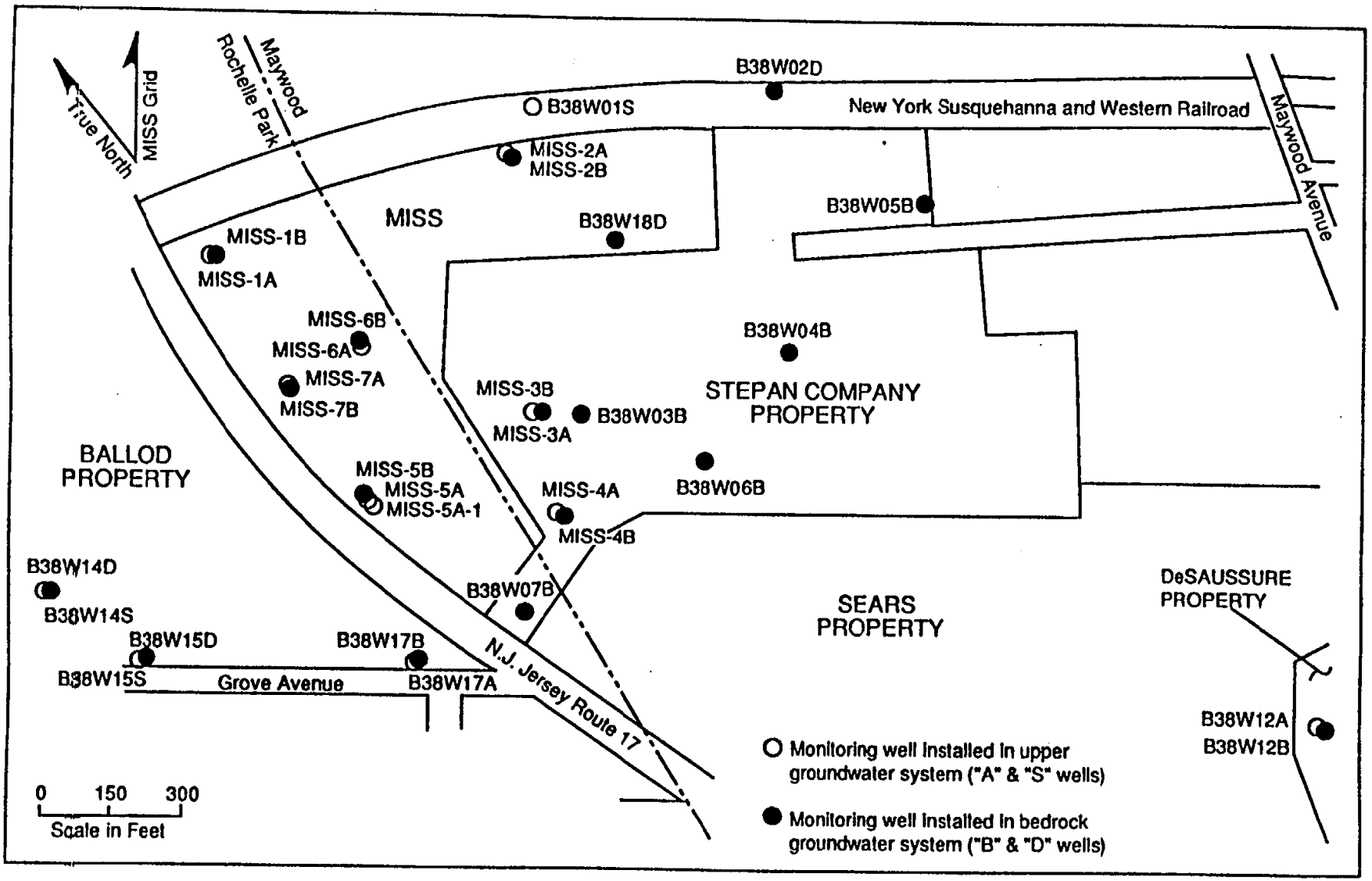


**Figure 2-5. Location of Groundwater Wells Monitored for Radioactive and Chemical Contamination in 1990**

#### 2.2.3.3 Surface Water

Surface water samples were collected from four locations, three in Westerly Brook and one in Lodi Brook (Figure 2-6). Sampling location 3 is upgradient from site source areas and serves to establish background conditions for surface water and sediments. Sample analytes for surface water were total uranium, Ra-226, and Th-232. Average background concentrations were 3 pCi/L, 0.3 pCi/L, and 0.1 pCi/L, respectively. Results of the surface water analyses are presented in Section 4.4.1 of the RI report (BNI 1992).

#### 2.2.3.4 Outdoor Air

The RI presents only Rn-222 concentrations in air immediately adjacent to MISS. Airborne particulate contaminants were not evaluated because the contaminants at MISS are stable with respect to these pathways. The average background Rn-222 concentration in the Maywood area is 0.4 pCi/L (BNI 1992).

#### 2.2.3.5 Indoor Air

The RI does not present background concentrations of Rn-222 in buildings. A study of over 9,000 buildings in New Jersey indicates an average background Rn-222 concentration of 1.4 pCi/l (Cohen 1991). This value was assumed valid for the Maywood site.

### 2.2.4 Soils

Surface and subsurface soil samples were collected from the Maywood site. Radiological analysis of over 3,000 samples indicates widespread contamination of Ra-226, Th-232, and U-238 (BNI 1992). The analytical results are summarized in Table 2-2.

The sampling regime focused on the relatively long-lived isotopes. The associated progeny, as shown on Table 2-3, are assumed to be in equilibrium with their respective parent nuclides. Because of the limited data, the activity of Th-230 was assumed to be in equilibrium with U-238.

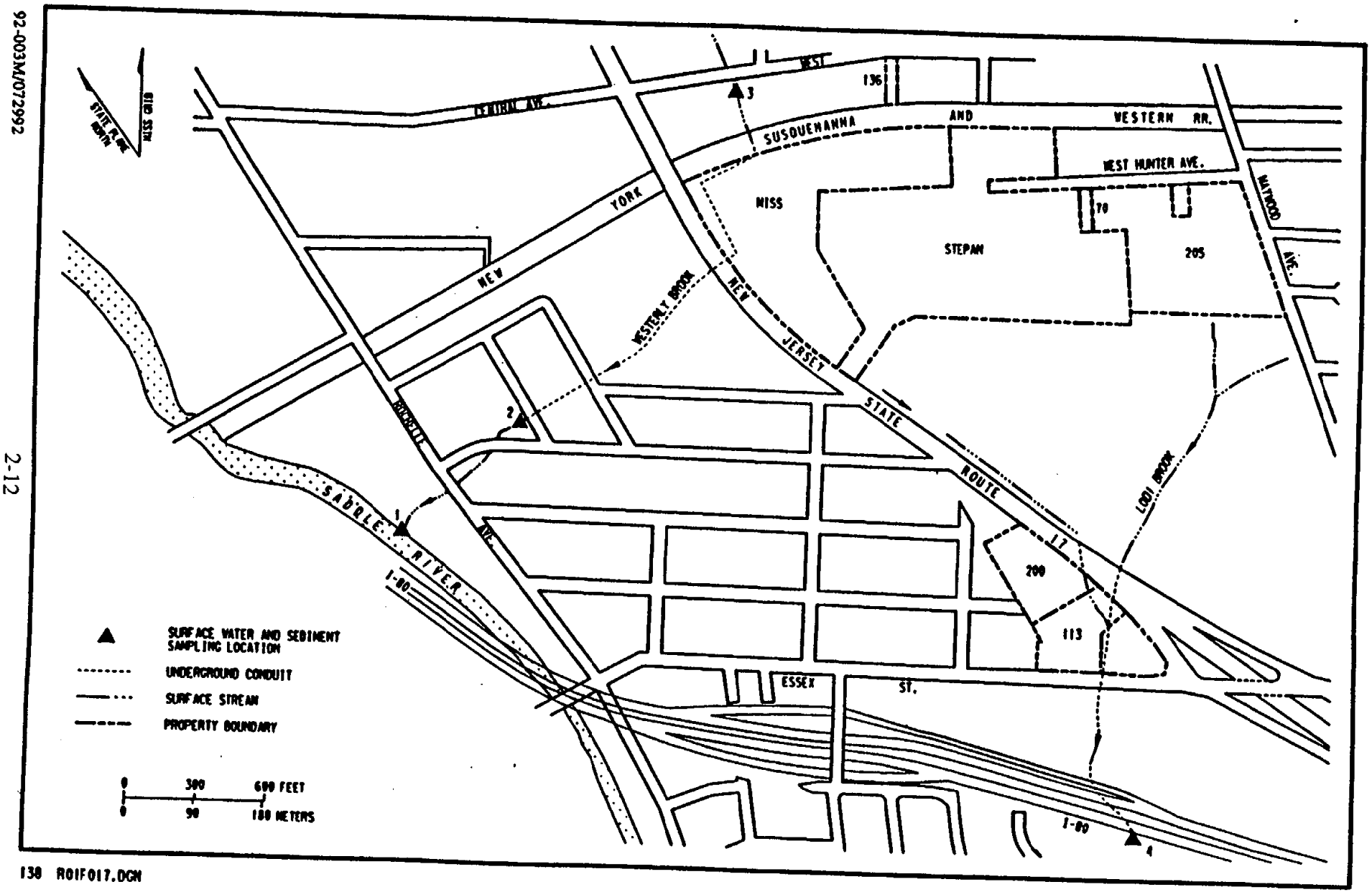




**Figure 2-6.**
**Offsite Surface Water and Sediment Sampling Locations for MISS**

## Table 2-2. Screening of Source Area Contaminants

| Nuclide | Detections, matrix | Maxium concentration (pCi/g) | Mean Concentration (pCi/g) | Background Concentration (pCi/g) | Sample Quantitation Limit (pCi/g) | COC |
|---|---|---|---|---|---|---|
| Ra-226 | 1077 surface soil | 190 | 2.4 | 0.7 | 0.2 | yes |
| Ra-226 | 1687 subsuface soil | 447 | 5.5 | 0.7 | 0.2 | yes |
| Th-232 | 1222 surface soil | 379 | 9.2 | 1.0 | 0.2 | yes |
| Th-232 | 1867 subsurface soil | 1698 | 22.8 | 1.0 | 0.2 | yes |
| U-238 | 113 surface soil | 77.1 | 7.6 | 2.9 | (note 1) | yes |
| U-238 | 215 subsurface soil | 624.7 | 13.1 | 2.9 | (note 1) | yes |

Note 1: SQL varies, generally ranging between 1 and 4 pCi/g.

## Table 2-3. Groupings of Radionuclides

| Parent Radionuclide | Associated Decay Products |
|---|---|
| Thorium-232 | |
| Radium-228+Decay Products | Actinium-228 |
| Thorium-228+Decay Products | Radium-224, radon-220, polonium-216, lead-212, bismuth-212, polonium-212, thallium-208 |
| Uranium-238+Decay Products | Thorium-234, protactinium-234 |
| Uranium-234 | |
| Thorium-230 | |
| Radium-226+Decay Products | Radon-222, polonium-218, lead-214, bismuth-214, polonium-214, |
| Lead-210+Decay Products | Bismuth-210, polonium-210 |
| Uranium-235+Decay Products | Thorium-231 |
| Protactinium-231 | |
| Actinium-227+Decay Products | Thorium-227, radium-223, radon-219, polonium-215, lead-211, bismuth-211, thallium-207 |

Source: Gilbert et. al, 1989

### 2.2.5 Groundwater

Groundwater data were aggregated as a single operable unit comprised of MISS/Stepan/Ballod results based on data evaluation and hydrology. Data were derived from historical records available from DOE's ongoing environmental monitoring program and from recent data (fourth quarter 1990 through third quarter 1991) collected as part of additional well sampling for the RI report (BNI 1992). For the risk assessment, data were evaluated as two separate units; the shallow alluvium groundwater and the deeper bedrock groundwater. The sedimentary section at the site is divided into two units: bedrock and a surficial and unconsolidated sediments unit. These two geologic units behave as a single interconnected hydrogeologic unit. Analyses were conducted quarterly. Average concentrations of total uranium, Ra-226, and Th-232 were 3 pCi/L, 0.9 pCi/L, and 0.4 pCi/L, respectively (BNI 1992).

### 2.2.6 Surface Water

Surface water was collected quarterly from three locations in Westerly Brook and one location in Lodi Brook. The concentrations of radionuclides were found to be close to background, indicating that radionuclides are not migrating via the surface water pathway (see Section 2.2.3.3). Average concentrations of uranium, Ra-226, and Th-232 were 4 pCi/L, 0.4 pCi/L, and 0.1 pCi/L, respectively.

### 2.2.7 Outdoor Air

Ra-222 concentrations have been measured at three onsite and 10 perimeter locations at the MISS (BNI 1992). The average onsite and perimeter Rn-222 concentration is 0.5 pCi/L. This approaches background levels (see Section 2.2.3.4).

### 2.2.8 Indoor Air

Fifty-five Rn-222 measurements were taken. The average Rn-222 concentration is 1.5 pCi/L. Although this value does not exceed twice the assumed background concentration, Rn-222 was retained as a COC in indoor air. This conservative assumption was made because Rn-222 is a decay product of Ra-226, a COC in soils.

### 2.2.9 Radiological COCs

The final list of radiological COCs for soil includes Ra-226, Th-232, U-235, U-238, and their associated decay products. No radiological contaminants of potential concern were identified in groundwater, surface water, or outdoor air. Rn-222 was identified as a contaminant of potential concern in indoor air.

## 2.3 CHEMICAL DATA EVALUATION

The chemical data evaluated are those reported in the RI report for the Maywood site (BNI 1992). Samples from the following media were evaluated for chemicals of concern: surficial soil horizon (0 to 2 ft depth), all soil horizons (0 to a maximum of 16.5 ft depth), alluvial (shallow) groundwater, bedrock groundwater, surface water, and sediment from Westerly and Lodi Brooks.

The goal of the data evaluation is to identify a set of COCs that are likely site-related and then select those COCs that are valid for use in the quantitative risk characterization. Chemical sample analyses for the RI report were performed by Roy F. Weston, Inc. analytical laboratories, in accordance with approved protocols. The detailed analytical results are contained in appendices to the RI report (BNI 1992) and are summarized in this chapter.

Data quality objectives and QA/QC procedures are discussed in Appendix I of the RI report. The quality assessment procedure for chemical data is presented in the *Quality Assurance Project Plan for the Maywood Site* (BNI 1990). After samples were analyzed, results were reviewed for precision, accuracy, completeness, comparability, and representativeness. Upon successful completion of the QA/QC process, data were included in the overall site database. QC samples were used to assess data quality in terms of precision and accuracy and to document that sampling and analysis procedures did not introduce variables that would render the data questionable. QC samples included field blanks and duplicates, method blanks and spikes, matrix spikes and duplicates, laboratory duplicates, and standard reference materials. The guidance documents used in the assessment and qualification of chemical data are the *Laboratory Data Validation: Functional Guidelines For Evaluating Organic Analysis* (EPA 1988) and the *Laboratory Data Validation: Functional Guidelines For Evaluating Inorganic Analyses* (EPA 1988).

### 2.3.1 Rationale and Criteria for Selection of COCs

Chemical data were aggregated by operable unit and medium for evaluation of COCs. These aggregates were as follows:

| Medium | Operable/Remedial Units |
|---|---|
| Soil | 1. MISS |
| | 2. Stepan Company property |
| | 3. Commercial/government vicinity properties |
| | 4. Residential vicinity properties, including municipal parks |

In addition to these formally designated OU's, the following additional remedial units were considered for aggregating chemical COCs:

| | |
|---|---|
| Groundwater | 5. MISS/Stepan/Ballod |
| Surface Water and Sediment | 6. Westerly Brook, Lodi Brook |

Soils data were aggregated by depth (surficial - 0 to 2 ft. depth and all horizons - 0 to 16.5 ft maximum depth) for each of the four operable units. Uranium data were derived from the radiological data set, and samples with an initial sample depth of 2 ft or less were aggregated. Groundwater data for MISS, Stepan, and Ballod properties were aggregated as a single unit by aquifer (shallow alluvium and bedrock) based on data review and hydrology. Groundwater data were not available for the residential vicinity properties and commercial/government vicinity properties. Surface water and sediment data were aggregated by drainage for Westerly Brook and Lodi Brook.

Chemicals in the RI database were evaluated in accordance with EPA data validation guidance in *Risk Assessment Guidance for Superfund, Volume 1* (EPA 1989b). All data qualifiers as well as results of all field and laboratory blanks were considered. Background samples for each medium were used to identify naturally occurring levels of chemicals and ambient concentrations attributable to onsite sources.

Data presented in the RI report were evaluated on the basis of quality, with respect to sample quantitation limits, laboratory qualifiers and codes, and blanks. Data selected for use in the BRA include unqualified data, including those data with qualifiers that indicate uncertainties in concentrations but not in compound identification, and those data detected at levels significantly elevated above concentrations detected in associated sample blanks. Organic contaminant data selected include those with no qualifiers and those designated with = (no data qualifier required) or J (analyte present; reported as an estimated value). Inorganic contaminant data selected include those with no qualifiers and those designated with =, J, B [reported value less than contract required detection limit (CRDL) but greater than or equal to instrument detection limit (IDL)], or BJ (both B and J). All data with any other qualifier or combination of qualifiers were excluded from the BRA database. Chemical data were evaluated according to the following criteria to select the subset of COCs appropriate for quantitative risk assessment:

- Comparison to Quantitation Limits (QL) - Inorganic and organic chemicals were eliminated if the chemical was detected only once or twice in a medium and if detected concentrations were less than reported quantitation limits (i.e., carried a J qualifier);
- Frequency of Detection - When there were twenty or more samples, chemicals that were detected at a frequency of 5 percent or less were eliminated; and
- Comparison to Background - Inorganic chemicals were eliminated if the estimated mean exposure concentration was less than or equal to twice the mean background concentration.

In estimating the exposure concentration, positively detected concentrations were considered with one-half the reported quantitation limits (a proxy concentration) for sample results reported as below the quantitation limit. Mean exposure concentrations were derived from the bias estimator of the mean for log normally distributed data (Gilbert 1987).

### 2.3.2 Background

#### 2.3.2.1 Soils

To establish soil chemical constituent concentrations that are representative of background conditions at the Maywood site, soil samples were collected from four locations at Borough Park in Maywood (see Figure 2-4). The park is located in a highly developed residential area that is also near industrial areas of the borough. Sampling locations were selected on the basis of proximity to the Maywood site, relative independence from potential impact by the site, and representativeness of area land uses.

Background samples were analyzed for metals and rare earth elements, VOCs, BNAEs, pesticides, and PCBs. The ranges in background concentrations for COCs are presented in the tables that summarize potential COCs for soil (see Section 2.3.3). Complete analytical results are reported in Appendix K of the RI report (BNI 1992).

#### 2.3.2.2 Groundwater

Groundwater background data were obtained from two monitoring wells, B38W02D and B38W05B (see Figure 2-5). These wells, located in the bedrock aquifer, are considered to be hydrologically upgradient from source areas (BNI 1992). Background samples were analyzed for metals and rare earth elements, VOCs, BNAEs, pesticides, PCBs, and mobile ions (chlorides, nitrates, phosphates, sulfates). The range in background concentrations for potential inorganic contaminants of concern are shown in the table summarizing potential COCs for bedrock groundwater (see Section 2.3.4). Results of groundwater analyses are presented in Section 4.3.2 of the RI report (BNI 1992).

#### 2.3.2.3 Surface Water and Sediment

Surface water and sediment samples were collected from four locations, three in Westerly Brook and one in Lodi Brook (see Figure 2-6). Sampling Location 3 is upgradient from Maywood site source areas and establishes background conditions for surface water and sediments. Sample analytes for surface water were dissolved and total metals, rare earth elements, VOCs, and mobile ions. Analytes for sediment were metals, and rare earth elements. The range in background concentrations for these media are shown in the tables summarizing potential COCs for surface water and sediments (see Section 2.3.5). Complete analytical data are reported in the RI report (BNI 1992).

### 2.3.3 Soil

Soils were evaluated for four operable units as described in Section 2.3.1.

#### 2.3.3.1 MISS Soil

Seventy-nine soil samples from 34 MISS onsite boreholes were analyzed for metals and rare earth elements (Figure 2-7). Twenty-seven metals and rare earth elements were detected in the

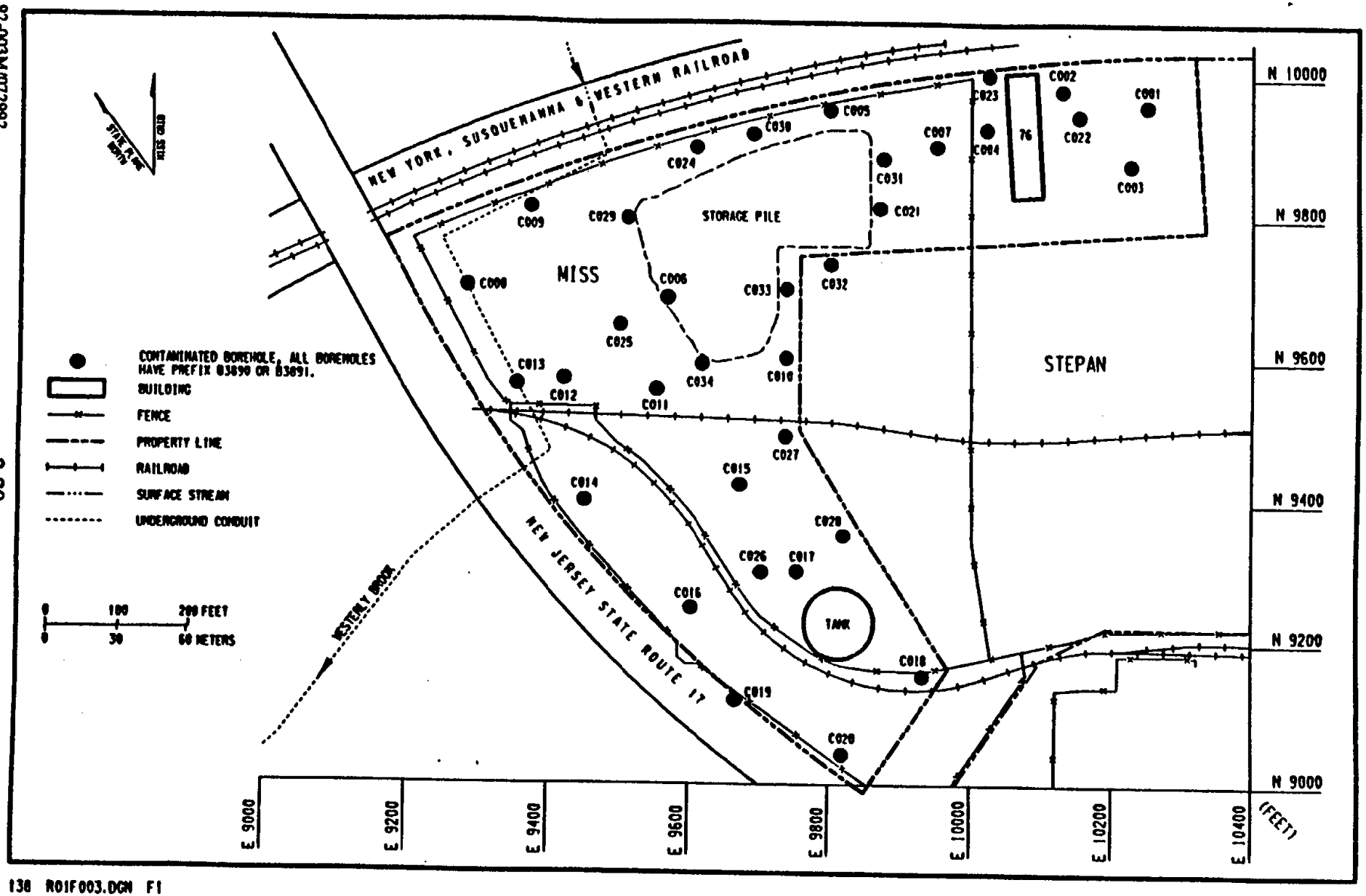


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**Figure 2-7.**
**MISS Onsite Chemical Borehole Locations**

surficial soil horizon (0-2 ft), and 37 were detected in all soil horizons. Uranium was detected in MISS surface soil and all soil horizons (Tables 2-4 and 2-5). Five metals known to be constituents of lithium or thorium wastes (arsenic, chromium, copper, lead, and lithium) were detected with frequency at levels above background concentrations. Rare earth elements generally were detected only at depth intervals that were radioactively contaminated.

VOCs were analyzed in 82 soil samples from 33 boreholes in MISS onsite soils. Six VOCs were detected in the surficial soil horizon, and 12 were detected in all soil horizons (Tables 2-6 and 2-7). Toluene was detected most frequently. The BNAE compounds identified, and the concentrations at which they were detected, are typical for industrialized areas (Tables 2-6 and 2-7). Both VOCs and BNAEs occurred in trace levels in both radioactively contaminated and noncontaminated locations. Alpha and gamma chlordane, aroclor-1254 and -1260, heptachlor epoxide, and 4,4'-DDD were detected at low concentration and frequency in MISS onsite soils.

Thirty-three chemicals were eliminated as COCs from MISS surficial soils (Table 2-8). Seventeen metals had concentrations within background. Five VOCs, nine BNAEs and two pesticides were detected less than three times and at concentrations below the reported quantitation limit (QL). Forty-one chemicals were eliminated from MISS onsite soils (all horizons). Twenty-eight metals had concentrations within background levels. Eight VOCs, three BNAEs, and two pesticides were detected in 5 percent or less of the samples analyzed when sample size was 20 or more samples.

#### 2.3.3.2 Stepan Property Soil

Ten boreholes were sampled on the Stepan property (Figure 2-8). Metals and rare earth elements were analyzed from 39 samples collected from surface depths (0-2 ft) to a maximum of 16.5 ft depth. Twenty-three metals and rare earth elements were detected in the surficial soil horizon (0-2 feet), and 34 were detected in all soil horizons. Uranium was detected in Stepan surface soil and all soil horizons (Tables 2-9 and 2-10). Tellurium was detected once in the surficial soil horizon and once at a depth of 6-8 feet (Tables 2-9 and 2-10). Lutetium was detected only once in surficial soils. Arsenic, lead, lithium, nickel, and selenium occurred most frequently in radioactively contaminated areas. The frequency of detection of all metals present generally decreased with sampling depth. More than 90 percent of the above-background occurrences of the rare earth elements cerium, lanthanum, and neodymium were from samples collected from areas of radioactive contamination.

## Table 2-4. Potential Inorganic Contaminants of Concern in the MISS Site Surficial Soils (0-2 ft depth)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | | |
| | aluminum | 10/10 | 2730 - 24900 | 6888 | 7448 |
| | antimony | 1/10 | 30.3 | 5.6 | 4.7 |
| | arsenic | 9/10 | 2.3 - 20.8 | 10 | 3.3 |
| | barium | 9/10 | 23.9 - 310 | 90 | 45 |
| | beryllium | 4/10 | 0.3 - 2.6 | 0.75 | 0.56 |
| | boron | 1/10 | 23.7 | 13 | 24 |
| | cadmium | 1/10 | 1.2 | 0.62 | 0.71 |
| * | calcium | 10/10 | 3130 - 104000 | 18598 | 1210 |
| * | cerium | 3/10 | 186 - 671 | 210 | 47 |
| * | chromium | 8/10 | 12.9 - 1100 | 170 | 13 |
| | cobalt | 5/10 | 3.1 - 8.80 | 4.5 | 7.6 |
| * | copper | 9/10 | 15.2 - 173 | 62 | 18 |
| | iron | 10/10 | 4140 - 12800 | 8955 | 14448 |
| * | lanthanum | 3/10 | 112 - 374 | 117 | 47 |
| * | lead | 10/10 | 36.3 - 399 | 149 | 39 |
| * | lithium | 4/10 | 25.3 - 2030 | 355 | 24 |
| | magnesium | 7/10 | 1500 - 5650 | 2435 | 1841 |
| | manganese | 10/10 | 67.1 - 415 | 203 | 466 |
| | neodymium | 3/10 | 62 - 299 | 85 | 47 |
| | nickel | 6/10 | 7.8 - 83.7 | 15 | 9 |
| | potassium | 3/10 | 261 - 352 | 513 | 405 |
| | samarium | 1/10 | 57.5 | 28 | 47 |
| | selenium | 4/10 | 0.55 - 1.2 | 0.66 | 0.45 |
| * | sodium | 4/10 | 163 - 2400 | 618 | 62 |
| * | uranium | 22/145 | 16.5 - 161 | 53 | 4.4 |
| | vanadium | 8/10 | 9.8 - 19 | 13 | 20 |
| * | zinc | 9/10 | 29.1 - 491 | 140 | 51 |

* Contaminant of Concern

## Table 2-5. Potential Inorganic Contaminants of Concern in the MISS Site Soils (All Horizons)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | | |
| | aluminum | 69/79 | 1260 - 55700 | 6500 | 7448 |
| | antimony | 13/79 | 3.0 - 30.3 | 3.5 | 4.7 |
| * | arsenic | 78/79 | 0.53 - 1060 | 9.8 | 3.3 |
| | barium | 79/79 | 15.3 - 310 | 59 | 45 |
| | beryllium | 75/79 | 0.10 - 5.3 | 0.54 | 0.56 |
| | boron | 6/79 | 23.7 - 114 | 13 | 24 |
| | cadmium | 7/79 | 0.87 - 2.3 | 0.43 | 0.71 |
| * | calcium | 79/79 | 507 - 216000 | 12554 | 1210 |
| * | cerium | 18/79 | 52.6 - 3140 | 101 | 47 |
| * | chromium | 60/79 | 1.0 - 1510 | 145 | 13 |
| | cobalt | 73/79 | 1.0 - 269 | 5.7 | 7.6 |
| * | copper | 71/79 | 3.0 - 224 | 42 | 18 |
| | dysprosium | 3/79 | 52.0 - 59.2 | 22 | 47 |
| | erbium | 2/79 | 46.2 - 58.1 | 22 | 506 |
| | gadolinium | 2/79 | 56.7 - 129 | 23 | 47 |
| | holmium | 2/79 | 57.5 - 58.7 | 22 | 47 |
| | iron | 75/79 | 381 - 32700 | 7801 | 14448 |
| | lanthanum | 17/79 | 40.3 - 1560 | 76 | 47 |
| | lead | 69/79 | 2.2 - 580 | 76 | 39 |
| * | lithium | 37/79 | 17.4 - 2290 | 122 | 24 |
| | magnesium | 79/79 | 137 - 6500 | 1321 | 1841 |
| | manganese | 76/79 | 11.4 - 588 | 141 | 466 |
| | neodymium | 15/79 | 53.7 - 1310 | 58 | 47 |
| | nickel | 79/79 | 2.8 - 135 | 12 | 8.8 |
| | potassium | 74/79 | 167 - 1690 | 531 | 405 |
| * | praseodymium | 1/65 | 372 | 24 | 4.7 |
| | samarium | 5/79 | 44.8 - 316 | 27 | 47 |
| | selenium | 18/79 | 0.41 - 3.40 | 0.41 | 0.45 |
| | silver | 27/79 | 0.84 - 2.8 | 1.3 | 3.6 |
| * | sodium | 78/79 | 33.3 - 28300 | 759 | 62 |
| | tellurium | 1/79 | 106 | 22 | 47 |
| | terbium | 1/79 | 67.7 | 22 | 59 |
| | thulium | 1/79 | 51.0 | 22 | 483 |
| * | uranium | 31/355 | 12.0 - 913 | 51 | 4.4 |
| | vanadium | 74/79 | 1.8 - 30.6 | 11 | 20 |
| | ytterbium | 1/79 | 68.6 | 22 | 47 |
| | zinc | 56/79 | 13.1 - 491 | 64 | 50 |

* Contaminant of Concern

## Table 2-6. Potential Organic and Mobile Ion Contaminants of Concern in the MISS Site Surficial Soils (0-2 ft depth)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|---|
| **VOLATILE ORGANICS (µg/kg)** | | | | |
| | carbon disulfide | 1/11 | 13 | 6 - 12 |
| | 1,2-dichloroethane (total) | 1/11 | 2 | 6 - 20 |
| | methylene chloride | 1/11 | 49 | -- |
| * | toluene | 3/11 | 3-6 | 6 - 12 |
| | tetrachloroethane (total) | 1/11 | 2 | 6 - 12 |
| | trichloroethylene | 2/11 | 2-5 | 6 - 12 |
| **BNAEs (µg/kg)** | | | | |
| | acenaphthene | 2/10 | 61 - 92 | 340 - 1900 |
| | acenaphthylene | 1/10 | 57 | 320 - 1900 |
| * | anthracene | 4/10 | 58 - 270 | 340 - 1900 |
| * | benzo(a)anthracene | 8/10 | 99 - 1100 | 350 - 1900 |
| * | benzo(a)pyrene | 9/10 | 100 - 1000 | 350 - 1900 |
| * | benzo(b)fluoranthene | 9/10 | 92 - 1100 | 350 - 1900 |
| * | benzo(g,h,i)perylene | 4/10 | 200 - 420 | 350 -1900 |
| | benzoic acid | 1/10 | 200 | 1600 - 9300 |
| * | benzo(k)fluoranthene | 6/10 | 100 - 1100 | 350 -1900 |
| * | bis(2-ethylhexyl)phthalate | 7/10 | 49 - 590 | 49 - 1900 |
| * | butylbenzylphthalate | 3/10 | 57 - 150 | 320 - 1900 |
| * | chrysene | 8/10 | 110 - 1200 | 340 - 1900 |
| * | dibenzo(a,h)anthracene | 4/10 | 52 - 100 | 340 - 1900 |
| | dibenzofuran | 2/10 | 43 - 45 | 57 - 1900 |
| * | di-n-butylphthalate | 6/10 | 40 - 180 | 57 - 1900 |
| | 1,2-diphenylhydrazine | 1/10 | 840 | 340 - 1900 |
| * | fluoranthene | 9/10 | 200 - 2200 | 340 - 1900 |
| | fluorene | 2/10 | 84 - 94 | 340 - 1900 |
| * | indeno(1,2,3-cd)pyrene | 4/10 | 190 - 590 | 340 - 1900 |
| | naphthalene | 2/10 | 34 - 44 | 340 -1900 |
| | n-nitrosodiphenylamine | 1/10 | 78 | 320 - 1900 |
| | pentachlorophenol | 1/10 | 81 | 1700 - 9300 |
| * | phenanthrene | 9/10 | 69 - 110 | 340 - 1900 |
| * | pyrene | 9/10 | 150 - 1700 | 350 -1900 |
| **PESTICIDES/PCBs (µg/kg)** | | | | |
| * | alpha chlordane | 3/10 | 20 - 54 | NA |
| | arochlor-1260 | 1/13 | 100 | NA |
| * | gamma chlordane | 4/10 | 17 - 51 | NA |
| | heptachlor epoxide | 2/10 | 1.9 - 4.7 | NA |
| **MOBILE IONS (mg/kg)** | | | | |
| * | phosphate | 1/1 | 729 | NA |

* Contaminant of Concern
NA Data not available; quantitation limit not reported in BNI 1992.

## Table 2-7. Potential Organic and Mobile Ion Contaminants of Concern in the MISS Site Soils (All Horizons)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|---|
| | **VOLATILE ORGANICS (µg/kg)** | | | |
| | acrolein | 1/82 | 8 | 11 - 23 |
| | acrylonitrile | 1/82 | 6 | 11 - 23 |
| | benzene | 1/82 | 2 - 21 | 6 - 12 |
| * | 2-butanone | 9/82 | 3 - 170 | 11 - 23 |
| * | carbon disulfide | 13/82 | 1 - 29 | 6 - 12 |
| | chloromethane | 2/82 | 1 - 9 | 11 - 23 |
| | 1,2-dichloroethane (total) | 1/82 | 2 | 6 - 12 |
| | tetrachloroethylene | 1/82 | 3 | 6 - 12 |
| * | toluene | 24/82 | 1 - 160 | 6 - 12 |
| | 1,1,1-trichloroethane | 2/82 | 3 - 5 | 6 - 12 |
| | trichloroethane | 3/82 | 1 - 5 | 6 - 12 |
| * | xylenes (total) | 5/82 | 2 - 4 | 6 - 12 |
| | **BNAEs (µg/kg)** | | | |
| * | acenaphthene | 7/78 | 61 - 930 | 340 - 1900 |
| * | acenaphthylene | 5/78 | 47 - 73 | 320 - 1900 |
| * | anthracene | 17/78 | 41 - 2600 | 340 - 1900 |
| * | benzo(a)anthracene | 32/78 | 51 - 7300 | 350 - 1900 |
| * | benzo(a)pyrene | 31/78 | 44 - 5000 | 350 - 1900 |
| * | benzo(b)fluoranthene | 34/78 | 38 - 4900 | 350 - 1900 |
| * | benzo(g,h,i)perylene | 17/78 | 50 - 2900 | 350 - 1900 |
| * | benzoic acid | 5/78 | 72 - 270 | 1600 - 9300 |
| * | benzo(k)fluoranthene | 31/78 | 40 - 3800 | 340 - 1900 |
| * | bis(2-ethylhexyl)phthalate | 32/78 | 43 - 4200 | 49 - 1900 |
| * | butylbenzylphthalate | 5/78 | 49 - 240 | 320 - 1900 |
| * | chrysene | 32/78 | 44 - 6000 | 340 - 1900 |
| * | dibenzo(a,h)anthracene | 12/78 | 48 - 1100 | 340 - 1900 |
| * | dibenzofuran | 6/78 | 43 - 880 | 340 - 1900 |
| * | di-n-butylphthalate | 21/78 | 40 - 4300 | 57 - 1900 |
| * | 1,2-diphenylhydrazine | 6/78 | 44 - 5700 | 340 - 1900 |
| * | fluoranthene | 37/78 | 43 - 4000 | 340 - 1900 |
| * | fluorene | 7/78 | 48 - 1400 | 340 - 1900 |
| * | indeno(1,2,3-cd)pyrene | 17/78 | 66 - 2900 | 340 - 1900 |
| * | 2-methylphenol | 3/78 | 47 - 3100 | 320 - 1900 |
| * | 4-methyphenol | 2/78 | 58 - 300 | 320 - 1900 |
| * | naphthalene | 5/78 | 34 - 570 | 340 - 1900 |
| * | nitrobenzene | 4/78 | 47 - 460 | 340 - 1900 |
| * | n-nitrosodiphenylamine | 7/78 | 42 - 2100 | 320 - 1900 |
| | 4-nitrophenol | 2/78 | 120 - 520 | 1700 - 9300 |

## Table 2-7. (continued)

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|
| * pentachlorophenol | 6/78 | 44 - 250 | 1700 - 9300 |
| * phenanthrene | 31/78 | 64 - 1100 | 340 - 1900 |
| * phenol | 4/78 | 63 - 180 | 49 - 1900 |
| * pyrene | 42/78 | 36 - 10000 | 350 - 1900 |
| **PESTICIDES/PCBs (µg/kg)** | | | |
| * alpha chlordane | 6 / 77 | 2.1 - 54 | NA |
| arochlor-1254 | 1/115 | 110 | NA |
| 4,4'-DDD | 1 / 77 | 7.6 | NA |
| * gamma chlordane | 8 / 77 | 1.7 - 51 | NA |
| **MOBILE IONS (µg/kg)** | | | |
| * chloride | 3 / 37 | 16.4 - 209 | NA |
| * nitrate | 12 / 37 | 1.3 - 24.3 | NA |
| * phosphate | 37/37 | 315 - 58100 | NA |

* Contaminant of Concern

NA Data not available; quantitation limits not reported in RI BNI 1992

## Table 2-8. Potential Contaminants of Concern in Soil Eliminated from the Risk Assessment

| Contaminant | Screening Rationale [a] |
|---|---|
| **MISS Site - Surficial Soils** | |
| Metals and Rare Earths | |
| aluminum | 1 |
| antimony | 1 |
| arsenic | 1 |
| barium | 1 |
| beryllium | 1 |
| boron | 1 |
| cadmium | 1 |
| cobalt | 1 |
| iron | 1 |
| magnesium | 1 |
| manganese | 1 |
| neodymium | 1 |
| nickel | 1 |
| potassium | 1 |
| samarium | 1 |
| selenium | 1 |
| vanadium | 1 |
| Volatile Organics | |
| carbon disulfide | 2 |
| 1,2-dichloroethane (total) | 2 |
| methylene chloride | 2 |
| tetrachloroethane (total) | 2 |
| trichloroethylene | 2 |

## Table 2-8. (continued)

| Contaminant | Screening Rationale [a] |
|---|---|
| BNAEs | |
| acenaphthene | 2 |
| acenaphthylene | 2 |
| benzoic acid | 2 |
| dibenzofuran | 2 |
| 1,2-diphenylhydrazine | 2 |
| fluorene | 2 |
| naphthalene | 2 |
| n-nitrosodiphenylamine | 2 |
| pentachlorophenol | 2 |
| Pesticides/PCBs | |
| arochlor-1260 | 2 |
| heptachlor epoxide | 2 |
| **MISS Site - All Horizons** | |
| Metals and Rare Earths | |
| aluminum | 1 |
| antimony | 1 |
| barium | 1 |
| beryllium | 1 |
| boron | 1 |
| cadmium | 1 |
| cobalt | 1 |
| dysprosium | 1 |
| erbium | 1 |
| gadolinium | 1 |
| holmium | 1 |
| iron | 1 |
| lanthanum | 1 |
| lead | 1 |
| magnesium | 1 |
| manganese | 1 |
| neodymium | 1 |

## Table 2-8. (continued)

| Contaminant | Screening Rationale[a] |
|---|---|
| Metals and Rare Earths (continued) | |
| nickel | 1 |
| potassium | 1 |
| samarium | 1 |
| selenium | 1 |
| silver | 1 |
| tellurium | 1 |
| terbium | 1 |
| thulium | 1 |
| vanadium | 1 |
| ytterbium | 1 |
| zinc | 1 |
| Volatile Organics | |
| acrolein | 3 |
| acrylonitrile | 3 |
| benzene | 3 |
| chloromethane | 3 |
| 1,2-dichloroethane (total) | 3 |
| tetrachloroethylene | 3 |
| 1,1,1-trichloroethane | 3 |
| trichloroethane | 3 |
| BNAEs | |
| 2 - methylphenol | 3 |
| 4 - methyphenol | 3 |
| 4 - nitrophenol | 3 |
| Pesticides/PCBs | |
| arochlor-1254 | 3 |
| 4,4'-DDD | 3 |

## Table 2-8. (continued)

| Contaminant | Screening Rationale[a] |
|---|---|
| **Stepan Site - Surficial Soils** | |
| Metals and Rare Earths | |
| barium | 1 |
| beryllium | 1 |
| cadmium | 1 |
| cerium | 1 |
| chromium | 1 |
| cobalt | 1 |
| copper | 1 |
| iron | 1 |
| lanthanum | 1 |
| lithium | 1 |
| lutetium | 1 |
| magnesium | 1 |
| nickel | 1 |
| selenium | 1 |
| silver | 1 |
| tellurium | 1 |
| thallium | 2 |
| BNAEs | |
| acenaphthene | 2 |
| dibenzo(a,h)anthracene | 2 |
| dibenzofuran | 2 |
| 2 - methylnaphthalene | 2 |
| naphthalene | 2 |
| phenanthrene | 2 |
| pyrene | 2 |

## Table 2-8. (continued)

| Contaminant | Screening Rationale[a] |
|---|---|
| **Stepan Site - All Horizons** | |
| Metals and Rare Earths | |
| alumium | 1 |
| antimony | 1 |
| barium | 1 |
| beryllium | 1 |
| boron | 1 |
| cadmium | 1 |
| cobalt | 1 |
| copper | 1 |
| dysprosium | 1 |
| gadolinium | 1 |
| iron | 1 |
| lithium | 1 |
| lutetium | 1 |
| magnesium | 1 |
| manganese | 1 |
| molybdenum | 1 |
| nickel | 1 |
| samarium | 1 |
| silver | 1 |
| tellurium | 1 |
| terbium | 1 |
| vanadium | 1 |
| zinc | 1 |

## Table 2-8. (continued)

| Contaminant | Screening Rationale[a] |
|---|---|
| Volatile Organics | |
| benzene | 2 |
| 2-butanone | 2 |
| carbon disulfide | 2 |
| carbon tetrachloride | 2 |
| chloroform | 2 |
| 2-hexanone | 2 |
| xylenes (total) | 2 |
| BNAEs | |
| acenaphthene | 2 |
| benzoic acid | 2 |
| dibenzo(a,h)anthracene | 2 |
| dibenzofuran | 2 |
| 1,2-diphenylhydrazine | 2 |
| 2-methylnaphthalene | 2 |
| naphthalene | 2 |
| pentachlorophenol | 2 |
| **Commercial/Government Vicinity Properties - Surficial Soils** | |
| Metals and Rare Earths | |
| aluminum | |
| arsenic | 1 |
| beryllium | 1 |
| cerium | 1 |
| chromium | 1 |
| cobalt | 1 |
| erbium | 1 |
| iron | 1 |
| lanthanum | 1 |
| magnesium | 1 |
| manganese | 1 |
| neodymium | 1 |
| nickel | 1 |
| potassium | 1 |
| selenium | 1 |
| terbium | 1 |
| vanadium | 1 |
| zinc | 1 |

## Table 2-8. (continued)

| Contaminant | Screening Rationale[a] |
|---|---|
| Volatile Organics | |
| 2-butanone | 2 |
| carbon disulfide | 2 |
| tetrachloroethylene | 2 |
| toluene | 2 |
| trichloroethylene | 2 |
| BNAEs | |
| phenanthrene | 2 |
| **Commercial/Government Vicinity Properties - All Horizons** | |
| Metals and Rare Earths | |
| aluminum | 1 |
| antimony | 1 |
| arsenic | 1 |
| beryllium | 1 |
| cerium | 1 |
| cobalt | 1 |
| copper | 1 |
| erbium | 1 |
| iron | 1 |
| lanthanum | 1 |
| lead | 1 |
| lutetium | 1 |
| magnesium | 1 |
| manganese | 1 |
| neodymium | 1 |
| nickel | 1 |
| potassium | 1 |
| selenium | 1 |
| silver | 1 |
| tellurium | 1 |
| terbium | 1 |
| thallium | 1 |
| vanadium | 1 |

## Table 2-8. (continued)

| Contaminant | Screening Rationale[a] |
|---|---|
| Volatile Organics | |
| 2-butanone | 2 |
| carbon disulfide | 2 |
| tetrachloroethylene | 2 |
| toluene | 2 |
| trichloroethylene | 2 |
| BNAEs | |
| anthracene | 2 |
| benzo(a)pyrene | 2 |
| benzo(b)fluoranthene | 2 |
| benzo(g,h,i)perylene | 2 |
| benzo(k)fluoranthene | 2 |
| indeno(1,2,3-cd)pyrene | 2 |
| **Residential Vicinity Properties - Surficial Soils** | |
| Metals and Rare Earths | |
| aluminum | 1 |
| antimony | 1 |
| arsenic | 1 |
| beryllium | 1 |
| cadmium | 1 |
| cerium | 1 |
| chromium | 1 |
| cobalt | 1 |
| copper | 1 |
| iron | 1 |
| lanthanum | 1 |
| magnesium | 1 |
| manganese | 1 |
| neodymium | 1 |
| nickel | 1 |
| potassium | 1 |
| selenium | 1 |
| sodium | 1 |
| vanadium | 1 |

## Table 2-8. (continued)

| Contaminant | Screening Rationale [a] |
|---|---|
| **Residential Vicinity Properties - All Horizons** | |
| Metals and Rare Earths | |
| aluminum | 1 |
| antimony | 1 |
| arsenic | 1 |
| beryllium | 1 |
| cadmium | 1 |
| cobalt | 1 |
| copper | 1 |
| iron | 1 |
| lanthanum | 1 |
| lutetium | 1 |
| magnesium | 1 |
| manganese | 1 |
| neodymium | 1 |
| nickel | 1 |
| potassium | 1 |
| selenium | 1 |
| sodium | 1 |
| vanadium | 1 |
| zinc | 1 |
| uranium | 1 |

[a] **Screening Rationale Key**

1 Mean of detected concentrations was less than or equal to twice the mean background concentration.

2 Chemical detected less than three times and detected concentrations were less than quantitation limit (QL).

3 Chemical detected at a frequency 5% or less at sample size of 20 or greater.

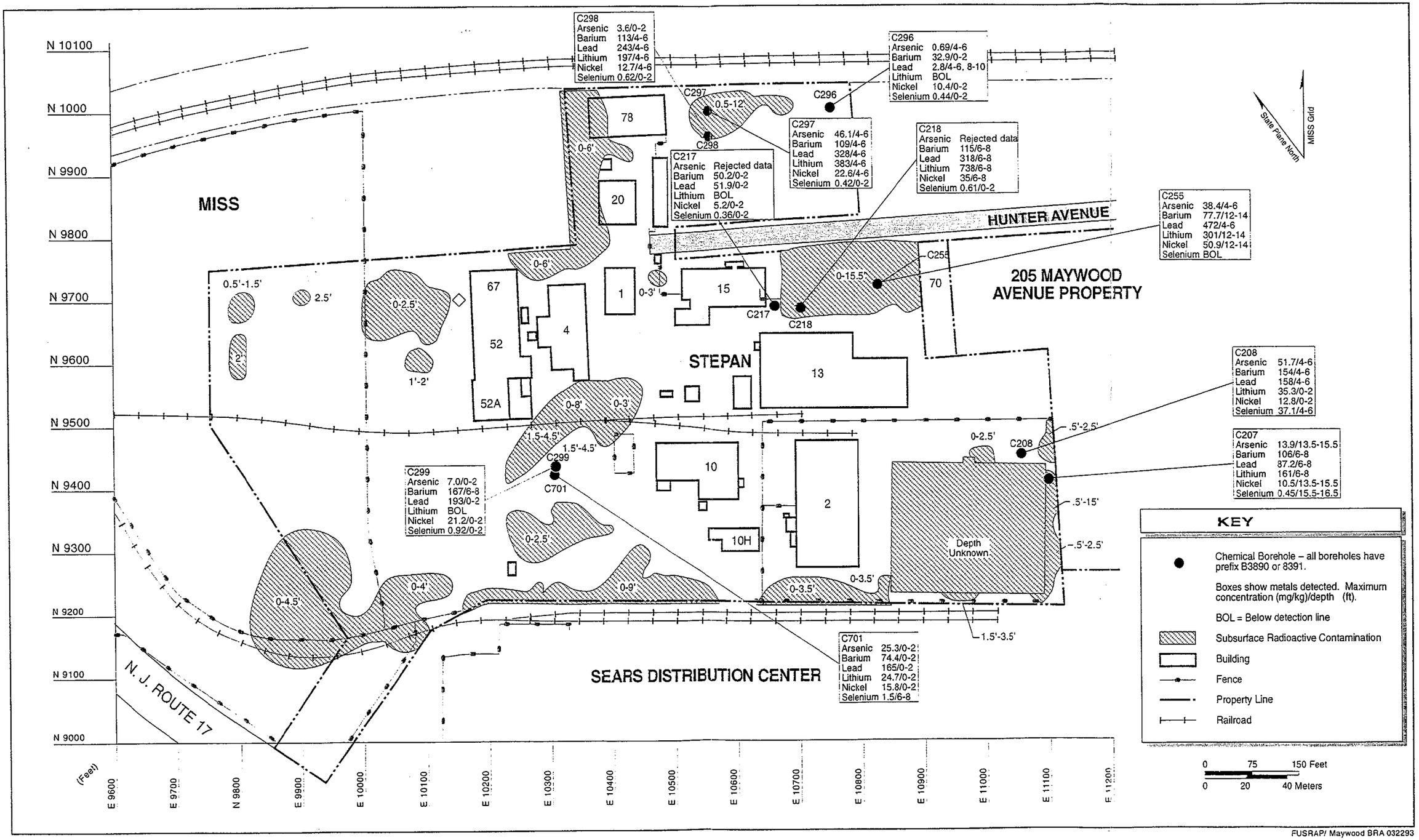



Figure 2-8. Stepan Property Locations of Chemical Boreholes and Areas of Subsurface Radioactive Contamination

## Table 2-9. Potential Inorganic Contaminants of Concern in Stepan Site Surficial Soils (0-2 ft. depth)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | | |
| * | arsenic | 7/10 | 0.84 - 25.3 | 12 | 3.3 |
| | barium | 10/10 | 32.6 - 92.3 | 56 | 45 |
| | beryllium | 9/10 | 0.36 - 0.72 | 0.46 | 0.56 |
| | cadmium | 2/10 | 1.0 - 2.1 | 0.64 | 0.71 |
| * | calcium | 10/10 | 1010 - 16500 | 5817 | 1210 |
| | cerium | 2/10 | 48.6 - 67.4 | 29 | 47 |
| | chromium | 9/10 | 5.0 - 80.6 | 21 | 13 |
| | cobalt | 10/10 | 3.2 - 10.3 | 5.7 | 7.6 |
| | copper | 5/10 | 10.6 - 57.4 | 32 | 18 |
| | iron | 10/10 | 5530 - 13900 | 9893 | 14448 |
| | lanthanum | 1/10 | 52.4 | 26 | 47 |
| * | lead | 9/10 | 0.79 - 193 | 93 | 39 |
| | lithium | 2/10 | 24.7 - 35.3 | 15 | 24 |
| | lutetium | 1/10 | 1070 | 70 | 47 |
| | magnesium | 10/10 | 843 - 3720 | 2030 | 1841 |
| | nickel | 10/10 | 5.2 - 21.2 | 11 | 8.8 |
| | selenium | 8/10 | 0.36 - 1.4 | 0.62 | 0.45 |
| | silver | 1/10 | 1.3 | 0.58 | 3.6 |
| * | sodium | 10/10 | 41.1 - 386 | 150 | 62 |
| | tellurium | 1/10 | 1070 | 70 | 47 |
| | thallium | 1/10 | 15 | 4.6 | 0.45 |
| * | zinc | 7/10 | 57.9 - 238 | 110 | 50 |
| * | uranium | 46/593 | 4.8 - 165 | 10 | 4.4 |

* Contaminant of Concern

## Table 2-10. Potential Inorganic Contaminants of Concern in Stepan Site Soils (All Horizons)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | | |
| | aluminum | 39/39 | 2530 - 44400 | 6324 | 7448 |
| | antimony | 2/39 | 5.05 - 5.34 | 2.7 | 4.7 |
| * | arsenic | 29/39 | 0.43 - 51.7 | 16 | 3.3 |
| | barium | 39/39 | 23.6 - 167 | 71 | 45 |
| | beryllium | 35/39 | 0.2 - 1.8 | 0.53 | 0.56 |
| | boron | 1/39 | 44.6 | 12 | 24 |
| | cadmium | 2/39 | 1.0 - 2.1 | 0.49 | 0.71 |
| * | calcium | 39/39 | 335 - 82900 | 20417 | 1210 |
| * | cerium | 10/39 | 48.6 - 5680 | 681 | 47 |
| * | chromium | 36/39 | 1.7 - 1570 | 65 | 13 |
| | cobalt | 37/39 | 2.0 - 10.3 | 5.0 | 7.6 |
| | copper | 18/39 | 5.5 - 96.2 | 28 | 18 |
| | dysprosium | 4/39 | 71.8 - 94.5 | 29 | 47 |
| | gadolinium | 7/39 | 36.2 - 192 | 37 | 47 |
| | iron | 39/39 | 4650 - 36000 | 10079 | 14448 |
| * | lanthanum | 12/39 | 52.4 - 3770 | 190 | 47 |
| * | lead | 29/39 | 2.6 - 328 | 128 | 39 |
| | lithium | 15/39 | 26.4 - 738 | 61 | 47 |
| | lutetium | 2/39 | 1070 - 1090 | 40 | 24 |
| | magnesium | 39/39 | 512 - 3420 | 1343 | 1841 |
| | manganese | 39/39 | 31.3 - 861 | 233 | 466 |
| | molybdenum | 3/39 | 22.7 - 29.7 | 12 | 24 |
| * | neodymium | 39/39 | 4.6 - 50.9 | 217 | 47 |
| | nickel | 12/39 | 46.2 - 2400 | 11 | 8.8 |
| | samarium | 6/39 | 54.1 - 454 | 43 | 47 |
| * | selenium | 17/39 | 0.36 - 37.1 | 1.2 | 0.45 |
| | silver | 3/39 | 1.3 - 1.7 | 0.56 | 3.6 |
| * | sodium | 38/39 | 54.7 - 5470 | 531 | 62 |
| | tellurium | 2/39 | 1070 - 1100 | 40 | 47 |
| | terbium | 3/39 | 45.3 - 58.9 | 25 | 59 |
| * | thallium | 1/39 | 15.0 | 2.4 | 0.45 |
| * | uranium | 74/1014 | 4.8 - 511 | 10 | 4.4 |
| | vanadium | 36/39 | 4.1 - 32.8 | 12 | 20 |
| | zinc | 24/39 | 7.7 - 238 | 71 | 50 |

* Contaminant of Concern

Twelve soil samples from four boreholes (C207, C296, C299, C701) were analyzed for VOCs. No VOCs were detected in the surficial soil horizon (Table 2-11), while 10 VOCs were detected in all soil horizons (Table 2-12). Toluene was detected most frequently. All VOC concentrations were in the low ppb range and generally found in both radioactively contaminated and noncontaminated areas. Eleven soil samples from five boreholes (C207, C296, C298, C299, C701) were analyzed for BNAEs. Fifteen BNAEs were detected in surficial soils (Table 2-11), and twenty-two BNAEs were detected in all soil horizons (Table 2-12). Trace concentrations generally were not associated with either radioactively contaminated or noncontaminated areas and were characteristic of industrial settings. Most BNAEs detected were polycyclic aromatic hydrocarbons (PAHs). Pesticides and PCBs were not detected in Stepan property soils. Forty-six chemicals were eliminated from all Stepan soil horizons.

Twenty-four chemicals were eliminated as COCs for Stepan property surficial soils (see Table 2-8). Sixteen metals had concentrations within background levels. One metal, thallium, was detected only once and at a concentration less than the reported QL. Seven BNAEs were detected less than three times at concentrations less than QLs. Twenty-three metals, seven VOCs, and eight BNAEs detected in all horizon soils were eliminated from the risk assessment. Twenty-three metals had concentrations within background levels. The VOCs and the BNAEs were detected less than three times and at concentrations below QLs.

#### 2.3.3.3 Commercial/Government Vicinity Properties Soil

Nineteen soil samples were collected from four boreholes on three commercial/government vicinity properties: 113 Essex Street, 200 Route 17, and 205 Maywood Avenue. Twenty-four metals and rare earth elements were detected in the surficial soil horizon (0-2 feet), and 29 were detected in all soil horizons. Uranium was detected in the commercial/government vicinity properties surface soil and all soil horizons (Tables 2-13 and 2-14). Five VOCs and seven BNAEs were detected in surficial soils (Table 2-15). Six VOCs and 14 BNAEs were detected in all soil horizons (Table 2-16). Pesticides and PCBs were not detected. In general, the metals and rare earth elements were detected in areas of radioactivity.

Twenty-four chemicals were eliminated as COCs for commercial/government properties surficial soils (see Table 2-8). Eighteen metals had concentrations within background levels. Five VOCs and one BNAE were detected less than three times, with concentrations below QLs. Thirty-six chemicals detected in all soil horizons were eliminated as COCs. Twenty-five metals

## Table 2-11. Potential Organic and Mobile Ion Contaminants of Concern in Stepan Site Surficial Soils (0-2 ft depth)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|---|
| **BNAEs (µg/kg)** | | | | |
| | acenaphthene | 1/4 | 220 | 340 - 7500 |
| * | anthracene | 1/4 | 2100 | 340 - 7500 |
| * | benzo(a)anthracene | 1/4 | 5700 | 340 - 7500 |
| * | benzo(a)pyrene | 3/4 | 420 - 9000 | 340 - 3800 |
| * | benzo(b)fluoranthene | 1/4 | 6400 | 340 - 7500 |
| * | benzo(g,h,i)perylene | 1/4 | 7600 | 340 - 7500 |
| | dibenzo(a,h)anthracene | 1/4 | 5800 | 340 - 7500 |
| | dibenzofuran | 1/4 | 470 | 340 - 7500 |
| * | di-n-butylphthalate | 1/4 | 4800 | 340 - 7500 |
| * | fluorene | 1/4 | 1300 | 340 - 7500 |
| * | indeno(1,2,3-cd)pyrene | 1/4 | 2400 | 340 - 7500 |
| | 2-methylnapthalene | 1/4 | 5000 | 340 - 7500 |
| | napthhalene | 1/4 | 1000 | 340 - 7500 |
| | phenanthrene | 1/4 | 570 | 340 - 7500 |
| | pyrene | 2/4 | 770 - 910 | 340 - 3800 |
| **MOBILE IONS (mg/kg)** | | | | |
| * | nitrate | 9/11 | 1.5 - 5.8 | NA |
| * | phosphate | 11/11 | 148 - 1700 | NA |

* Contaminant of Concern

NA Data not available; quantitation limit not reported in BNI 1992.

## Table 2-12. Potential Organic and Mobile Ion Contaminants of Concern in Stepan Site Soils (All Horizons)

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|
| **VOLATILE ORGANICS (µg/kg)** | | | |
| benzene | 1/12 | 87 | 6 - 28 |
| 2-butanone | 2/12 | 18 - 96 | 11 - 96 |
| carbon disulfide | 1/12 | 3 | 6 - 28 |
| carbon tetrachloride | 2/12 | 3 - 16 | 6 - 28 |
| chloroform | 2/12 | 1 - 5 | 6 - 28 |
| 2-hexanone | 1/12 | 110 | 11 - 56 |
| * tetrachloroethylene | 3/12 | 2 - 15 | 6 - 28 |
| * toluene | 6/12 | 1 - 190 | 2 - 6 |
| * trichloroethylene | 3/12 | 1 - 2 | 6 |
| xylenes (total) | 2/12 | 1 - 3 | 6 - 28 |
| **BNAEs (µg/kg)** | | | |
| acenaphthene | 2/11 | 1100 - 2100 | 340 - 7500 |
| * anthracene | 2/11 | 2300 - 5700 | 340 - 7500 |
| * benzo(a)anthracene | 4/11 | 120 - 9000 | 340 - 3800 |
| * benzo(a)pyrene | 2/11 | 63 - 9400 | 340 - 7500 |
| * benzo(b)fluoranthene | 2/11 | 75 - 7600 | 340 - 7500 |
| * benzo(g,h,i)perylene | 2/11 | 1800 - 4800 | 340 - 7500 |
| benzoic acid | 1/11 | 210 | 1700 - 38000 |
| * benzo(k)fluoranthene | 3/11 | 71 - 7200 | 340 - 7500 |
| * bis(2-ethylhexyl)phthalate | 3/11 | 64 - 140 | 360 - 7500 |
| * chrysene | 5/11 | 140 - 9200 | 340 - 7500 |
| * di-n-butylphthalate | 2/11 | 57 - 5800 | 340 - 7500 |
| dibenzo(a,h)anthracene | 2/11 | 270 - 470 | 340 - 7500 |
| dibenzofuran | 2/11 | 400 - 1300 | 340 - 7500 |
| 1,2-diphenylhydrazine | 1/11 | 94 | 340 - 7500 |
| * fluoranthene | 3/11 | 270 - 25000 | 340 - 7500 |
| * fluorene | 2/11 | 750 - 2400 | 340 - 7500 |
| * indeno(1,2,3-cd)pyrene | 2/11 | 1500 - 5000 | 340 - 7500 |
| 2-methylnaphthalene | 1/11 | 220 | 340 - 7500 |
| naphthalene | 1/11 | 1000 | 340 - 7500 |
| pentachlorophenol | 1/11 | 620 | 1700 - 38000 |
| * phenanthrene | 4/11 | 230 - 21000 | 340 - 7500 |
| * pyrene | 6/11 | 47 - 15000 | 360 - 3800 |

Table 2-12. (continued)

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|
| **MOBILE IONS (mg/kg)** | | | |
| * chloride | 1/40 | 147 | NA |
| * nitrate | 26/40 | 1.3 - 33.9 | NA |
| * phosphate | 40/40 | 111 - 17700 | NA |

* Contaminant of Concern

NA Data not available; quantitation limit not reported in BNI 1992.

## Table 2-13. Potential Inorganic Contaminants of Concern in Commercial/Government Vicinity Properties Surficial Soils (0-2 ft. depth)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | | |
| | aluminum | 4/4 | 2670 - 7970 | 4841 | 7448 |
| | arsenic | 4/4 | 2.6 - 5.3 | 3.6 | 3.3 |
| * | barium | 4/4 | 109 - 214 | 143 | 45 |
| | beryllium | 3/4 | 0.23 - 0.44 | 0.43 | 0.56 |
| * | calcium | 4/4 | 2360 - 3720 | 2705 | 1210 |
| | cerium | 2/4 | 104 - 193 | 80 | 47 |
| | chromium | 2/4 | 6.9 - 34.1 | 21 | 13 |
| | cobalt | 3/4 | 3.7 - 6.3 | 5.1 | 7.6 |
| * | copper | 2/4 | 24.1 - 101 | 55 | 18 |
| | erbium | 1/4 | 47.8 | 27 | 506 |
| | iron | 4/4 | 4470 - 13100 | 9369 | 14448 |
| | lanthanum | 2/4 | 137 - 193 | 90 | 47 |
| * | lead | 4/4 | 54.1 - 455 | 217 | 39 |
| | magnesium | 4/4 | 888 - 2110 | 1560 | 1841 |
| | manganese | 4/4 | 72.5 - 198 | 145 | 466 |
| | neodymium | 2/4 | 56.1 - 104 | 37 | 47 |
| | nickel | 4/4 | 4.6 - 12.3 | 12 | 8.8 |
| | potassium | 1/4 | 369 | 319 | 405 |
| | selenium | 3/4 | 0.5 - 0.86 | 0.52 | 0.45 |
| * | sodium | 2/4 | 94 - 128 | 128 | 62 |
| | terbium | 1/4 | 62.2 | 30 | 59 |
| * | uranium | 59/761 | 1.8 - 1885 | 11 | 4.4 |
| | vanadium | 4/4 | 11.4 - 28.8 | 16 | 20 |
| | zinc | 4/4 | 65.6 - 109 | 76 | 50 |

* Contaminant of Concern

## Table 2-14. Potential Inorganic Contaminants of Concern in Commercial/Government Vicinity Properties Soils (All Horizons)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | | |
| | aluminum | 16/19 | 1470 - 11900 | 5113 | 7448 |
| | antimony | 1/19 | 6.1 | 3.2 | 4.7 |
| | arsenic | 15/19 | 0.5 - 5.3 | 2.4 | 3.3 |
| * | barium | 16/19 | 36 - 425 | 131 | 45 |
| | beryllium | 12/19 | 0.17 - 0.92 | 0.40 | 0.56 |
| * | calcium | 16/19 | 903 - 13400 | 4135 | 1210 |
| | cerium | 6/19 | 48.2 - 309 | 50 | 47 |
| * | chromium | 8/19 | 1.7 - 238 | 57 | 13 |
| | cobalt | 14/19 | 2.4 - 11.4 | 5.3 | 7.6 |
| | copper | 12/19 | 5.4 - 101 | 30 | 18 |
| | erbium | 1/19 | 47.8 | 22 | 506 |
| | iron | 16/19 | 11.1 - 20700 | 20352 | 14448 |
| | lanthanum | 6/19 | 46.5 - 952 | 73 | 47 |
| | lead | 15/19 | 2.9 - 455 | 70 | 39 |
| | lutetium | 1/19 | 646 | 34 | 47 |
| | magnesium | 16/19 | 689 - 7050 | 1852 | 1841 |
| | manganese | 16/19 | 34.8 - 294 | 158 | 466 |
| | neodymium | 4/19 | 39.7 - 158 | 33 | 47 |
| | nickel | 16/19 | 3.2 - 23.3 | 11 | 8.8 |
| | potassium | 8/19 | 170 - 1440 | 518 | 405 |
| | selenium | 6/19 | 0.44 - 1.4 | 0.40 | 0.45 |
| | silver | 1/19 | 0.9 | 0.69 | 3.6 |
| * | sodium | 12/19 | 34.8 - 147 | 272 | 62 |
| | tellurium | 1/19 | 644 | 34 | 47 |
| | terbium | 1/19 | 62.2 | 23 | 59 |
| | thallium | 1/19 | 0.66 | 1.6 | 0.45 |
| * | uranium | 112/1621 | 1.5 - 1885 | 8.6 | 4.4 |
| | vanadium | 16/19 | 3.9 - 36.7 | 15 | 20 |
| | zinc | 16/19 | 11.7 - 113 | 62 | 50 |

* Contaminant of Concern

## Table 2-15. Potential Organic and Mobile Ion Contaminants of Concern in Commercial/ Government Vicinity Properties Surficial Soils (0-2 ft. depth)

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|
| **Volatile Organics (µg/kg)** | | | |
| 2-butanone | 2/2 | 3 - 19 | 11 |
| carbon disulfide | 1/2 | 3 | 6 |
| tetrachloroethylene | 1/2 | 6 | 6 |
| toluene | 1/2 | 3 | 6 |
| trichloroethylene | 1/2 | 1 | 6 |
| **BNAEs (µg/kg)** | | | |
| * benzo(a)anthracene | 1/2 | 440 | 380 - 380 |
| * butylbenzylphthalate | 1/2 | 980 | 380 - 830 |
| * chrysene | 1/2 | 510 | 380 - 380 |
| * di-n-butylphthalate | 1/2 | 6300 | 380 - 380 |
| * fluoranthene | 1/2 | 1100 | 380 - 380 |
| phenanthrene | 2/2 | 39 - 290 | ND |
| * pyrene | 1/2 | 950 | ND |
| **MOBILE IONS (mg/kg)** | | | |
| * chloride | 3/6 | 74.6 - 165 | NA |
| * nitrate | 3/7 | 1.5 - 6.8 | NA |
| * phosphate | 7/7 | 240 - 629 | NA |

* Contaminant of Concern
NA Data not available; quantitation limit not reported in BNI, 1992.
ND No data, no detection limits reported.

## Table 2-16. Potential Organic and Mobile Ion Contaminants of Concern in Commercial/ Government Vicinity Properties Soils (All Horizons)

| | Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|---|
| **VOLATILE ORGANICS (µg/kg)** | | | | |
| | 2-butanone | 2/3 | 3 - 19 | 11 |
| | carbon disulfide | 1/3 | 3 | 6 |
| | tetrachloroethylene | 2/3 | 1 - 6 | 6 |
| | toluene | 1/3 | 3 | 6 |
| | trichloroethylene | 1/3 | 1 | 6 |
| * | xylenes (total) | 1/3 | 7 | 6 |
| **BNAEs (µg/kg)** | | | | |
| | anthracene | 1/3 | 62 | 380 - 830 |
| * | benzo(a)anthracene | 2/3 | 440 - 440 | 380 - 380 |
| | benzo(a)pyrene | 2/3 | 200 - 460 | 380 - 380 |
| | benzo(b)fluoranthene | 2/3 | 190 - 530 | 380 - 380 |
| | benzo(g,h,i)perylene | 2/3 | 97 - 180 | 380 - 380 |
| | benzo(k)fluoranthene | 2/3 | 150 - 400 | 380 - 380 |
| * | bis(2-ethylhexyl)phthalate | 1/3 | 6100 | 380 - 380 |
| * | butylbenzylphthalate | 1/3 | 980 | 380 - 830 |
| * | chrysene | 2/3 | 190 - 510 | 380 - 380 |
| * | di-n-butylphthalate | 2/3 | 450 - 6300 | 380 - 380 |
| * | fluoranthene | 2/3 | 380 - 1100 | 380 - 380 |
| | indeno(1,2,3-cd)pyrene | 1/3 | 160 | 380 - 830 |
| * | phenanthrene | 3/3 | 39 - 290 | ND |
| * | pyrene | 3/3 | 66 - 950 | ND |
| **MOBILE IONS (mg/kg)** | | | | |
| * | chloride | 7/18 | 27.1 - 180 | NA |
| * | nitrate | 13/18 | 1.1 - 6.8 | NA |
| * | phosphate | 19/19 | 240 - 716 | NA |

* Contaminant of Concern
NA Data not available; quantitation limit not reported in BNI, 1992
ND No data; no detection limits reported.

had concentrations within background levels. Five VOCs and six BNAEs were detected less than three times and with concentrations below QLs.

2.3.3.4 Residential Vicinity Properties Soil

Twelve soil samples collected from four boreholes at three residential vicinity properties (90 Avenue C, 113 Avenue E, and 62 Trudy Drive) were analyzed for metals and rare earth elements and PCBs. Analyses for VOCs, BNAEs, and pesticides were not initiated. Twenty-five metals and rare earth elements were detected in both the surficial soil horizon and all soil horizons. Uranium was detected in the residential vicinity properties surface soil and all soil horizons (Tables 2-17 and 2-18). Seven of the metals (aluminum, calcium, iron, magnesium, manganese, potassium and sodium) are common, naturally occurring soil constituents. No PCBs were detected in residential vicinity property soils (Tables 2-19 and 2-20).

Nineteen metals in surficial soils and eighteen in all soil horizons were eliminated as COCs because their detected concentrations were within background concentrations (see Table 2-8).

### 2.3.4 Groundwater

Groundwater samples for chemical analyses were collected from the same wells as were radiological samples (see Figure 2-5). All analyses were quarterly, except VOCs and BNAEs, which were analyzed yearly from 1986 through 1991. In addition, samples collected during fourth quarter 1990 through third quarter 1991 were analyzed for metals, rare earth elements, and mobile ions.

Twenty-five metals and rare earth elements were detected in alluvium groundwater and 33 were detected in bedrock groundwater (Tables 2-21 and 2-22). Nine VOCs and four BNAEs were detected in alluvium groundwater (Table 2-23). Fifteen VOCs and five BNAEs were detected in bedrock groundwater (Table 2-24).

Metals and rare earth elements comprise the largest contaminant group (Tables 2-21 and 2-22). Significant migration of metals is not apparent. The most frequently and consistently detected VOCs include tetrachloroethylene, 1,2-dichloroethene, trichloroethylene, benzene, and vinyl chloride from onsite MISS wells. Organic compounds were not detected in the two upgradient background wells. Ten VOCs have been detected in Stepan well (MISS-4B) with 1,2 dichloroethene consistently present since 1986. VOCs also are present in Ballod property

## Table 2-17. Potential Inorganic Contaminants of Concern in Residential Vicinity Properties Surficial Soils (0-2 ft. depth)

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | |
| aluminum | 4/4 | 4260 - 6170 | 5544 | 7448 |
| antimony | 2/4 | 6.1 - 9.2 | 6.5 | 4.7 |
| arsenic | 4/4 | 3.2 - 5.1 | 4.0 | 3.3 |
| * barium | 4/4 | 63.5 - 242 | 116 | 45 |
| beryllium | 2/4 | 0.41 - 0.44 | 0.44 | .56 |
| cadmium | 1/4 | 1.8 | 0.80 | .71 |
| * calcium | 4/4 | 898 - 6910 | 3309 | 1210 |
| cerium | 3/4 | 53.1 - 141 | 78 | 47 |
| chromium | 4/4 | 4.7 - 22.2 | 16 | 13 |
| cobalt | 2/4 | 3.9 - 5.6 | 5.1 | 7.6 |
| copper | 3/4 | 17.4 - 43.5 | 30 | 18 |
| iron | 4/4 | 6710 - 11500 | 8612 | 14448 |
| lanthanum | 2/4 | 53 - 107 | 61 | 47 |
| * lead | 4/4 | 62.9 - 1000 | 402 | 39 |
| * lutetium | 1/4 | 1150 | 427 | 47 |
| magnesium | 3/4 | 808 - 2170 | 1282 | 1841 |
| manganese | 4/4 | 121 - 251 | 212 | 466 |
| neodymium | 1/4 | 58.7 | 23 | 47 |
| nickel | 2/4 | 6.5 - 9.3 | 6.2 | 8.8 |
| potassium | 2/4 | 317 - 566 | 492 | 405 |
| selenium | 2/4 | 0.43 - 0.49 | 0.46 | .45 |
| sodium | 2/4 | 46.5 - 86.7 | 87 | 62 |
| * uranium | 54/887 | 2.1 - 111 | 10 | 4.4 |
| vanadium | 4/4 | 11.4 - 20.2 | 15 | 20 |
| * zinc | 4/4 | 48.5 - 655 | 260 | 50 |

* Contaminant of Concern

## Table 2-18. Potential Inorganic Contaminants of Concern in Residential Vicinity Properties Soils (All Horizons)

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | |
| aluminum | 12/12 | 3450 - 15000 | 7239 | 7448 |
| antimony | 3/12 | 6.1 - 9.2 | 5.2 | 4.7 |
| arsenic | 12/12 | 0.3 - 12.7 | 4 | 3.3 |
| * barium | 10/12 | 64.3 - 299 | 121 | 45 |
| beryllium | 7/12 | 0.33 - .82 | 0.48 | .56 |
| cadmium | 1/12 | 1.8 | 0.56 | .71 |
| * calcium | 10/12 | 853 - 14300 | 5726 | 1210 |
| * cerium | 5/12 | 53.1 - 652 | 109 | 47 |
| * chromium | 11/12 | 3.1 - 221 | 34 | 13 |
| cobalt | 7/12 | 3.6 - 7.3 | 4.9 | 7.6 |
| copper | 8/12 | 12.4 - 60.2 | 28 | 18 |
| iron | 12/12 | 4320 - 15900 | 9516 | 14448 |
| lanthanum | 4/12 | 53 - 485 | 78 | 47 |
| * lead | 12/12 | 4.2 - 1000 | 185 | 39 |
| lutetium | 1/12 | 1150 | 58 | 47 |
| magnesium | 9/12 | 808 - 2400 | 1299 | 1841 |
| manganese | 12/12 | 41.3 - 252 | 165 | 466 |
| neodymium | 3/12 | 58.7 - 336 | 78 | 47 |
| nickel | 7/12 | 5.5 - 15 | 7.1 | 8.8 |
| potassium | 7/12 | 223 - 566 | 424 | 405 |
| selenium | 5/12 | 0.43 - 2.2 | 0.61 | .45 |
| sodium | 7/12 | 46.5 - 115 | 261 | 62 |
| * uranium | 111/1858 | 0.9 - 112 | 8.1 | 4.4 |
| vanadium | 11/12 | 11.4 - 31.4 | 16 | 20 |
| * zinc | 11/12 | 17.3 - 655 | 139 | 50 |

* Contaminant of Concern

## Table 2-19. Potential Organic and Mobile Ion Contaminants of Concern in Residential Vicinity Properties Surficial Soils (0-2 ft. depth)

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|
| **MOBILE IONS (mg/kg)** | | | |
| * chloride | 1/4 | 33.2 | NA |
| * nitrate | 4/4 | 2.6 - 11.0 | NA |
| * phosphate | 4/4 | 237 - 949 | NA |

* Contaminant of Concern

NA Data not available; quantitation limit not reported in BNI 1992.

## Table 2-20. Potential Organic and Mobile Ion Contaminants of Concern in Residential Vicinity Properties Soils (All Horizons)

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit Range |
|---|---|---|---|
| **MOBILE IONS (mg/kg)** | | | |
| * chloride | 1/12 | 33.2 | NA |
| * nitrate | 12/12 | 1.8 - 11.0 | NA |
| * phosphate | 12/12 | 116 - 1780 | NA |

* Contaminant of Concern

NA Data not available; quantitation limit not reported in BNI 1992.

## Table 2-21. Potential Inorganic Contaminants of Concern in MISS Site Alluvium Groundwater

| Contaminant | Frequency of Detection | Range of Detected Concentrations [1] | Estimated Mean Exposure Concentration | Mean Background Concentration [2] |
|---|---|---|---|---|
| **METALS AND RARE EARTHS (µg/L)** | | | | |
| * aluminum | 29/40 | 128 - 56400 | 12436 | -- |
| antimony | 1/40 | 24.6 | 17 | -- |
| * arsenic | 20/40 | 3.6 - 2310 | 92 | -- |
| * barium | 17/40 | 26.5 - 1290 | 177 | -- |
| * beryllium | 9/40 | 0.7 - 8.6 | 1.5 | -- |
| * boron | 20/40 | 100 - 2740 | 427 | -- |
| * calcium | 40/40 | 18800 - 7540000 | 164968 | -- |
| * cerium | 2/40 | 329 - 623 | 119 | -- |
| * chromium | 18/40 | 6.1 - 1340 | 368 | -- |
| * copper | 24/40 | 6.6 - 420 | 157 | -- |
| erbium | 1/40 | 213 | 104 | -- |
| * gadolinium | 2/40 | 232 - 255 | 108 | -- |
| * iron | 40/40 | 729 - 111000 | 92188 | -- |
| lanthanum | 1/40 | 356 | 115 | -- |
| * lead | 17/40 | 2.5 - 389 | 39 | -- |
| * lithium | 15/40 | 119 - 12400 | 1301 | -- |
| * magnesium | 38/40 | 321 - 69400 | 20946 | -- |
| * manganese | 40/40 | 35.6 - 5130 | 2632 | -- |
| * nickel | 14/40 | 10 - 2453 | 72 | -- |
| * potassium | 38/40 | 2689 - 237000 | 55670 | -- |
| * selenium | 5/40 | 1.7 - 10.2 | 3.7 | -- |
| * sodium | 40/40 | 139 - 1240000 | 342245 | -- |
| terbium | 2/40 | 214 - 298 | 109 | -- |
| * vanadium | 8/40 | 22.2 - 125 | 28 | -- |
| * zinc | 38/40 | 4.4 - 3520 | 273 | -- |

* Contaminant of Concern

1 Detected concentrations are for total metals; dissolved metal data not used.

2 Background concentrations not availble for alluvium groundwater.

## Table 2-22. Potential Inorganic Contaminants of Concern in MISS Site Bedrock Groundwater

| Contaminant | Frequency of Detection | Range of Detected Concentrations (1) | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|
| **METALS AND RARE EARTHS (µg/L)** | | | | |
| aluminum | 14/60 | 145 - 2330 | 241 | 1850 |
| antimony | 1/60 | 25.2 | 16 | 26 |
| * arsenic | 16/60 | 2.4 - 155 | 6.2 | 2 |
| barium | 20/60 | 11.6 - 356 | 88 | 230 |
| beryllium | 9/60 | 1 - 1.6 | 0.79 | 0.95 |
| * boron | 45/60 | 118 - 4280 | 562 | 100 |
| cadmium | 1/60 | 3.8 | 2.1 | 4 |
| calcium | 60/60 | 2078 - 500000 | 13974 | 92800 |
| cerium | 6/60 | 206 - 1320 | 129 | 200 |
| chromium | 21/60 | 3.9 - 265 | 7.3 | 26 |
| cobalt | 5/60 | 9 - 36.2 | 7.0 | 6 |
| copper | 16/60 | 2.3 - 244 | 12 | 12 |
| dysprosium | 1/60 | 206 | 102 | 200 |
| erbium | 2/60 | 238 - 312 | 105 | 200 |
| europium | 1/60 | 224 | 102 | 200 |
| * iron | 52/60 | 34.5 - 106000 | 84307 | 2258 |
| lanthanum | 3/60 | 231 - 1320 | 119 | 200 |
| lead | 16/60 | 2.2 - 118 | 4.9 | 5 |
| * lithium | 29/60 | 103 - 17400 | 2200 | 100 |
| * magnesium | 59/60 | 1020 - 78200 | 21224 | 7228 |
| * manganese | 58/60 | 21.7 - 10200 | 4848 | 337 |
| molybdenum | 1/60 | 111 | 131 | 100 |
| neodymium | 2/60 | 292-510 | 108 | 200 |
| nickel | 9/60 | 6.2 - 51.4 | 11 | 22 |
| * potassium | 59/60 | 1958 - 286000 | 40978 | 3206 |
| selenium | 10/60 | 1.1-11.6 | 2.1 | 2 |
| silver | 1/60 | 17.7 | 3.5 | 6 |
| * sodium | 60/60 | 13600 -1910000 | 201221 | 12200 |
| tellurium | 1/60 | 208 | 102 | 200 |
| terbium | 3/60 | 208 - 399 | 110 | 200 |
| thallium | 1/60 | 21 | 11 | 4 |
| vanadium | 14/60 | 6 - 39.7 | 19 | 15 |
| * zinc | 44/59 | 3.4 - 3100 | 141 | 55 |

* Contaminant of Concern

1 Detected concentrations are for total metals; dissolved metal data not used.

## Table 2-23. Potential Organic and Mobile Ion Contaminants of Concern in MISS Site Alluvium Groundwater

| Contaminant | Frequency of Detection | Range of Detected Concentrations (1) | Quantitation Limit |
|---|---|---|---|
| **VOLATILE ORGANICS (µg/L)** | | | |
| * carbon disulfide | 1/6 | 16 | 5 |
| * 1,1-dichloroethene | 3/3 | 5 - 9 | 5 |
| * 1,2-dichloroethene | 6/6 | 5 - 360 | 5 |
| * methylene chloride | 1/6 | 95 | 3 |
| * tetrachloroethylene | 3/3 | 190 - 640 | 5 |
| * toluene | 2/9 | 1 - 9 | 5 |
| * 1,1,1-trichloroethane | 4/6 | 1 - 18 | 5 |
| * trichloroethylene | 5/6 | 1 - 55 | 5 |
| * vinyl chloride | 4/6 | 14 - 190 | 10 |
| **BNAEs (µg/L)** | | | |
| * bis(2-chloroethyl)ether | 1/5 | 10 | 10 |
| * bis(2-ethylhexyl)phthalate | 2/6 | 17 - 21 | 10 |
| * phenanthrene | 1/6 | 2 | 10 |
| * phenol | 3/9 | 2 - 34 | 10 |
| **MOBILE IONS (mg/L)** | | | |
| * chloride | 30/33 | 5.7 - 112 | NA |
| * nitrate | 22/33 | 0.06 - 13 | NA |
| * phosphate | 26/33 | 0.03 - 118 | NA |
| * sulfate | 21/24 | 68.7 - 1530 | NA |

* Contaminant of Concern

NA Data not available; quantitation limit not reported in BNI 1992.

## Table 2-24. Potential Organic and Mobile Ion Contaminants of Concern in MISS Site Bedrock Groundwater

| Contaminant | Frequency of Detection | Range of Detected Concentrations | Quantitation Limit |
|---|---|---|---|
| **VOLATILE ORGANICS (µg/L)** | | | |
| * benzene | 12/26 | 3 -180 | 5 |
| * carbon disulfide | 6/30 | 2 - 13 | 5 |
| * chloroform | 3/12 | 2 - 17 | 5 |
| * 1,1 dichloroethene | 2/6 | 5 - 7 | 5 |
| * 1,2 dichloroethene | 19/25 | 2 - 750 | 5 |
| * ethylbenzene | 1/6 | 15 | 5 |
| * methylene chloride | 1/6 | 32 | 3 |
| * 4-methyl-2-pentanone | 1/6 | 75 | 10 |
| * 1,1,2,2, tetrachloroethane | 2/9 | 16 - 40 | 5 |
| * tetrachloroethylene | 15/17 | 4 - 570 | 5 |
| * toluene | 11/25 | 5 - 340 | 5 |
| * 1,1,1 trichloroethane | 3/9 | 1 - 60 | 5 |
| * trichloroethylene | 10/18 | 1-150 | 5 |
| * vinyl chloride | 1/6 | 180 | 10 |
| * xylenes (total) | 1/6 | 1800 | 5 |
| **BNAEs (µg/L)** | | | |
| * bis(2-chloroethyl)ether | 2/6 | 40 - 65 | 10 |
| * bis(2-ethylhexyl)phthalate | 1/6 | 330 | 10 |
| * 2-methylnaphthalene | 1/6 | 18 | 10 |
| * naphthalene | 2/7 | 43 - 150 | 10 |
| * n-nitrosodiphenylamine | 1/6 | 4 | 10 |
| **PESTICIDES/PCBs (µg/L)** | | | |
| * dieldrin | 1/3 | 0.19 | NA |
| **MOBILE IONS (mg/L)** | | | |
| * chloride | 57/61 | 7.6 - 778 | NA |
| * nitrate | 42/64 | 0.1 - 5.6 | NA |
| * phosphate | 49/63 | 0.02 - 2.5 | NA |
| * sulfate | 41/48 | 15.3 - 3430 | NA |

* Contaminant of Concern

wells (B38W14S, B38W14D, B38W15S and B38W15D). Seven different BNAEs were detected in groundwater. Bis(2-chloroethyl)ether and bis(2-ethylhexyl)phthalate were detected in both the shallow and bedrock units. Naphthalene, 2-methylnaphthalene, and n-nitrosodiphenylamine were detected only in bedrock samples; and phenanthrene and phenol were detected only in shallow alluvial groundwater. BNAEs were detected in four MISS wells (MISS-2B, -6A, -6B and B38W01S) and three Stepan wells (MISS-3A, -4B and B38W3B). Most BNAEs were detected in 1989, and none are prevalent. One pesticide, dieldrin, was detected once in bedrock groundwater.

Four metals and rare earth elements, antimony, erbium, lanthanum, and terbium were eliminated as COCs from alluvium groundwater because they were detected only once or twice in forty samples (Table 2-25). Thirteen metals and rare earths elements were eliminated as bedrock groundwater COCs because they had concentrations within background levels. Eleven were eliminated due to low frequency of detection. Uranium was not retained as a COC in groundwater because radiological measurements of total uranium were within background concentrations. (The average sampled concentration of total uranium was the same as the average background concentration of 3 pCi/L (see Sections 2.2.3.2 and 2.2.5). No VOCs or BNAEs were eliminated from the risk assessment. The pesticide dieldrin was also retained as a COC.

### 2.3.5 Surface Water and Sediment

Surface water and sediment samples were collected quarterly from three locations in Westerly Brook and one location in Lodi Brook (see Figure 2-6). Sampling Location 3 served to establish background conditions.

#### 2.3.5.1 Westerly Brook

Fifteen metals and three VOCs were detected in Westerly Brook surface water (Table 2-26). The source of the VOCs is unknown. Except for lithium, which was not detected upgradient, the metals are natural components of surface waters with downstream concentrations comparable to upstream levels. The source for lead is uncertain because it was detected at the upgradient location as well. The concentrations of mobile ions were generally low with similar upstream/downstream levels.

## Table 2-25. Potential Contaminants of Concern in Groundwater Eliminated from the Risk Assessment

| Contaminant | Screening Rationale[a] |
|---|---|
| **ALLUVIUM GROUNDWATER** | |
| Metals and Rare Earths | |
| antimony | 3 |
| erbium | 3 |
| lanthanum | 3 |
| terbium | 3 |
| **BEDROCK GROUNDWATER** | |
| Metals and Rare Earths | |
| aluminum | 1 |
| antimony | 3 |
| barium | 1 |
| beryllium | 1 |
| cadmium | 3 |
| calcium | 1 |
| cerium | 1 |
| chromium | 1 |
| cobalt | 1 |
| copper | 1 |
| dysprosium | 3 |
| erbium | 1 |
| europium | 3 |
| lanthanum | 3 |
| lead | 1 |
| molybdenum | 3 |
| neodymium | 3 |
| nickel | 1 |
| selenium | 1 |
| silver | 3 |
| tellurium | 3 |
| terbium | 3 |
| thallium | 3 |
| vanadium | 1 |

[a] **Screening Rationale Key**

1 Mean of detected concentrations was less than or equal to twice the mean background concentration.

2 Chemical detected less than three times and detected concentrations were less than quantitation limit (QL).

3 Chemical detected at a frequency of 5% or less at a sample size of twenty or greater.

## Table 2-26. Potential Contaminants of Concern in Westerly Brook Surface Water

| Contaminant | Frequency of Detection | Range of Detected Concentrations[1] | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|
| **METALS AND RARE EARTHS (µg/L)** | | | | |
| * arsenic | 5/8 | 3.5 - 31.9 | 11 | 2.5 |
| barium | 5/8 | 69 - 109 | 87 | 121 |
| boron | 8/8 | 145 - 715 | 245 | 126 |
| calcium | 8/8 | 55900 - 118000 | 81608 | 59375 |
| copper | 7/8 | 6.9 - 14.4 | 8.6 | 9.4 |
| iron | 8/8 | 272 - 1290 | 734 | 848 |
| lead | 5/8 | 2.5 - 12.3 | 5.5 | 113 |
| * lithium | 7/8 | 115 - 620 | 341 | 100 |
| magnesium | 8/8 | 7820 - 13500 | 11225 | 6852 |
| manganese | 8/8 | 144 - 629 | 454 | 326 |
| * potassium | 8/8 | 4470 - 26000 | 14006 | 3175 |
| silver | 2/8 | 4.4 - 4.5 | 3.1 | 6.6 |
| sodium | 8/8 | 5200 - 77200 | 63638 | 77950 |
| vanadium | 6/8 | 4.1 - 12.5 | 5.3 | 7.4 |
| zinc | 7/8 | 18.8 - 132 | 58 | 110 |
| **VOLATILE ORGANICS (µg/L)** | | | | |
| * 1,2-dichloroethene | 1/1 | 38 | 5 | NA |
| * 1,1,2,2-tetrachloroethane | 1/1 | 42 | 5 | NA |
| * trichloroethylene | 1/1 | 13 | 5 | NA |
| **MOBILE IONS (mg/L)** | | | | |
| chloride | 6/6 | 56 - 162 | 88 | 153 |
| nitrate | 10/10 | 0.5 - 3.2 | 1.6 | 2.1 |
| phosphate | 7/8 | 0.083 - 0.67 | 0.25 | 0.16 |
| * sulfate | 6/6 | 35.6 - 154 | 99 | 31 |

* Contaminant of Concern
NA Data not available
1 Detected concentrations are for total metals; dissolved metal data not used.

Twenty-four metals and rare earth elements were detected in Westerly Brook sediment (Table 2-27). The metals are indicative of natural conditions and neither MISS nor Stepan appears to be a contributor. The rare earth elements, lanthanum and lutetium, were detected only once and were not present in surface water.

Nine metals and the mobile ions chloride, nitrate, and phosphate were eliminated as Westerly Brook surface water COCs because their concentrations were within background concentrations (Table 2-28). Uranium was eliminated as a COC because radiological measurements of total uranium were within background concentrations (see Sections 2.2.3.3 and 2.2.6). All metals and rare earth elements detected in Westerly Brook sediment were eliminated as COCs because their concentrations were within background. The mobile ions, chloride, nitrate, and sulfate, also were eliminated based on background concentrations.

#### 2.3.5.2 Lodi Brook

Only one location was sampled in Lodi Brook. Thirteen metals and four mobile ions were detected in surface water (Table 2-29). Nineteen metals and the four mobile ions were detected in sediment (Table 2-30). Twelve metals in surface water and sixteen metals in sediment were eliminated from quantitative risk assessment because they were detected at concentrations below background (see Table 2-28). Uranium was eliminated as a COC in surface water because radiological measurements of total uranium were within background concentrations. The mobile ions chloride and nitrate were eliminated as surface water COCs because their concentrations also were within background levels. All four mobile ions detected in Lodi Brook sediments were eliminated as COCs based on background concentrations.

### 2.3.6 Contaminants of Concern

Potential COCs detected at the Maywood site were screened according to EPA guidance for data evaluation. The COCs selected for quantitative risk assessment are those retained after the screening process. COCs retained for evaluation in the quantitative risk assessment are presented by medium in Tables 2-31, 2-32, and 2-33. Uranium was retained as a COC for the purpose of assessing potential risk from non radiological effects. Toxicity information for these COCs was then reviewed to ascertain the availability of toxicity data. Appropriate toxicity values were not available for several contaminants, thereby precluding their inclusion in the quantitative risk assessment. These COCs are denoted by a pound sign (#) in Tables 2-31, 2-32, and 2-33.

## Table 2-27. Potential Contaminants of Concern in Westerly Brook Sediment

| Contaminant | Frequency of Detection | Range of Detected Concentrations[1] | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | |
| aluminum | 8/8 | 1740 - 3620 | 2635 | 2700 |
| arsenic | 8/8 | 2.4 - 9.1 | 5.0 | 5 |
| barium | 7/8 | 26.6 - 102 | 52 | 84 |
| beryllium | 5/8 | 0.23 - 0.42 | 0.26 | .38 |
| cadmium | 2/8 | 1.7 | 0.74 | 1.6 |
| calcium | 8/8 | 1230 - 12100 | 5591 | 3927 |
| chromium | 8/8 | 5.3 - 66.2 | 23 | 15 |
| cobalt | 8/8 | 2.3 - 5.9 | 4.4 | 4.2 |
| copper | 8/8 | 7 - 88.3 | 40.6 | 74 |
| iron | 8/8 | 4690 - 21300 | 9529 | 8460 |
| lanthanum | 1/8 | 997 | 186 | 200 |
| lead | 8/8 | 26.1 - 600 | 161 | 237 |
| lithium | 2/8 | 21.7 - 30.4 | 16 | 35 |
| lutetium | 1/8 | 959 | 183 | 200 |
| magnesium | 7/8 | 685 - 3570 | 2289 | 1863 |
| manganese | 8/8 | 94.8 - 337 | 189 | 101 |
| nickel | 8/8 | 5.4 - 25 | 14 | 21 |
| potassium | 3/8 | 269 - 388 | 187 | 250 |
| selenium | 1/8 | 0.47 | 0.33 | .31 |
| silver | 3/8 | 1.5 - 3 | 1.6 | 2.2 |
| sodium | 8/8 | 78.1 - 417 | 185 | 372 |
| thallium | 1/8 | 7.1 | 1.3 | .82 |
| vanadium | 8/8 | 3.6 - 9.4 | 6.3 | 8.1 |
| zinc | 8/8 | 49.8 - 377 | 207 | 312 |
| **MOBILE IONS (mg/kg)** | | | | |
| chloride | 6/8 | 29 - 120 | 72 | 82 |
| nitrate | 6/8 | 0.8 - 14.7 | 4.0 | 4.5 |
| * phosphate | 6/8 | 0.2 - 575 | 96 | 0.2 |
| sulfate | 4/6 | 25.4 - 63.5 | 45 | 149 |

* Contaminant of Concern

1 Detected concentrations are for total metals; dissolved metal data not used.

## Table 2-28. Potential Contaminants of Concern in Surface Water and Sediment Eliminated from the Risk Assessment

| Contaminant | Screening [a] Rationale |
|---|---|
| **WESTERLY BROOK SURFACE WATER** | |
| Metals and Rare Earths | |
| barium | |
| boron | |
| calcium | 1 |
| copper | 1 |
| iron | 1 |
| lead | 1 |
| magnesium | 1 |
| manganese | 1 |
| silver | 1 |
| sodium | 1 |
| vanadium | 1 |
| zinc | 1 |
| Mobile Ions | |
| chloride | 1 |
| nitrate | 1 |
| phosphate | 1 |
| **WESTERLY BROOK SEDIMENT** | |
| Metals and Rare Earths | |
| aluminum | 1 |
| arsenic | 1 |
| barium | 1 |
| beryllium | 1 |
| cadmium | 1 |
| calcium | 1 |
| chromium | 1 |
| cobalt | 1 |
| copper | 1 |
| iron | 1 |
| lanthanum | 1 |
| lead | 1 |
| lithium | 1 |
| lutetium | 1 |
| magnesium | 1 |
| manganese | 1 |
| nickel | 1 |
| potassium | 1 |
| selenium | 1 |
| silver | 1 |
| sodium | 1 |
| thallium | 1 |
| vanadium | 1 |
| zinc | 1 |

## Table 2-28. (continued)

| Contaminant | Screening [a] Rationale |
|---|---|
| Mobile Ions | |
| chloride | 1 |
| nitrate | 1 |
| sulfate | 1 |
| **LODI BROOK SURFACE WATER** | |
| Metals and Rare Earths | |
| barium | 1 |
| boron | 1 |
| calcium | 1 |
| copper | 1 |
| iron | 1 |
| lead | 1 |
| lithium | 1 |
| magnesium | 1 |
| manganese | 1 |
| sodium | 1 |
| vanadium | 1 |
| zinc | 1 |
| Mobile Ions | |
| chloride | 1 |
| nitrate | 1 |
| **LODI BROOK SEDIMENTS** | |
| Metals and Rare Earths | |
| aluminum | 1 |
| antimony | 1 |
| arsenic | 1 |
| barium | 1 |
| beryllium | 1 |
| cadmium | 1 |
| calcium | 1 |
| cobalt | 1 |
| copper | 1 |
| iron | 1 |
| magnesium | 1 |
| nickel | 1 |
| potassium | 1 |
| sodium | 1 |
| vanadium | 1 |
| zinc | 1 |
| Mobile Ions | |
| chloride | 1 |
| nitrate | 1 |

## Table 2-28. (continued)

| Contaminant | Screening [a] Rationale |
|---|---|
| phosphate | 1 |
| sulfate | 1 |

[a] **Screening Rationale Key**

1 Mean of detected concentrations was less than or equal to twice the mean background concentration.
2 Chemical detected less than three times and detected concentrations were less than quantitation limit (QL).
3 Chemical detected at a frequency of 5% or less at a sample size of twenty or greater.

## Table 2-29. Potential Contaminants of Concern in Lodi Brook Surface Water

| | Contaminant | Frequency of Detection | Range of Detected Concentrations[1] | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|---|
| **METALS AND RARE EARTHS (µg/L)** | | | | | |
| | barium | 2/3 | 79.7 - 95.6 | 84 | 121 |
| | boron | 3/3 | 113 - 168 | 121 | 126 |
| | calcium | 3/3 | 51500 - 74300 | 66231 | 59375 |
| | copper | 3/3 | 9.3 - 15.1 | 11 | 9.4 |
| | iron | 3/3 | 262 - 510 | 453 | 848 |
| | lead | 3/3 | 5.3 - 7.0 | 6.3 | 113 |
| | lithium | 1/3 | 218 | 180 | 100 |
| | magnesium | 3/3 | 11000 - 15600 | 11774 | 6852 |
| | manganese | 3/3 | 94.7 - 320 | 320 | 326 |
| * | potassium | 2/3 | 5840 - 9380 | 7448 | 3175 |
| | sodium | 3/3 | 45200 - 51300 | 48347 | 77950 |
| | vanadium | 2/3 | 9.5 - 13.2 | 7 | 7.4 |
| | zinc | 2/3 | 33.6 - 134 | 134 | 110 |
| **MOBILE IONS (mg/L)** | | | | | |
| | chloride | 2/3 | 5 - 87.3 | 56 | 153 |
| | nitrate | 4/5 | 1.4 - 5.3 | 2.1 | 2.1 |
| * | phosphate | 3/4 | 0.05 - 1.4 | 0.52 | 0.16 |
| * | sulfate | 2/3 | 35.6 - 103 | 69 | 31 |

* Contaminant of Concern

1 Detected concentrations for total metals; dissolved metal data not used.

## Table 2-30. Potential Contaminants of Concern in Lodi Brook Sediments

| Contaminant | Frequency of Detection | Range of Detected Concentrations[1] | Estimated Mean Exposure Concentration | Mean Background Concentration |
|---|---|---|---|---|
| **METALS AND RARE EARTHS (mg/kg)** | | | | |
| aluminum | 3/3 | 75.5 - 2700 | 1689 | 2700 |
| antimony | 1/3 | 7.3 | 5.7 | 8.5 |
| arsenic | 2/3 | 2.1 - 4.1 | 4.1 | 5 |
| barium | 2/3 | 68.4 - 77 | 49 | 84 |
| beryllium | 1/3 | 0.29 | 0.18 | .38 |
| cadmium | 2/3 | 1.1 - 1.9 | 1.3 | 1.6 |
| calcium | 2/3 | 9390 - 11000 | 6800 | 3927 |
| * chromium | 2/3 | 41.6 - 66.9 | 36 | 15 |
| cobalt | 2/3 | 5.7 - 7.0 | 4.4 | 4.2 |
| copper | 2/3 | 98.8 - 125 | 75 | 74 |
| iron | 2/3 | 19500 - 28100 | 15868 | 8460 |
| * lead | 3/3 | 77.8 - 625 | 587 | 237 |
| magnesium | 2/3 | 3420 - 3540 | 2323 | 1863 |
| * manganese | 2/3 | 306 - 316 | 207 | 101 |
| nickel | 2/3 | 21.2 - 22 | 15 | 21 |
| potassium | 1/3 | 397 | 322 | 250 |
| sodium | 2/3 | 196 - 262 | 155 | 372 |
| vanadium | 1/3 | 3.8 | 3.5 | 8.1 |
| zinc | 2/3 | 368-391 | 253 | 312 |
| **MOBILE IONS (mg/kg)** | | | | |
| chloride | 2/3 | 5 - 227 | 116 | 83 |
| nitrate | 2/3 | 2 - 7.3 | 4.6 | 4.5 |
| phosphate | 3/3 | 0.05 - 0.65 | 0.37 | 0.20 |
| sulfate | 1/2 | 125 | 125 | 149 |

* Contaminant of Concern

1 Detected concentrations for total metals; dissolved metal data not used.

## Table 2-31. Soil Contaminants of Concern Retained for Risk Assessment

| CONTAMINANT | MISS | | STEPAN | | COMMERCIAL/GOVERNMENT | | RESIDENTIAL | |
|---|---|---|---|---|---|---|---|---|
| | Surficial | All Horizons | Surficial | All Horizons | Surficial | All Horizons | Surficial | All Horizons |
| **METALS AND RARE EARTHS** | | | | | | | | |
| arsenic | | X | X | X | | | | |
| barium | | | | | X | X | X | X |
| # calcium | X | X | X | X | X | X | X | X |
| # cerium | X | X | | X | | | | X |
| chromium | X | X | | X | | X | | X |
| copper | X | X | | | X | | | |
| # lanthanum | X | | | X | | X | | |
| # lead | X | | X | X | X | | X | X |
| lithium | X | X | | | | | X | |
| # lutetium | | | | | | | | |
| # neodymium | | | | X | | | | |
| # praseodymium | | X | | | | | | |
| selenium | | | | X | | | | |
| # sodium | X | X | X | X | X | X | | |
| # thallium | | | | X | | | | |
| uranium | X | X | X | X | X | X | X | |
| # zinc | X | | | | | | X | X |
| **VOLATILE ORGANICS** | | | | | | | | |
| 2-butanone | | X | | | | | | |
| carbon disulfide | | X | | | | | | |
| tetrachloroethylene | | | | X | | | | |
| toluene | X | X | | X | | | | |
| trichloroethylene | | | | X | | | | |
| xylenes (total) | | X | | | | X | | |
| **BNAEs** | | | | | | | | |
| acenaphthene | | X | | | | | | |
| acenaphthylene | | X | | | | | | |
| anthracene | X | X | X | X | | | | |
| benzo(a)anthracene | X | X | X | X | X | X | | |
| benzo(a)pyrene | X | X | X | X | | | | |
| benzo(b)fluoranthene | X | X | X | X | | | | |

Table 2-31. (continued)

| CONTAMINANT | MISS | | STEPAN | | COMMERCIAL/GOVERNMENT | | RESIDENTIAL | |
|---|---|---|---|---|---|---|---|---|
| | Surficial | All Horizons | Surficial | All Horizons | Surficial | All Horizons | Surficial | All Horizons |
| # benzo(g,h,i)perylene | X | X | X | X | | | | |
| benzo(k)fluoranthene | X | X | | X | | | | |
| benzoic acid | | X | | | | | | |
| bis(2-ethylhexyl)phthalate | X | X | | X | | X | | |
| butylbenzylphthalate | X | X | | | X | X | | |
| chrysene | X | X | | X | X | X | | |
| dibenzo(a,h)anthracene | X | X | | | | | | |
| # dibenzofuran | | X | | | | | | |
| di-n-butylphthalate | X | X | X | X | X | X | | |
| 1,2-diphenylhydrazine | | X | | | | | | |
| fluoranthene | X | X | | X | X | X | | |
| fluorene | | X | X | X | | | | |
| indeno(1,2,3-cd)pyrene | X | X | X | X | | | | |
| naphthalene | | X | | | | | | |
| # nitrobenzene | | X | | | | | | |
| n-nitrosodiphenylamine | | X | | | | | | |
| # pentachlorophenol | | X | | | | | | |
| # phenanthrene | X | X | | X | | X | | |
| phenol | | X | | | | | | |
| pyrene | X | X | | X | X | X | | |
| **PESTICIDES/PCBs** | | | | | | | | |
| # alpha chlordane | X | X | | | | | | |
| # gamma chlordane | X | X | | | | | | |
| **MOBILE IONS** | | | | | | | | |
| # chloride | | X | | X | X | X | X | X |
| # nitrate | | X | X | X | X | X | X | X |
| # phosphate | X | X | X | X | X | X | X | X |

# Appropriate toxicity values not available.

## Table 2-32. Groundwater Contaminants of Concern Retained for Risk Assessment

| | Contaminant | Alluvium | Bedrock |
|---|---|---|---|
| | **METALS AND RARE EARTHS** | | |
| | aluminum | X | |
| | arsenic | X | X |
| | barium | X | |
| | beryllium | X | |
| | boron | X | X |
| # | calcium | X | |
| # | cerium | X | |
| | chromium | X | |
| | copper | X | |
| # | gadolinium | X | |
| # | iron | X | X |
| # | lead | X | |
| | lithium | X | X |
| # | magnesium | X | X |
| | manganese | X | X |
| | nickel | X | |
| # | potassium | X | X |
| | selenium | X | |
| # | sodium | X | X |
| | vanadium | X | |
| # | zinc | X | X |
| | **VOLATILE ORGANICS** | | |
| | benzene | | X |
| | carbon disulfide | X | X |
| | chloroform | | X |
| | 1,1-dicholorethene | X | X |
| | 1,2-dicholorethene | X | X |
| | ethylbenzene | | X |
| | methylene chloride | X | X |
| # | 4-methyl-2-pentanone | | X |
| | 1,1,2,2-tetrachloroethane | | X |
| | tetrachloroethylene | X | X |
| | toluene | X | X |
| | 1,1,1-trichloroethane | X | X |
| | trichloroethylene | X | X |
| | vinyl chloride | X | X |
| | xylenes (total) | | X |
| | **BNAEs** | | |
| | bis(2-chloroethyl)ether | X | X |
| | bis(2-ethylhexyl)phthalate | X | X |
| # | 2-methylnaphthalene | | X |
| | naphthalene | | X |
| | n-nitrosodiphenylamine | | X |
| # | phenanthrene | X | |
| | phenol | X | |

## Table 2-32. (continued)

| CONTAMINANT | Alluvium | Bedrock |
|---|---|---|
| **PESTICIDES/PCBs** | | |
| dieldrin | | X |
| **MOBILE IONS** | | |
| # chloride | X | X |
| # nitrate | X | X |
| # phosphate | X | X |
| # sulfate | X | X |

# Appropriate toxicity values not available.

## Table 2-33. Surface Water and Sediment Contaminants of Concern Retained For Risk Assessment

| CONTAMINANT | Westerly Brook | | Lodi Brook | |
|---|---|---|---|---|
| | Surface Water | Sediment | Surface Water | Sediment |
| **METALS AND RARE EARTHS** | | | | |
| arsenic | X | | | |
| chromium | | | | X |
| # lead | | | | X |
| lithium | X | | | |
| manganese | | | | X |
| # potassium | X | | X | |
| **VOLATILE ORGANICS** | | | | |
| 1,2-dichloroethene | X | | | |
| 1,1,2,2-tetrachloroethane | X | | | |
| trichloroethylene | X | | | |
| **MOBILE IONS** | | | | |
| # phosphate | | X | X | |
| # sulfate | X | | X | |

# Appropriate toxicity values not available.

COCs without toxicity factors are addressed in the Risk Characterization (Section 5.2.2) and the Uncertainty Section (5.3). The final list of COCs retained for risk assessment in all media, excluding those eliminated due to a lack of toxicity data, is summarized in Table 2-34.

## 2.4 SUMMARY OF COCs

### 2.4.1 Radiological Contaminants

The potential radiological COCs for the Maywood site were screened according to EPA guidance (EPA 1989b) to identify a list of COCs for the quantitative risk assessment. Radiological data were aggregated by operable unit, medium, and location of sample within each medium before screening. The screening rationale and criteria are discussed in Section 2.2.1. The final list of COCs for the risk assessment is comprised of those radionuclides that remained after applying the screening criteria.

The radiological COCs for evaluation in the quantitative risk assessment were as follows:

| Medium | Contaminant of Concern | | | | |
|---|---|---|---|---|---|
| | U-235 | U-238 | Th-232 | Ra-226 | Rn-222 |
| Soil (surface, subsurface and sediment) | Yes | Yes | Yes | Yes | No |
| Groundwater | No | No | No | No | No |
| Surface water | No | No | No | No | No |
| Indoor Air | No | No | No | No | Yes |
| Outdoor Air | No | No | No | No | No |

As discussed in Section 2.2, the associated decay products of the three primary radioactive contaminants (U-238, Th-232, Ra-226) are included as COCs, as are U-235 and associated decay products.

### 2.4.2 Chemical COCs

The potential chemical COCs for the Maywood Site were screened according to EPA guidance (EPA 1989b) to identify a list of COCs for the quantitative risk assessment. Chemical data were

## Table 2-34. Summary of Contaminants of Concern for Quantitative Risk Assessment

| Risk | | Contaminants of Concern | SOIL | | | | | | | | GROUNDWATER | | SURFACE WATER | | SEDIMENT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MISS | | STEPAN | | COMM/ GOVT | | RES | | ALLUVIUM | BEDROCK | WESTERLY BROOK | LODI BROOK | WESTERLY BROOK | LODI BROOK |
| | | **Metals and Rare Earths** | S | AH | S | AH | S | AH | S | AH | | | | | | |
| | NC | aluminum | | | | | | | | | • | | | | | |
| C | NC | arsenic | | • | • | • | | | | | • | | • | | | |
| | NC | barium | | | | | • | • | • | • | • | | | | | |
| C | NC | beryllium | | | | | | | | | • | | | | | |
| | NC | boron | | | | | | | | | • | • | | | | |
| C | NC | chromium | • | • | | • | | • | | • | • | | | | | • |
| | NC | copper | • | • | | | • | • | | | • | | | | | |
| | NC | lithium | • | • | | | | | | | • | • | • | | | |
| | NC | manganese | | | | | | | | | • | • | | | | • |
| C | NC | nickel | | | | | | | | | • | | | | | |
| | NC | selenium | | | | • | | | | | • | | | | | |
| | NC | vanadium | | | | | | | | | • | | | | | |
| C | NC | uranium | • | • | • | • | • | • | • | | | | | | | |
| | | **Volatile Organics** | | | | | | | | | | | | | | |
| C | | benzene | | | | | | | | | | • | | | | |
| | NC | 2-butanone | | • | | | | | | | | | | | | |
| | NC | carbon disulifide | | • | | | | | | | • | • | | | | |
| C | NC | chloroform | | | | | | | | | | • | | | | |
| C | NC | 1,1-dichloroethene | | | | | | | | | • | • | | | | |
| | NC | 1,2-dichloroethene | | | | | | | | | • | • | • | | | |
| | NC | ethylbenzene | | | | | | | | | | • | | | | |
| C | NC | methylene chloride | | | | | | | | | • | • | | | | |
| C | | 1,1,2,2-tetrachloroethane | | | | | | | | | | • | • | | | |
| C | NC | tetrachloroethylene | | | | • | | | | | • | • | | | | |
| | NC | toluene | • | • | | • | | | | | • | • | | | | |
| | NC | 1,1,1-trichloroethane | | | | | | | | | | | | | | |
| C | NC | trichloroethylene | | | | • | | | | | • | • | • | | | |
| C | | vinyl chloride | | | | | | | | | • | • | | | | |
| | NC | xylenes (total) | | • | | | | • | | | | • | | | | |
| | | **BNAEs** | | | | | | | | | | | | | | |
| C | | 1,2-diphenylhydrazine | | • | | | | | | | | | | | | |
| C | NC | acenaphthene | | • | | | | | | | | | | | | |
| C | | acenaphthylene | | • | | | | | | | | | | | | |
| C | NC | anthracene | • | • | • | • | | | | | | | | | | |
| C | | benzo(a)anthracene | • | • | • | • | • | • | | | | | | | | |
| C | | benzo(a)pyrene | • | • | • | • | | | | | | | | | | |
| C | | benzo(b)fluoranthene | • | • | • | • | | | | | | | | | | |
| C | | benzo(g,h,i)perylene | • | • | • | • | | | | | | | | | | |
| | NC | benzoic acid | | • | | | | | | | | | | | | |
| C | | benzo(k)fluoranthene | • | • | | • | | | | | | | | | | |
| C | | bis(2-chloroethyl)ether | | | | | | | | | • | • | | | | |
| C | NC | bis(2-ethylhexyl)phthlate | • | • | | • | | • | | | • | • | | | | |
| | NC | butylbenzylphthalate | • | • | | | • | • | | | | | | | | |

## Table 2-34. (continued)

| Risk | | Contaminants of Concern | SOIL | | | | | | | | GROUNDWATER | | SURFACE WATER | | SEDIMENT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MISS | | STEPAN | | COMM/ GOVT | | RES | | ALLUVIUM | BEDROCK | WESTERLY BROOK | LODI BROOK | WESTERLY BROOK | LODI BROOK |
| | | **BNAEs** | S | AH | S | AH | S | AH | S | AH | | | | | | |
| C | | chrysene | • | • | | • | • | • | | | | | | | | |
| C | | dibenzo(a,h)anthracene | • | • | | | | | | | | | | | | |
| | NC | di-n-butylphthalate | • | • | • | • | • | • | | | | | | | | |
| C | NC | fluoranthene | • | • | | • | • | • | | | | | | | | |
| C | NC | fluorene | | • | • | • | | | | | | | | | | |
| C | | indeno(1,2,3-cd)pyrene | • | • | • | • | | | | | | | | | | |
| | NC | naphthalene | | • | | | | | | | | • | | | | |
| C | NC | n-nitrosodiphenylamine | | • | | | | | | | | • | | | | |
| C | NC | pentachlorophenol | | • | | | | | | | | | | | | |
| | NC | phenol | | • | | | | | | | • | | | | | |
| C | NC | pyrene | • | • | | • | • | • | | | | | | | | |
| | | **Pesticides/PCBs** | | | | | | | | | | | | | | |
| C | NC | dieldrin | | | | | | | | | | • | | | | |

| Risk | | Radiologic Contaminants of Concern | SOIL | | | | | | | | GROUNDWATER | | SURFACE WATER | | SEDIMENT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MISS | | STEPAN | | COMM/ GOVT | | RES | | ALLUVIUM | BEDROCK | WESTERLY BROOK | LODI BROOK | WESTERLY BROOK | LODI BROOK |
| | | **BNAEs** | S | AH* | S | AH* | S | AH* | S | AH* | | | | | | |
| C | | U-238 | • | • | • | • | • | • | • | • | | | | | AS | AS |
| C | | Th-232 | • | • | • | • | • | • | • | • | | | | | AS | AS |
| C | | Ra-226 | • | • | • | • | • | • | • | • | | | | | AS | AS |

Notes:
C = Carcinogenic Effects
NC = Noncarcinogenic Effects
S = Surficial Soil Horizon
AH = All Soil Horizons
* = Subsurface soil horizon only
AS = Aggregated with surficial soil

See Table 4-1 for presentation of carcinogenic and noncarcinogenic toxicity data.

aggregated by operable unit, medium, and location of sample within each medium before screening. The screening rationale and criteria are discussed in Section 2.3.1. The final list of COCs for the risk assessment is comprised of those chemicals that remained after application of the screening criteria (see Tables 2-31, 2-32, and 2-33).

The COCs retained for evaluation in the quantitative risk assessment, excluding those for which toxicity factors are not available, are summarized in Table 2-34. The following is a summary of COCs by class of chemical:

| Medium | Contaminant of Concern | | | |
|---|---|---|---|---|
| | Metals | VOCs | BNAEs | Pesticides |
| Soil | 7 | 6 | 23 | 0 |
| Groundwater | 13 | 13 | 5 | 1 |
| Surface water | 2 | 3 | 0 | 0 |
| Sediment | 2 | 0 | 0 | 0 |

BNAEs were the predominant COCs in soils, and VOCs and metals were predominant in groundwater. Few COCs were retained for surface water and sediment.

# 3. EXPOSURE ASSESSMENT

This section addresses the environmental fate and transport of the COCs identified in Section 2. It also includes the potential pathways by which human populations (e.g., residents and workers) could be exposed to radiological and chemical contaminants at or originating from the Maywood site. Exposure estimates are provided for MISS; Stepan property; commercial/ government vicinity properties; and residential vicinity properties, including municipal parks. These are the operable units used in the RI report (BNI 1992), and each contains one or more property units that were defined for risk assessment purposes as described in Section 1.2. Contaminant concentrations were determined by sampling and analysis, radiation survey measurements, and/or modeling. The data are summarized in this section of the BRA and presented as the mean and RME. The RME is defined as the 95th percentile upper confidence limit on the mean ($UL_{95}$) for each property unit. While identifying primary pathways of exposure at each location, current and plausible future land uses of the properties and surrounding areas are considered. This section develops information on exposure pathways, estimates the concentration of the radionuclides and chemical contaminants of potential concern at points of human exposure, and determines receptor intakes (doses). RME estimates are presented for radiation dose and chemical intakes within each scenario. The uncertainties of the exposure assessment are discussed in Section 5.

## 3.1 CHARACTERIZATION OF EXPOSURE SETTING

The exposure setting for the Maywood site is described briefly in terms of both the natural environment and local land use and demography. The setting is described in more detail in the RI/FS-EIS work plan (ANL and BNI 1992) and the RI report for the Maywood site (BNI 1992).

### 3.1.1 Environmental Setting

Parameters that can affect human exposure to contaminated materials at Maywood include topography; climate; ecological resources; geology; surface water and groundwater; and soil type, including vegetation.

#### 3.1.1.1 Topography

The topography in the Maywood area is generally flat to rolling with local hilly areas. Little of the Maywood topography remains undisturbed because of the urban nature of the setting.

MISS covers 4.7 ha (11.7 acres), with an average slope of 1.2 percent (BNI 1992). Most of MISS is covered with grass; the exceptions are the interim waste storage pile (which is covered by a synthetic cover), unpaved roads, and the railroad spurs. Because of the relatively flat topography and grass cover, erosion and sediment transport from the site are minimal.

The Stepan property covers 7.4 ha (18.2 acres) and consists of a series of man-made terraces on which the facility was constructed. The change in elevation from the highest to lowest terrace is approximately 7.5 m (25 ft).

#### 3.1.1.2 Climate

The regional climate is humid, with a mean annual precipitation of about 120 cm (48 in.) and approximately 120 days of precipitation per year. Mean monthly temperatures range from a January low of -1.2°C (29.8°F) to a July high of 23.8°C (74.9°F). The prevailing winds are from the northwest during October-April and from the southwest during the remainder of the year.

#### 3.1.1.3 Ecological Resources

The Maywood site comprises mainly residential and commercial properties, including homes/yards, transportation corridors, parking lots, and industrial buildings. The residential properties contain plant species common to landscaped yards, such as lawn grasses, flowers, garden vegetables, evergreen shrubs, and trees. Transportation rights-of-way and unused corners of commercial/industrial properties often contain native habitat in the form of early to late old-field successional stages, dominated by grasses and forbs with scattered shrubs and trees.

Aquatic habitats on the site include drainage ways, small temporary ponds, the limited above-ground portions of westerly and Lodi Brooks, and the Saddle River. Based on visual observation, water quality in the streams ranged from fair to very poor. Riparian habitat of trees, shrubs, and groundcover occurring along the two small streams and the river provides much of the available wildlife habitat. The Saddle River and its floodplain constitute the most productive habitat in the site vicinity.

Freshwater wetlands cover approximately 4.1 acres of the study area. Palustrine emergent vegetation, dominated by common reed (*Phragimites australis*) and cattails (*Typha latifola*), is associated with the ditches that transverse the area. Other wetland areas are vegetated by broad-leaved deciduous trees or by mowed turf grass mixed with a few sedges and spike grass (*Eleocharis sp*). Because there are no endangered or threatened plant or animal species inhabiting the area, the wetlands within the site boundaries may be classified as freshwater wetlands of intermediate or ordinary resource value (Iliff and Longo 1992).

The wildlife community found on the site is generally characterized by a low number and diversity of species due to the relative lack of suitable habitat. Wildlife inhabiting the site are mostly commonly-occurring species of suburban and urban environments, such as gray squirrels, rabbits, muskrats, opossums, raccoons, groundhogs, passerine birds, wading birds, and common waterfowl. The Maywood site supports no federally- or state-listed threatened or endangered species.

#### 3.1.1.4 Geology

The regional and local geology of the Maywood site is described in detail in the RI report (BNI 1992). For the BRA, the information on near-surface conditions and surface water and groundwater is significant.

Borings made at the Maywood site indicate that bedrock lies close to the surface covered with between 3 to 15 ft of weathered bedrock and unconsolidated deposits. Unconsolidated material overlying the bedrock is comprised largely of stratified drift. This drift exhibits considerable variability both areally and in depth; however, it generally consists of sand, gravel, silt, and clay and is poorly to well sorted. Borings also indicate that considerable amounts of fill material have been placed on this site during its many years of industrial use.

#### 3.1.1.5 Surface Water and Groundwater

Surface water features that could affect the fate and transport of contaminants include erosion patterns and surface water bodies such as ditches, streams, ponds, and lakes. The greater Maywood area lies between the Hackensack and Passaic rivers. The Maywood site lies within the Saddle River drainage basin (a tributary of the Passaic River) and is drained by Westerly and Lodi Brooks. Figure 3-1 shows Westerly Brook and Lodi Brook in relation to the MISS and vicinity

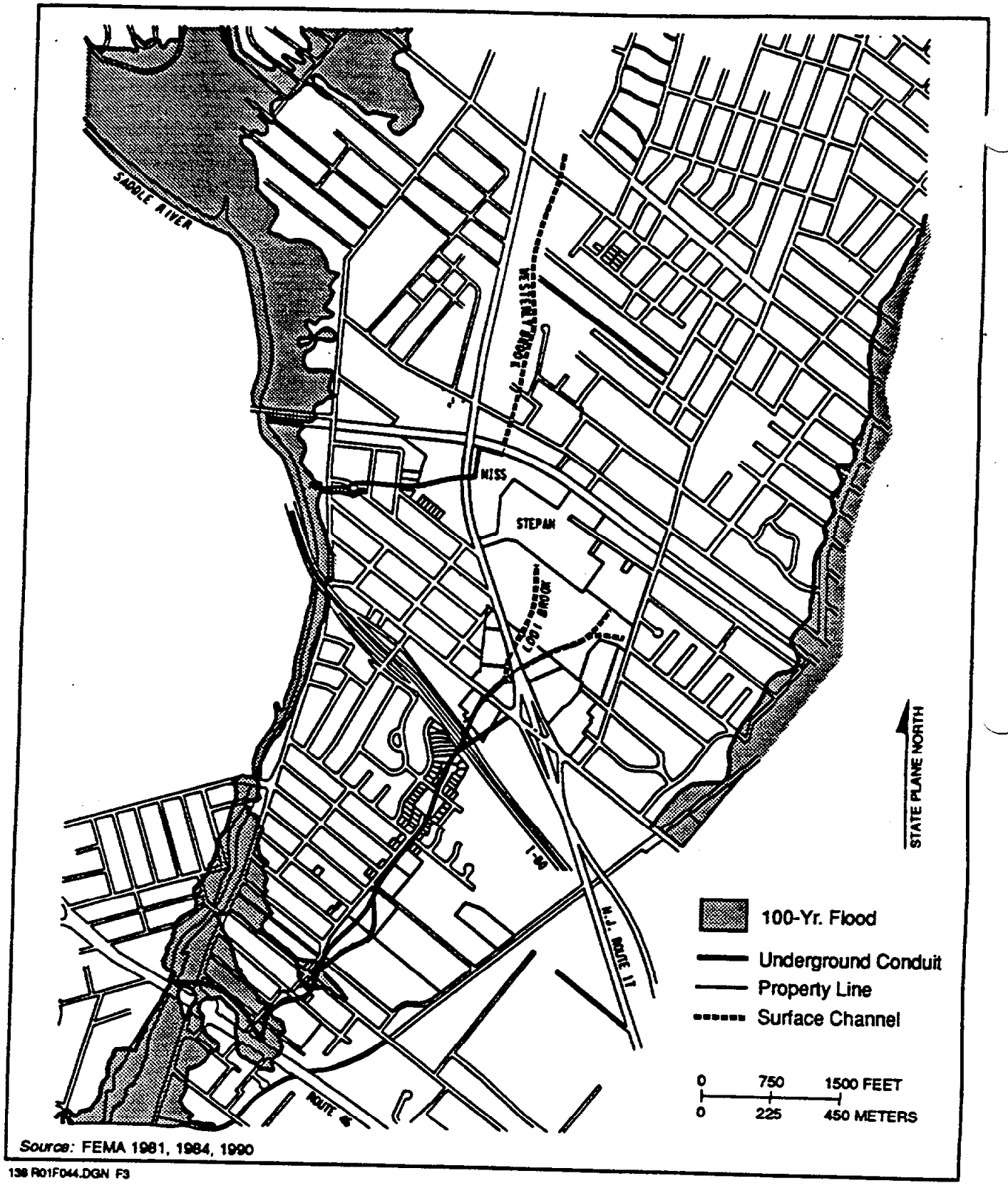



**Figure 3-1. Locations of the Westerly and Lodi Brooks in the Maywood Area**

properties. Most of Lodi Brook and parts of Westerly Brook are now enclosed in culverts in the vicinity of this site. Both Lodi Brook and Westerly Brook flow into the Saddle River. No municipal water supply intakes exist downstream from MISS (BNI 1992).

Westerly Brook drains an area of approximately 1.55 $km^2$ (0.6 $mi^2$) within the townships of Maywood and Rochelle Park. The channel slope is less than one percent, resulting in low flow velocities. The banks are well defined and are approximately 3.7 m (12 ft) deep.

Rainwater runoff from parts of the MISS and Stepan properties collects in a low area between the site, NJ Route 17, and the New York, Susquehanna and Western Railroad Tracks. Outflow via Westerly Brook to the Saddle River occurs during large storms.

Lodi Brook drains an area of approximately 3.24 $km^2$ (1.25 $mi^2$). It begins on the western side of the Sears property in a low, marshy area that collects runoff from the Sears property, the Stepan Company property, and a small portion of MISS. From the general source area, Lodi Brook flows south approximately 2.8 km (1.8 mi) before joining the Saddle River 2.3 km (1.5 mi) downstream of the confluence of Westerly Brook and the Saddle River. Before being enclosed in culverts, the flooding of Lodi Brook probably contributed to the spreading of contamination.

Groundwater in the Maywood area occurs in both the Brunswick Formation and the unconsolidated glacial deposits. The Brunswick Formation is a productive aquifer and a major water source for public and industrial use (Morton 1982; ANL 1984). Groundwater flows through weathered rock and secondary fracture openings in the Brunswick Formation, forming a system of tabular aquifers and aquicludes. Wells yield from 1.3 to 47 L/s (20 to 750 gpm). The water is moderately mineralized and moderately hard to very hard.

The unconsolidated glacial deposits provide a more variable source of groundwater. Small yields, e.g., 0.13 L/s (2 gpm), are available from unstratified till deposits, whereas stratified stream and lake deposits yield as much as 57 L/s (900 gpm). Based on local topography, the groundwater gradient in the area is low. Flow is to the southwest towards the Saddle River, where superficial groundwater flow is likely discharged. A canvass of the area within a 2-mile radius of MISS located records for 60 wells drilled between 1954-82 that range from 20-201 m (65-650 ft) deep. Almost all of the borough of Maywood and township of Rochelle Park are served by a municipal water system supplied by the Oradell, Lake Tappan, and Woodcliff reservoirs (BNI 1992). However, the groundwater resources within the classification review area were considered to be a potential source of drinking water.

Groundwater at the MISS generally flows from northeast to southwest. Figures 3-2 and 3-3 (reproduced from the RI report, BNI 1992) show water level elevations at the MISS and adjoining properties as determined in June 1991 for the unconsolidated and bedrock formations. The monitoring well locations for these aquifers are also shown. Although there is no current drinking water use of groundwater in the Maywood area, direction of groundwater movement may be important in future scenarios.

The Brunswick Formation and unconsolidated deposits are not separated by a continuous low permeability system; therefore, they behave as a single hydrologic system. Depth to ground water is shallow and ranges from approximately 1 to 4.6 m (3 to 15 ft) below ground surface (BGS). Water level elevations range from 12 to 16.5 m (39 to 54 ft) above mean sea level (MSL). Groundwater is continuous from the water table surface to at least the maximum depth of investigation [18 m (60 ft) BGS].

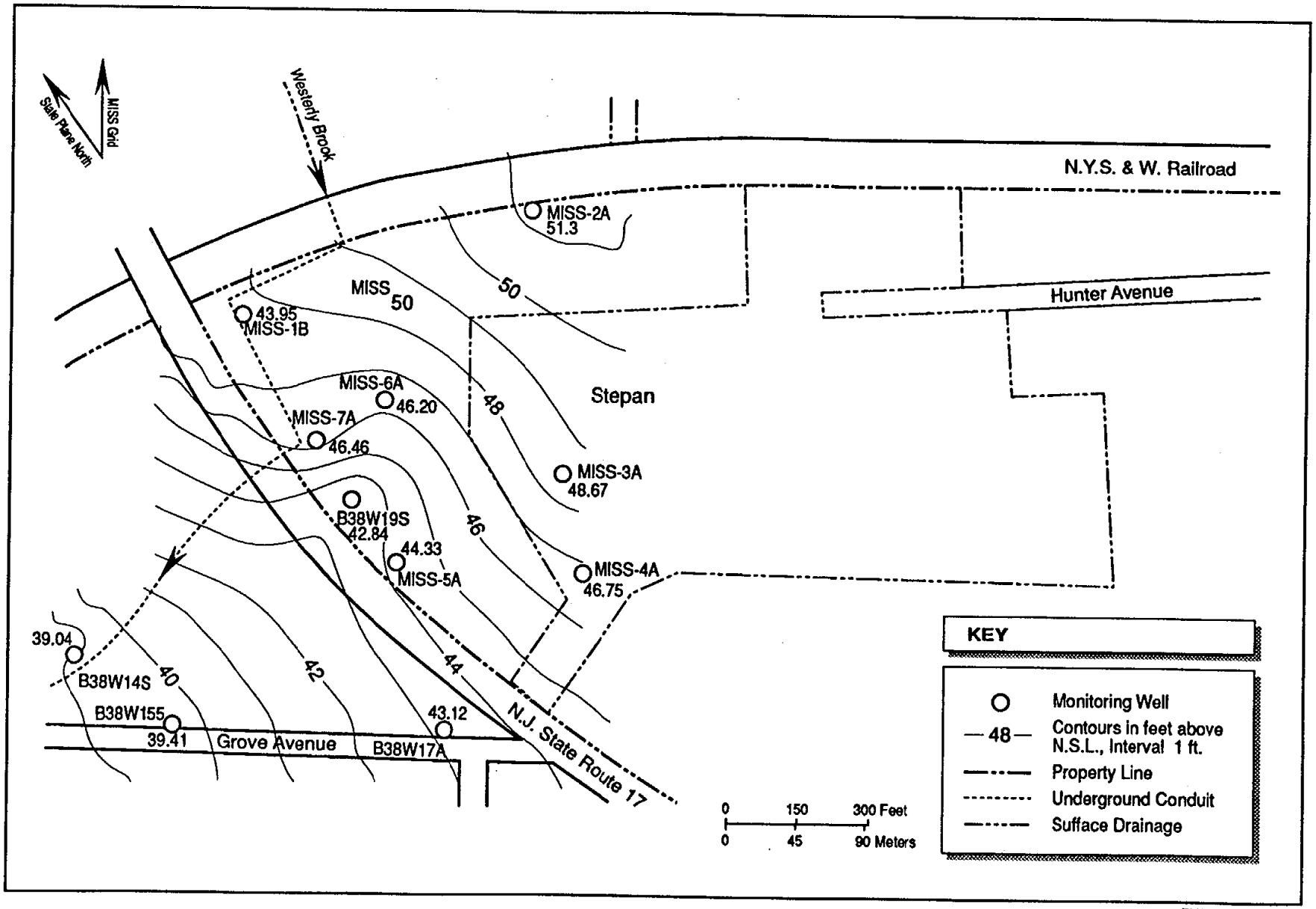
#### 3.1.1.6 Soils

Historically, the unconsolidated glacial deposits in the Maywood area were capped with a well-developed deciduous forest soil. However, extensive agricultural and urban development disturbed or destroyed much of this original soil horizon, and most of the current soil cover in the area may be classified as urban fill. Tests performed during the RI indicate that the soils could be classified as fine to coarse sand with a trace of gravel and silt or silt and fine sand with a trace of fine gravel.

### 3.1.2 Land Use And Demography

#### 3.1.2.1 Current and Future Land Use

Current land use around the Maywood area is summarized in Figure 3-4. The Maywood site is part of a large concentration of mixed commercial/industrial development adjacent to (east of) Highway 17. Other areas of commercial development and mixed commercial/residential are located along Highway 17 in the vicinity of the Maywood site. The area adjacent to and within the Maywood site is occupied by residences, limited commercial use, and light industry. Currently, 52 residences are located within the Maywood site. MISS is zoned for commercial and industrial use. Municipal parks are also located within the Maywood site.




FUS/Mayw'd-032293

**Figure 3-2. Water Level Elevations and Monitoring Wells in the Unconsolidated Formation at MISS, June 26, 1991**

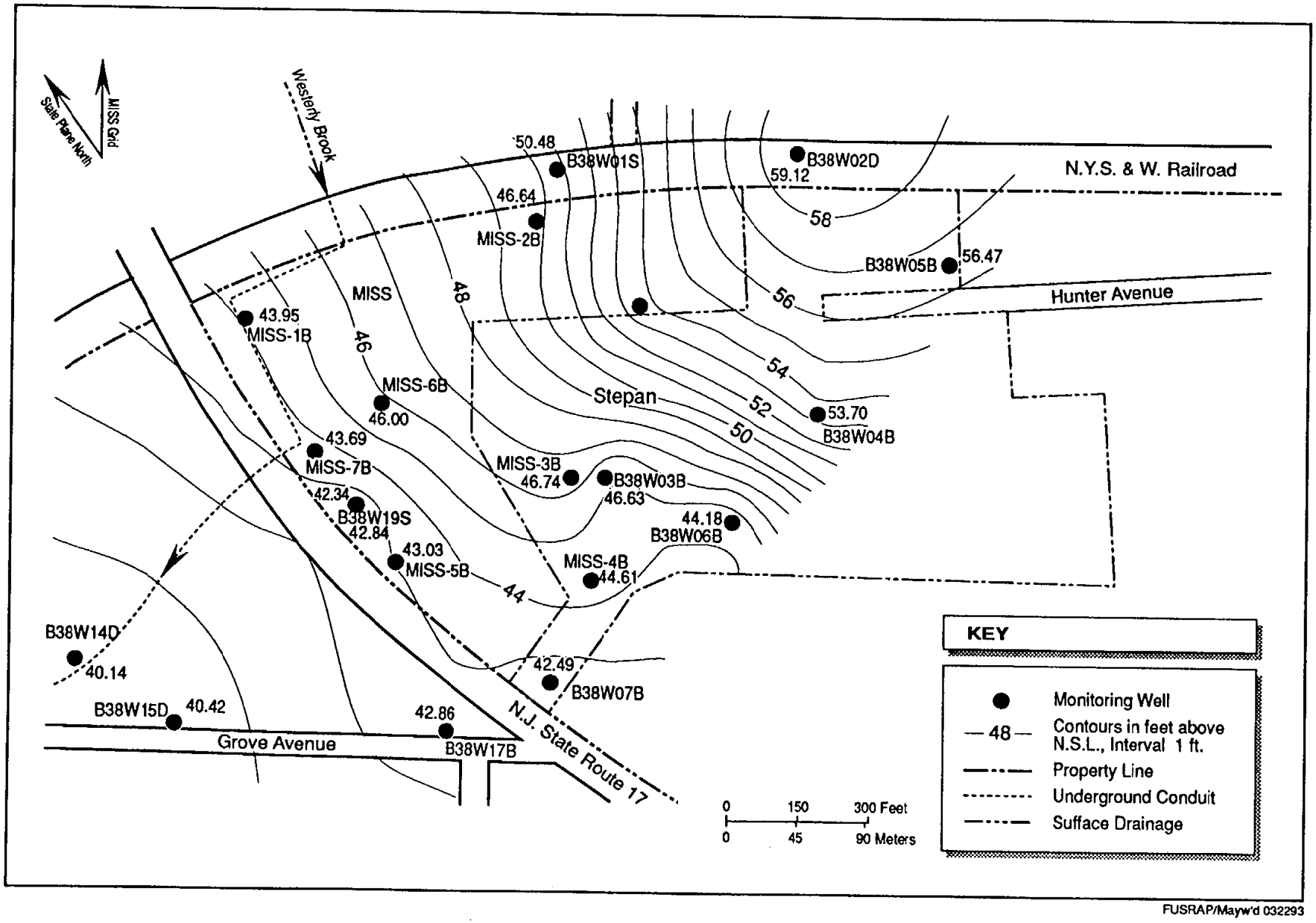



**Figure 3-3. Water Level Elevations and Monitoring Wells at MISS, June 26, 1991**

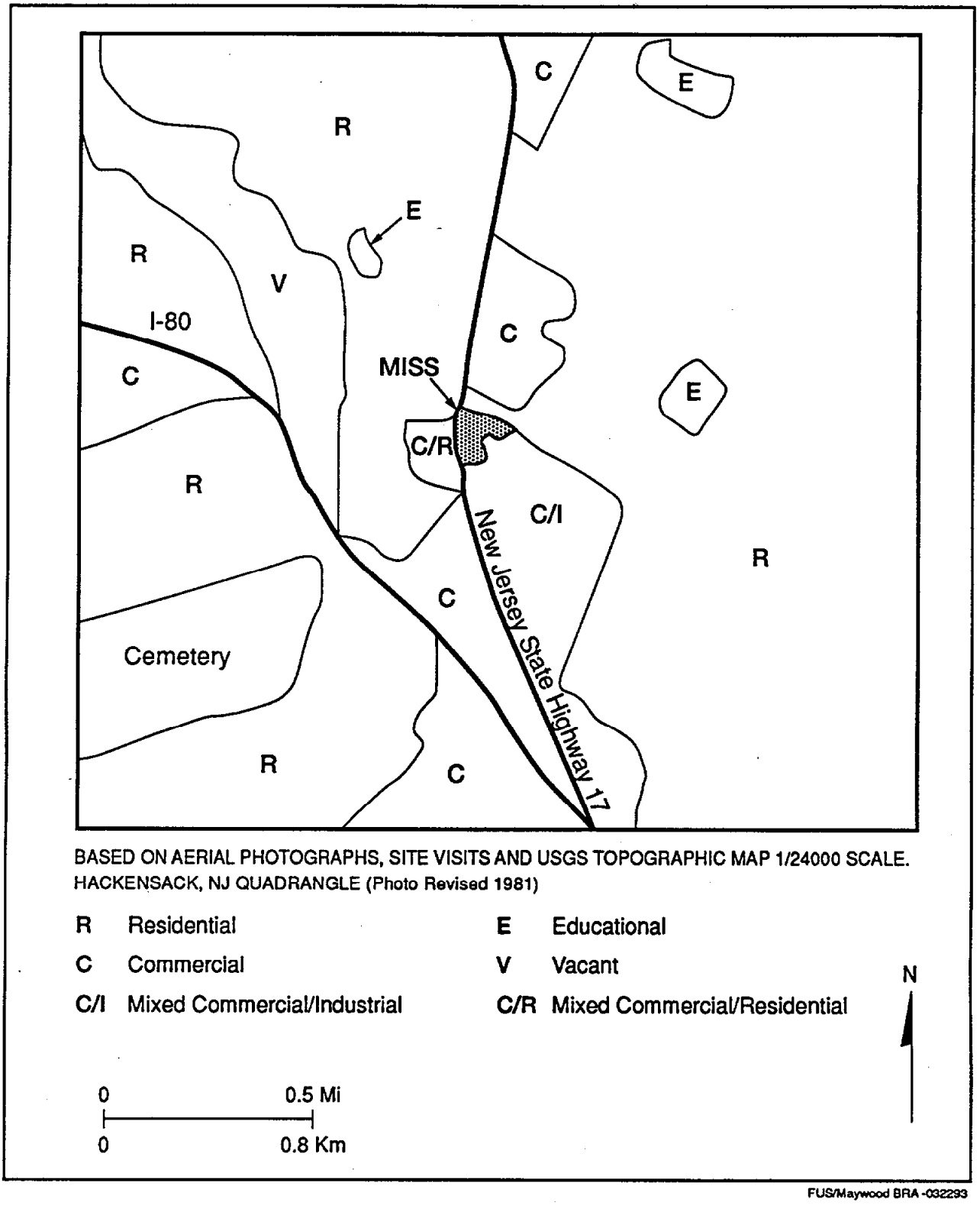



**Figure 3-4. Generalized Land Use in the Vicinity of MISS**

It is assumed that future activities will be limited to residences, municipal properties, highways, and commercial properties. Municipal properties, highways, and major commercial/industrial properties are assumed to maintain their function and condition for future use scenarios. The residential and light commercial properties are assumed to be interchangeable over the time period considered for this BRA.

3.1.2.2 Relative Locations of Populations with Respect to the Site

The Maywood site is located in a highly urbanized region northwest of the New York/Newark metropolitan area. The 1990 populations (Table 3-1) of the boroughs of Maywood and Lodi were 9,473 and 22,355, respectively; the 1990 population for the township of Rochelle Park was 5,587. The 1990 population of Bergen County as a whole was 825,380, reflecting a 0.3 percent decrease (Table 3-2) from 1980. These numbers indicate that the population in the county has been relatively stable over the last 10 years.

3.1.2.3 Subpopulations of Potential Concern

In addition to the risk assessed for the Maywood vicinity, risk to the population in an 80 km (50 mi) radius around Maywood was evaluated. For the population risk estimate, it was necessary to develop an estimate of distribution and diversity of population in this area. The population distribution in the 80 km around Maywood was estimated from 1990 Bureau of Census data (Tables 3-1 and 3-2). Figure 3-5 and Table 3-3 show the approximate population distribution within an 80 km (50 mi) radius from Maywood. This was determined by using the population data for New Jersey and New York and the population data for the metropolitan and zip code areas for the cities of population greater than about 10,000 people (Hoffman 1989). These urban area populations were subtracted from the total state population and then the nonurban population density was calculated (New Jersey was <750 people/mi$^2$ and New York was <115 people/mi$^2$). The nonurban population was uniformly distributed throughout the grid and then the local urban population was added back in for each grid sector. For areas within the state of Connecticut, the New Jersey nonurban population density was used since they are adjacent to the New York/Newark metropolitan area, and this would be a conservative assumption. The population data for nonurban areas of Connecticut would be much lower in general.

## Table 3-1. 1986 and 1990 Population and 1990 Population Density in the Areas Surrounding the Maywood Site

| Region | 1986 Population | 1990 Population | 1990 Land Area $km^2$ | 1990 Land Area $mi^2$ | 1990 Persons Per $km^2$ | 1990 Persons Per $mi^2$ |
|---|---|---|---|---|---|---|
| Maywood Borough | 9,780 | 9,473 | 3.3 | 1.3 | 2,870.6 | 7,286.9 |
| Lodi Borough | 22,910 | 22,355 | 5.9 | 2.3 | 3,789.0 | 9,719.6 |
| Rochelle Park Township | 5,320 | 5,587 | 2.7 | 1.0 | 2,069.3 | 5,587.0 |
| Bergen County | 837,100 | 825,380 | 606.6 | 234.2 | 1,360.7 | 3,524.3 |
| New Jersey State | 7,625,300 | 7,730,188 | 19,214.8 | 7,418.8 | 402.3 | 1,042.0 |

Sources: Bureau of the Census, U.S. Department of Commerce, 1990 CENSUS OF POPULATION AND HOUSING, SUMMARY POPULATION AND HOUSING CHARACTERIZATION, NEW JERSEY, August 1991, p. 135; Regional Economic Information System, Bureau of Economic Analysis, PERSONAL INCOME BY MAJOR SOURCE AND EARNINGS BY INDUSTRY, Table CA5, April 1991; Bureau of the Census, U.S. Department of Commerce, COUNTY AND CITY DATA BOOK, 1988, pp. 764-766.

**Table 3-2. Trends in Population Growth, 1980-1989**
**Bergen County and the State of New Jersey**

| Year | Bergen County Population (Thousands) | County Change (%) | New Jersey State Population (Thousands) | State Change (%) |
|---|---|---|---|---|
| 1980 | 845.8 | | 7,376.3 | |
| 1981 | 845.6 | -0.0 | 7,405.9 | 0.4 |
| 1982 | 842.8 | -0.3 | 7,427.6 | 0.3 |
| 1983 | 843.9 | 0.1 | 7,463.9 | 0.5 |
| 1984 | 843.7 | -0.0 | 7,511.3 | 0.6 |
| 1985 | 839.9 | -0.5 | 7,561.0 | 0.7 |
| 1986 | 837.1 | -0.3 | 7,625.3 | 0.9 |
| 1987 | 831.8 | -0.6 | 7,674.4 | 0.6 |
| 1988 | 829.5 | -0.3 | 7,721.1 | 0.6 |
| 1989 | 822.0 | -0.9 | 7,739.3 | 0.2 |
| AVG ANNL GROWTH, 1980-89 | | -0.3 | | 0.5 |

Source: Regional Economic Information Systems, Bureau of Economic Analysis, PERSONAL INCOME BY MAJOR SOURCE AND EARNINGS BY INDUSTRY, Table CA5, April 1991.

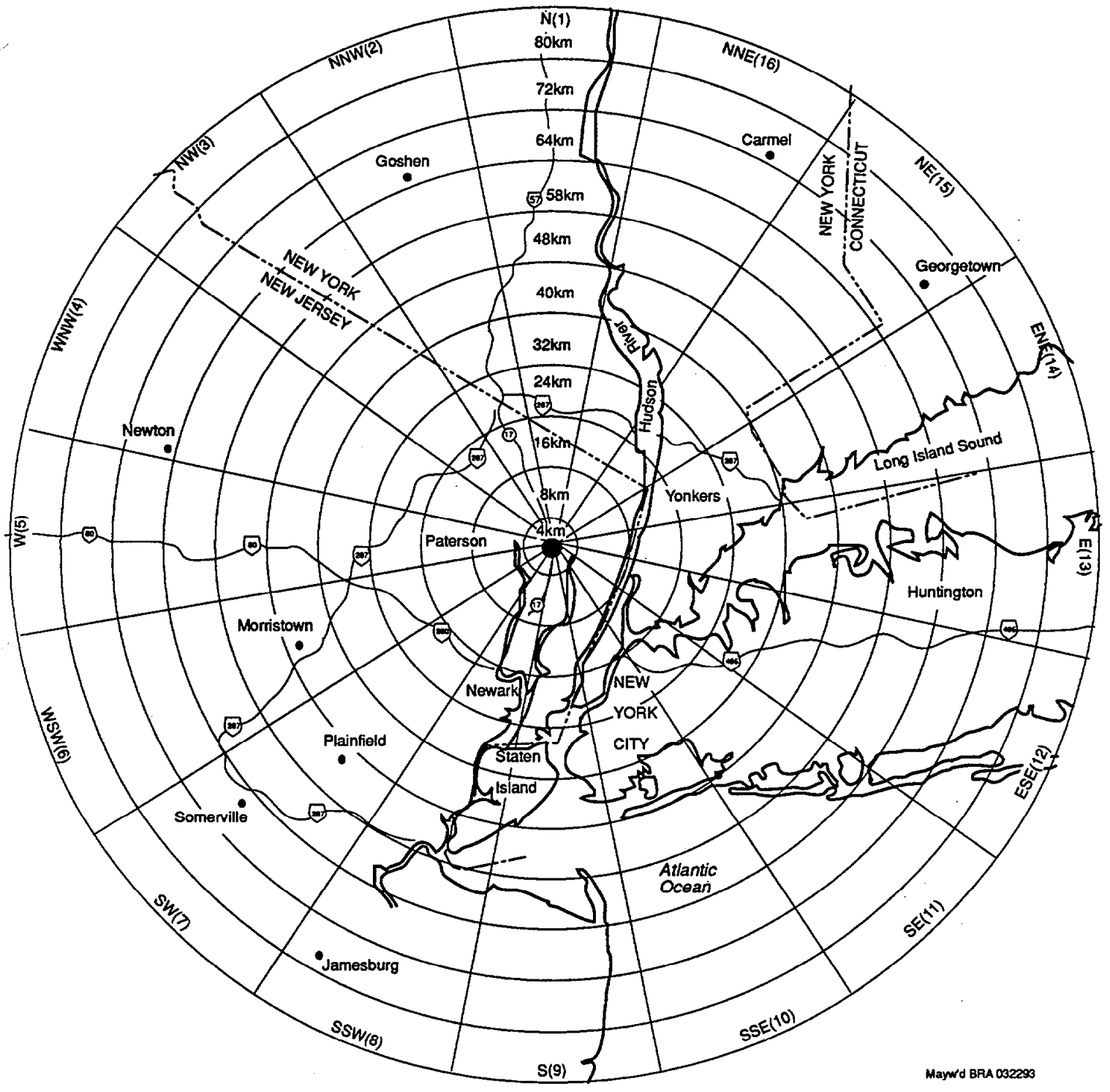



**Figure 3-5. Grid for Approximate Population Distribution Within 80-km Radius of Maywood Site**

## Table 3-3. Population Distribution for the Segments in the 80-km Radial Area Around the Maywood Site

| Direction \ Segment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Center | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| N | 26,767 | 63,952 | 8,671 | 11,558 | 14,455 | 17,342 | 33,166 | 47,565 | 26,013 | 28,900 |
| NNW | 30,322 | 5,773 | 8,671 | 11,558 | 1,455 | 17,342 | 20,299 | 23,127 | 47,486 | 28,900 |
| NW | 44,033 | 37,650 | 56,550 | 75,375 | 94,275 | 85,170 | 65,962 | 77,871 | 74,377 | 85,390 |
| WNW | 37,025 | 37,650 | 56,550 | 75,375 | 94,275 | 113,100 | 131,825 | 150,825 | 169,650 | 188,475 |
| W | 115,404 | 95,566 | 56,550 | 75,375 | 108,756 | 113,100 | 131,825 | 150,825 | 169,650 | 188,475 |
| WSW | 162,376 | 37,650 | 69,150 | 75,375 | 126,246 | 113,100 | 131,825 | 150,825 | 169,650 | 188,475 |
| SW | 65,616 | 121,775 | 203,385 | 249,795 | 158,219 | 198,284 | 131,825 | 150,825 | 169,650 | 188,475 |
| SSW | 18,825 | 142,067 | 143,470 | 509,125 | 334,325 | 299,055 | 206,113 | 164,500 | 169,650 | 188,475 |
| S | 18,825 | 99,1789 | 223,532 | 195,047 | 35,000 | 1,131 | 131,925 | 150,825 | 169,650 | 188,475 |
| SSE | 18,875 | 655,983 | 6,746,727 | 718,245 | 123,093 | 1,131 | 1,319 | 1,508 | 1,696 | 1,885 |
| SE | 32,557 | 486,931 | 378,265 | 1,134,795 | 73,433 | 109,228 | 113,804 | 231 | 260 | 289 |
| ESE | 39,007 | 701,353 | 175,338 | 378,265 | 34,812 | 67,014 | 138,585 | 23,127 | 26,013 | 28,900 |
| E | 42,023 | 136,427 | 137,007 | 29,174 | 14,455 | 17,342 | 20,229 | 23,127 | 26,013 | 28,900 |
| ENE | 57,120 | 110,589 | 97,675 | 52,254 | 88,893 | 145,376 | 228,297 | 149,417 | 248,206 | 242,546 |
| NE | 37,159 | 5,773 | 19,311 | 61,557 | 14,455 | 17,342 | 20,229 | 75,694 | 120,067 | 159,968 |
| NNE | 24,825 | 21,325 | 8,671 | 31,754 | 14,455 | 35,578 | 20,299 | 23,127 | 26,013 | 28,900 |

## 3.2 EXPOSURE SCENARIO DESCRIPTIONS AND ASSUMPTIONS

In this BRA, two time-sequenced hypothetical exposure scenarios are considered:

- current use – land use remains as it is now, and
- future use – land use in some property units changes to a reasonable maximum condition, such as residential; annual exposure is calculated based on the one-year period in which maximum exposure occurs.

### 3.2.1 Current Use Scenarios

Receptors considered at the MISS, Stepan, and commercial/government properties consist of indoor and outdoor employees. Other potential receptors at these property units include transients who may be visitors, customers, commuters, trespassers, and temporary or contractor personnel. For the residential properties, the current use scenario assumes that the resident has a vegetable garden, and may drink from groundwater sources. The mean RME resident individuals include both childhood and adult years of exposure.

### 3.2.2 Future Use Scenarios

Under the baseline condition, which assumes no remediation, the pile remains and no future land use change to residential would occur. Land use changes from DOE control to an industrial use. The future use scenarios at MISS are the same as the current use scenarios, with the addition of groundwater consumption by employees in the future scenario. The future use scenarios assume a child wading in Westerly Brook and Lodi Brook surface water and sediment for chemical exposure estimates.

## 3.3 IDENTIFICATION OF EXPOSURE PATHWAYS

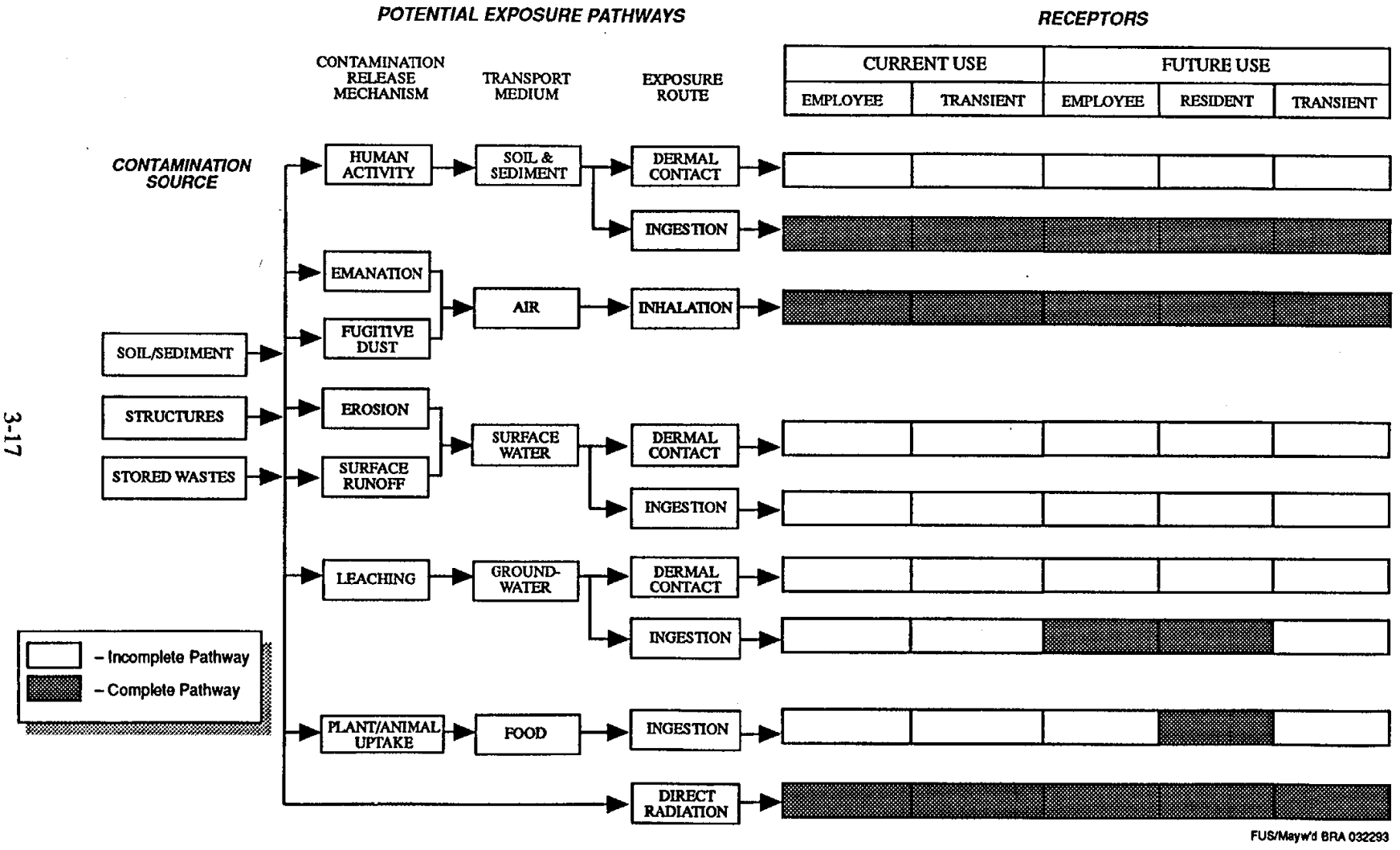
A complete exposure pathway consists of the following four elements: (1) a source and mechanism of contaminant release to the environment (with receiving media), (2) an environmental transport mechanism (fate and transport) for the released contaminants, (3) a point of human contact with the contaminated medium (exposure point), and (4) a route of entry of the contaminant into the human receptor (exposure route) at the exposure point. An integration of sources, releases, fate and transport mechanisms, exposure points, and exposure routes is evaluated for complete exposure pathways. If any of these elements is missing, the pathway is incomplete and will not be considered further in the risk evaluation.

Conceptual site models were developed to illustrate the potential exposure pathways for these scenarios and locations. Figures 3-6 through 3-9 are schematic diagrams depicting the pathways. In the conceptual site model diagrams, shaded blocks indicate the receptors potentially exposed in each completed pathway. Incomplete pathways occur when any of the pathway components is missing or when features such as engineering controls or access restrictions are in place to prevent release and migration of, or contact with, contaminants. Unshaded blocks indicate incomplete pathways.

The principal contaminant sources at the Maywood site are contaminated soils, structures, and waste materials. A smaller amount of contamination is present in sediments, surface water, and groundwater. Release mechanisms include the following:

- human activity that can mobilize contaminants or result in direct contact with contaminants,
- external gamma irradiation from contaminated soils and materials,
- emanation of radon and/or volatilization of chemicals into the atmosphere,
- wind dispersal of fugitive dust,
- erosion,
- surface runoff over contaminated soil following precipitation,
- leaching from contaminated surface and subsurface soils to groundwater,
- transport from contaminated groundwater to surface water or sediment, and
- plant or animal uptake.

Environmental transport media include soil, air, surface water, stream sediments, and groundwater. The exposure points are any locations where receptors can be exposed to contaminants through any of the exposure routes. The exposure points may include dermal contact, ingestion, inhalation, and direct radiation. The potential receptors include residents, employees, and transients (occasional visitors, customers, trespassers, recreational users, and commuters). Each component of the exposure pathways is discussed further in the following sections.




(Residential future land use is considered only for light commercial/properties; MISS, Stepan, and heavy industrial or commercial properties are assumed to remain in current land use.)

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**Figure 3-6. Conceptual Site Model of Exposure Pathways for Radiological Contaminants at MISS, Stepan, and Commercial/Government Properties**

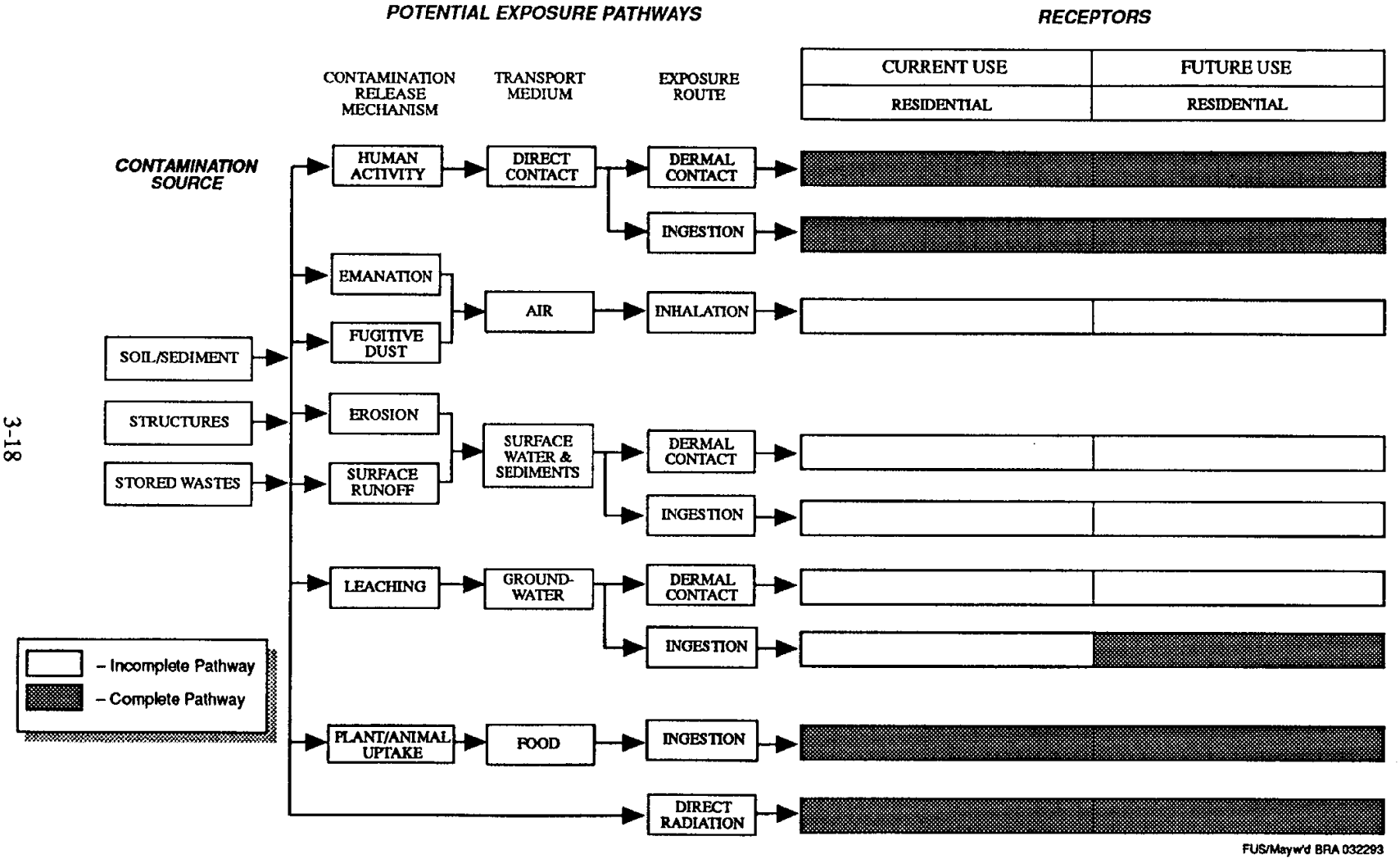



**Figure 3-7. Conceptual Site Model of Exposure Pathways for Radiological Contaminants at Residential Properties**

92-155M/020293

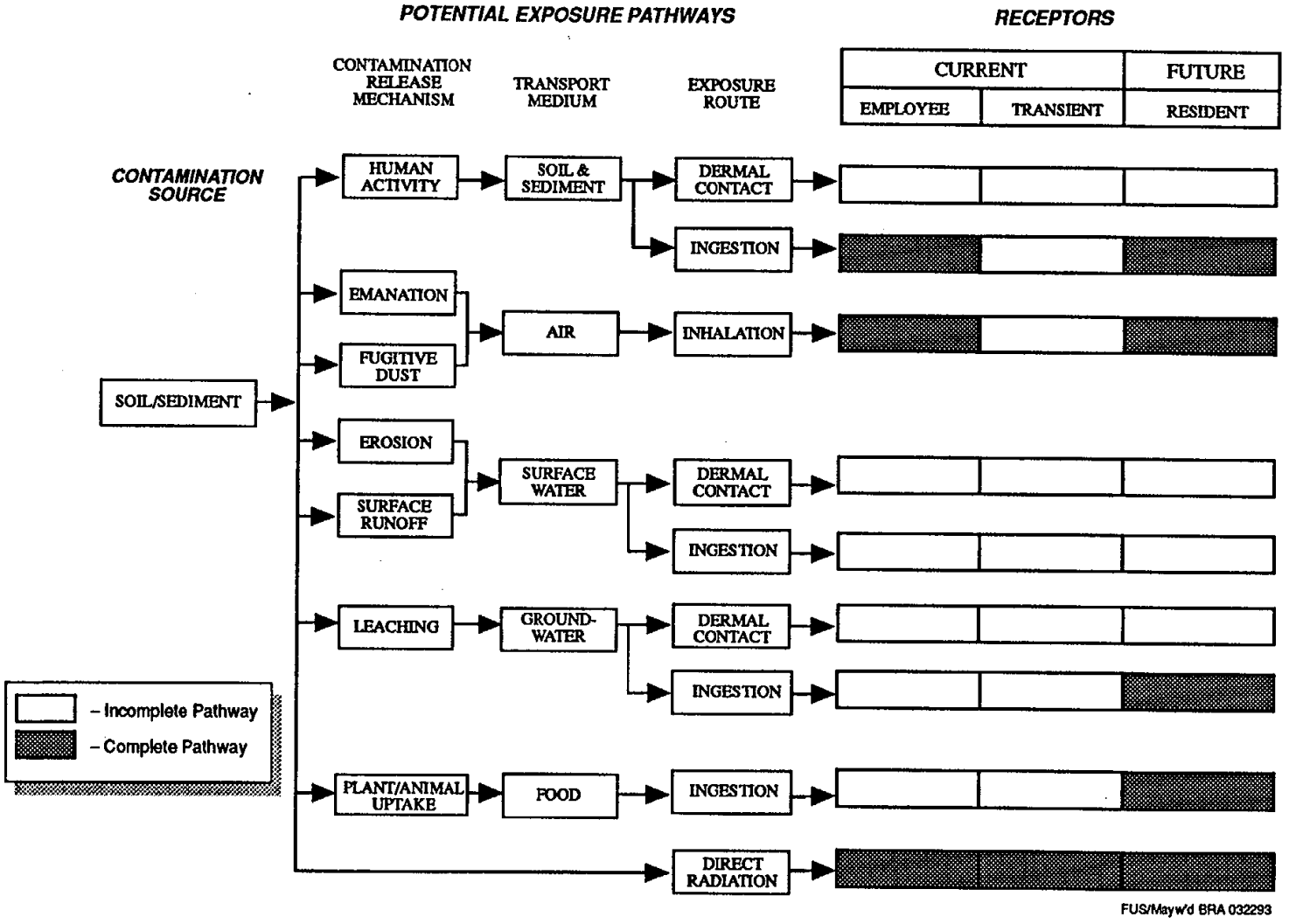



**Figure 3-8. Conceptual Site Model of Exposure Pathways for Radiologically Contaminanted Soil at Municipal Parks**

92-155M/020293

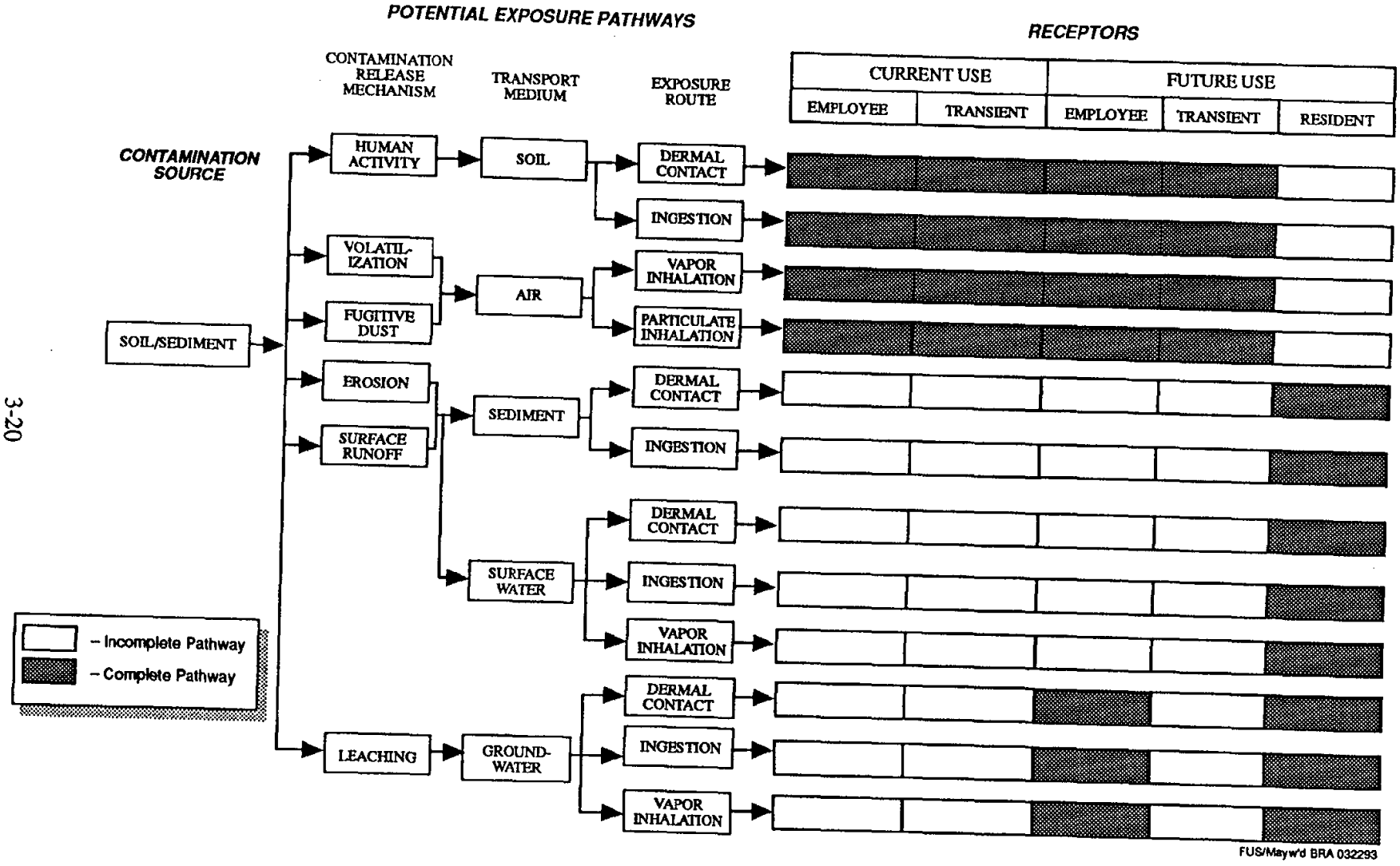



**Figure 3-9. Conceptual Site Model of Exposure Pathways for Chemically Contaminated Soil and Sediments at MISS, Stepan, and Commercial/Government Properties**

92-155M/020293

### 3.3.1 Contamination Sources and Release Mechanisms

#### 3.3.1.1 Radiological Contaminant Sources

The primary source for radioactive contaminants is soil which became contaminated due to past spills, waste disposal, and liquid effluent releases. Wastes from thorium processing were released to settling ponds, where the radioactive contaminants migrated into the soil. These soils were conveyed to other locations by various means including surface water movement and sedimentation, construction activity such as excavation and filling, and use in residential gardens. Several structures on the Stepan property are contaminated. In isolated cases contaminated lumber has been used in home repairs. Various forms of process wastes were also disposed at the site. Stored waste at MISS, which includes containerized waste and the interim storage waste pile, is also a potential source of contamination.

#### 3.3.1.2 Chemical Contaminant Sources

Chemical contaminants also have been detected in soils, principally at the MISS and Stepan properties. These are listed among the COCs.

Lithium and arsenic have been detected in groundwater at MISS. Arsenic is associated with thorium processing operations at the site, while lithium is associated with other, non-thorium processing activities at the site. Several halogenated organic compounds, including vinyl chloride (VC), tetrachloroethylene (PCE), trichloroethylene (TCE), chloroform ($CHCl_3$), and 1,1-dichloroethene (DCE), have been detected in groundwater at MISS or Stepan at concentrations significantly above potential applicable or relevant and appropriate requirements (ARARs) (Appendix B). VC, TCE, and DCE have been detected in Westerly Brook, and PCE was detected in a shallow alluvial well and a bedrock well on the Ballod property.

The source of these contaminants is not confirmed. Since these chemicals are not found in the two upgradient wells, it is possible they originate at Stepan or MISS.

Offsite migration of the groundwater contaminants also is possible, but current data are inconclusive. Additional groundwater investigation is underway, and will be addressed in an addendum to the RI. Lithium and arsenic are detected in onsite groundwater but not in the Ballod wells. The halogenated organic compounds are detected in both onsite and offsite locations. However, because they are so frequently found in heavily populated, industrial regions like the

Maywood area, it is difficult to draw conclusions as to their origin. In view of the levels of chlorinated hydrocarbons in groundwater at the MISS and Stepan properties and the direction of groundwater flow, it is likely that these contaminants are migrating to the Ballod monitoring wells. The absence of lithium or arsenic in the Ballod wells may be due to differences in point of origin for thorium process wastes and organic materials or to differences in attenuation in the aquifer. Further information to help resolve uncertainties related to sources and potential offsite migration of contaminants is forthcoming as a result of the separate remedial investigation being conducted by the Stepan Company.

3.3.1.3 Release Mechanisms For Radiological and Chemical Contaminants

As illustrated in Figures 3-6 through 3-9, contamination may be released from contaminant sources in several ways including the following:

- human activity such as excavation of soils, repair or demolition of structures, and management of stored waste;
- emission of radioactive gases or chemical vapors that escape the soils into the airborne environment where they or their progeny are inhaled by humans or deposited on the soil surface, plants, or structures;
- fugitive dust resulting from resuspension of particulate material from soil surfaces, where it is inhaled by humans or deposited on the soil surface, plants, or structures;
- erosion and surface runoff, which may carry contaminants to sedimentation points or to surface water or groundwater;
- leaching of material from the subsurface and surface soils, which may transfer contaminants to the surface water supply (Saddle River is not used as a drinking water source downstream of the Westerly Brook or Lodi Brook); and
- contaminant uptake from soil and/or attachment onto plant or vegetable surfaces with subsequent ingestion.

### 3.3.2 Fate and Transport Mechanisms

Upon release from sources, contaminants may migrate in environmental media by any of several transport mechanisms, including the following:

- direct contact with contaminants and external irradiation;
- emanation of radon, volatilization of organic chemicals, and resuspension of particulates in air;

- surface water flow and the accompanying movement of sediments;
- groundwater transport; and
- uptake and retention of contaminants by plants or animals. (In the Maywood area, there are home gardens in which soil contamination could result in contaminants adhering to root crop vegetables. There are no domestic or game animals used for food in the Maywood area currently, and this medium of contamination transport is implausible for the future.)

Because of site-specific factors, certain of these potential release mechanisms and receiving media do not play a significant role in contaminant fate and transport and resulting human exposure at the Maywood site. For example, because of the urban nature of the site, limited wildlife and vegetation are present, and uptake by biota is not currently an important release mechanism except for home gardens. Similarly, due to the topographic features of the site, surface water runoff is not considered a significant transport mechanism; however, it may have been quite important in previous times before Lodi Brook and Westerly Brook were enclosed in culverts. Since contaminants have been identified in site groundwater, a future water ingestion pathway has been included. However, the groundwater in the area of the site is not currently utilized for drinking or other household purposes, and a current pathway is not included.

The environmental release mechanisms and transport pathways that are considered most important for potential human exposures to site contaminants under current conditions include the following:

- external gamma radiation from radioactively contaminated soils and materials,
- emanation of radon gas from radium-contaminated soils,
- resuspension and airborne dispersal of particulates, and
- direct contact with contaminated soil and materials.

An additional release mechanism and transport pathway that might become a significant factor in the future scenarios is soil contaminants leaching to groundwater.

### 3.3.3 Exposure Points and Exposure Routes

In the assessment of human health risk, exposure points are locations where human receptors can come in contact with contaminants. In Maywood, this could occur at any of the properties where contaminant sources exist onsite or offsite in cases where contaminants have migrated.

Exposure route refers to the specific process in which the contaminant at the exposure point enters the human receptor. The exposure routes that exist at the Maywood site are dermal contact, ingestion, inhalation, and direct radiation. More specifically the exposure routes consist of the following:

- dermal contact occurring when contaminated soils, sediments, structural materials or stored waste are handled, or when contaminated groundwater or surface water is contacted while showering, swimming, etc.;
- inhalation of radon and progeny, chemical vapors, or resuspended particulates;
- direct ingestion of contaminated soils;
- ingestion of locally grown plants that have absorbed radioactive material from the soil and water or have contaminants adhering to them;
- ingestion of contaminated groundwater or surface water; and
- direct gamma radiation from contaminated soils and structures.

Because of the uncertainties in toxicological data for assessing dermal absorption for the Maywood site soil COCs a quantitative assessment of dermal absorption of contaminants from soil was not performed. Dermal contact with contaminated water is considered a possible exposure pathway for future residents using site groundwater. The most significant dermal contact with groundwater would be while showering. EPA interim guidance on the assessment of dermal exposure acknowledges that the currently available methods of deriving dermal permeability constants "can not and do not provide a reasonable estimate" for metals and defers this methodology to work currently under way (EPA 1991d). Therefore, in this assessment, possible dermal uptake of contaminants was not evaluated quantitatively.

### 3.3.4 Radiological Exposure Pathways

The same exposure pathways occur for the MISS, Stepan, and commercial/government properties, as shown in Figure 3-6. In the current use of these properties there are no residents, but there may be two categories of employees (indoor and outdoor). For properties with no buildings, employee occupancy is assumed to range between 1 and 10 hours per week, depending on actual employment conditions. This receptor also covers possible uses of company property for recreational purposes. Potential receptors also include transients, who may be visitors, customers, commuters, trespassers, and temporary or contractor personnel.

Conceptual site models for exposure pathways from soil/sediment and structure sources in residential properties and from soil/sediment sources in municipal parks are provided in Figures 3-7 and 3-8. In the RI report, the municipal parks are included with the residential operable unit. In the risk assessment, they are separated because there are no residents; but there are recreational park users such as children who may spend significant amounts of time in park playgrounds.

Potential receptors for both current use and future use scenarios may include residents, employees, and transients, as appropriate for the particular property unit. However, the future use scenario assumes an RME condition for some properties where applicable (e.g., occupancy by a resident who grows a portion of his own food supply on the property.)

In the conceptual site model for the MISS, Stepan, and commercial/government properties, inhalation of radon or radioactively contaminated particulates and direct radiation are completed pathways for all receptors and scenarios (see Figure 3-6). For transients in the current scenario, controls on access to contaminants limit the ingestion pathway but might not be present in the future scenario. The incidental soil ingestion pathway is considered a complete pathway for current and future employees.

The minimal extent of erosion and surface run-off eliminates these exposure pathways in all scenarios; before the enclosure of Lodi Brook and Westerly Brook in culverts through the site, surface water transport may have been a significant pathway. Completed groundwater pathways do not occur in current scenarios because groundwater in the area of the site is not currently used for drinking or other household purposes, but they may be complete pathways for future residents and employees. Ingestion of contaminated food is a complete pathway only for hypothetical future residents who may grow a portion of their produce in home gardens.

Contaminated structures include underground piping, drains, manholes, and foundations as well as above-ground structures. Stored waste includes the material in the MISS pile and containerized waste such as that in Building 76. It does not include buried waste or residues from waste disposal ponds, which are considered part of the soil/sediment sources. Engineering controls and access restrictions eliminate pathways to stored waste for all except current or future employees who maintain the waste.

For residential properties, exposure to contaminated soils, sediments and structures may occur via complete pathways for inhalation, direct radiation, consumption of locally grown produce, and incidental soil ingestion for all scenarios and receptors (see Figure 3-7). Although there are groundwater wells in the area, there are no public water supply wells installed in the bedrock aquifer and no known current use of groundwater by residents. Exposure by drinking water ingestion is possible, although unlikely, in the future (BNI 1992).

There are no current residents at municipal parks; but recreational users, particularly children, may spend extended periods in contact with soil (see Figure 3-8). The present use exposure pathways for municipal parks includes inhalation, direct radiation, and incidental soil ingestion. No significant completed pathways exist for surface water or groundwater at the municipal park property units under current use conditions. The future use residential scenario described above may exist in the future if these properties are converted to residential use.

### 3.3.5 Chemical Exposure Pathways

Chemical exposure pathways at the Maywood site are shown in Figure 3-9. An exposure scenario is developed from an analysis of complete and incomplete pathways based on current and future land use conditions, the spatial organization of operable units, the presence of human receptors, the availability of exposure media, and the availability of human routes of exposure. The current and future scenarios are the same at properties where land use is assumed to remain unchanged (i.e., commercial/industrial) at MISS, Stepan, and Ballod. The data for the residential and commercial/government properties were limited and exposure scenarios and risk estimates were not developed for these properties.

The conceptual site model is shown in Figure 3-9. A conceptual model was developed to illustrate the potential exposure pathways for the current and future land use scenarios. The model includes the human receptors at the MISS, Stepan, and Ballod properties who may be affected by organic and inorganic chemical contamination in or migrating from soil and sediment.

For the current use scenario, the receptors identified are employees and transients at the MISS, Stepan, and Ballod properties. The transient scenario addresses potential exposures for individuals who may spend limited time at these properties. The same receptors are included for the future land use scenario, with the addition of local resident children playing in Westerly Brook and Lodi Brook. Complete exposure pathways for employees and transients under current and future land use are considered to be dermal contact with and ingestion of soil and inhalation of vapors and

particulates in ambient air. In addition, employees may be exposed to groundwater through dermal contact, ingestion, and vapor inhalation during hypothetical use of groundwater as potable water. Exposure to sediment and surface water are considered incomplete pathways for employees and transients who would not be expected to come into contact with the brooks.

The complete exposure pathways identified for local resident children are based on contact with Westerly Brook and Lodi Brook downstream from the MISS, Stepan, and Ballod properties. They include dermal contact with and ingestion of stream sediments as well as dermal contact, ingestion, and vapor inhalation for surface water. Local resident children would not be exposed to soil, air, or groundwater at the MISS, Stepan, and Ballod properties.

At Maywood, the following chemical exposure assumptions control the chemical exposure scenarios.

- Current industrial and commercial land use at the MISS and Stepan will continue into the foreseeable future, with human receptors limited to the employee, the transient, a downstream resident child (surface water and sediment pathways), and a future resident who drinks groundwater;
- The chemical groundwater contamination is based on data from the MISS, Stepan, and Ballod properties, where all monitoring wells are installed. For the radiological assessments, exposure point concentration for future scenarios is modeled by the RESRAD program on the basis of soil concentrations. The measured groundwater values are not used because there presently are no radiological COCs in groundwater.
- The Westerly Brook surface water and sediment contamination, found at sampling stations located downstream from the MISS, Stepan, and Ballod properties, will affect only the offsite, downstream resident (child) in Rochelle Park.

Several additional assumptions pertain to the availability of exposure media, human routes of exposure, and completed pathways.

- As there are no public water supply wells installed in the bedrock aquifer, there are no completed pathways of exposure to the bedrock aquifer (BNI 1992).
- As the MISS Waste Storage Pile is physically and chemically isolated from the ambient environment and expected to remain as an industrial site, it is assumed that no completed pathways exist for external exposure of human receptors to chemicals from this source.
- Oral ingestion of in situ surface soils and the inhalation of airborne soil particulates are complete pathways requiring a quantitative risk estimate for each affected human receptor. However, the potential exposure to contaminants in soils via inhalation of volatilized organic chemicals (vapors) or by dermal contact and absorption are deemed insignificant pathways and do not warrant a quantitative risk estimate.

## 3.4 EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations of contaminants must be determined for quantitative health risk assessments. This may be accomplished by analyzing samples collected from locations where human receptors may come in contact with the contaminants or by onsite measurements with chemical or radiation detection instruments. When laboratory analysis or onsite measurement data are not available, exposure point concentrations may be estimated using a variety of modeling techniques.

For the Maywood properties, laboratory analysis data are available for the radionuclides Th-232, Ra-226, and U-238 in surface and subsurface soil samples in most of the areas. Surface soils are generally defined here as the initial 0 to 2 ft from the surface, whereas subsurface soils are generally greater than 2 ft deep. Groundwater radiological data for the MISS and adjoining properties were obtained by analysis of monitoring well samples as presented in the RI report and in environmental monitoring reports. Other locations were estimated by modeling. Soil radiological data (surface and subsurface) were used to estimate exposure point concentrations for the following pathways: external gamma irradiation, incidental ingestion, inhalation of radon, inhalation of particulates, and ingestion of homegrown produce. Because of the concentrations present and the limited contact with sediment by human receptors, the impact of radionuclides in sediment is included within the uncertainty in the impacts of soils.

Soil chemical data were available from laboratory analyses of site samples collected at the MISS, the Stepan property, residential properties, and commercial/government properties as presented in the RI report (BNI 1992). Surface soil samples are defined as chemical samples to a depth of 2 ft, as with surface soil radionuclide sample data. Groundwater, surface water, and sediment data utilized to determine chemical exposure point concentrations were also presented in the RI report (BNI 1992).

### 3.4.1 Soil Analyses and Calculated Contaminant Concentrations

*Radiological Data*

Radionuclide concentrations in surface and subsurface soils are presented in Table 3-4 A, B, C, and D. Each number shown in the table is a statistic, either the mean or UL95, of the data set that includes all the sample analysis results for each property unit and radionuclide parameter indicated.

# Table 3-4A. Mean Radionuclide Concentrations in Surface Soil, pCi/g

(LESS BACKGROUND, See Table 2-1))

| LOCATION | PROPERTY UNITS | Th-232 +D* | | | Ra-226 +D | | U-238 +D | | | U-235 +D** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th-232 | Ra-228 | Th-228 | Ra-226 | Pb-210 | U-238 | U-234 | Th-230 | U-235 | Pa-231 | Ac-227 |
| RESIDENTIAL | UNIT 1 | 2.88 | 2.88 | 2.88 | 0.52 | 0.52 | 3.39 | 3.39 | 3.39 | 0.17 | 0.17 | 0.17 |
| | UNIT 2 | 9.05 | 9.05 | 9.05 | 1.08 | 1.08 | 8.43 | 8.43 | 8.43 | 0.42 | 0.42 | 0.42 |
| STEPAN | UNIT 3 | 3.45 | 3.45 | 3.45 | 0.61 | 0.61 | 1.69 | 1.69 | 1.69 | 0.08 | 0.08 | 0.08 |
| | UNIT 3H | 16.33 | 16.33 | 16.33 | 3.77 | 3.77 | 4.37 | 4.37 | 4.37 | 0.22 | 0.22 | 0.22 |
| MUNICIPAL PARKS | UNIT4 | 1.21 | 1.21 | 1.21 | 0.17 | 0.17 | 0.96 | 0.96 | 0.96 | 0.05 | 0.05 | 0.05 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 2.05 | 2.05 | 2.05 | 0.31 | 0.31 | 1.98 | 1.98 | 1.98 | 0.10 | 0.10 | 0.10 |
| | UNIT 6 (MISS) | 7.91 | 7.91 | 7.91 | 1.43 | 1.43 | 12.78 | 12.78 | 12.78 | 0.64 | 0.64 | 0.64 |
| | UNIT 6H | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | UNIT 6B (BALLOD) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | UNIT 7 | 18.06 | 18.06 | 18.06 | 1.92 | 1.92 | 24.27 | 24.27 | 24.27 | 1.21 | 1.21 | 1.21 |
| | UNIT 7H | 46.76 | 46.76 | 46.76 | 4.93 | 4.93 | 26.60 | 26.60 | 26.60 | 1.33 | 1.33 | 1.33 |
| | UNIT 8 | 17.10 | 17.10 | 17.10 | 1.47 | 1.47 | 10.53 | 10.53 | 10.53 | 0.53 | 0.53 | 0.53 |

Shaded area indicates measured concentrations

* +D denotes that secular equilibrium was assumed to derive concentrations for associated decay products (non-shaded boxes)

** U-235 +D concentrations are 5% of U-238 value

ND = No Data

# Table 3-4B. Mean Radionuclide Concentrations in Subsurface Soil, pCi/g

(LESS BACKGROUND, See Table 2-1)

| LOCATION | PROPERTY UNITS | Th-232 +D* | | | Ra-226 +D | | U-238 +D | | | U-235 +D** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th-232 | Ra-228 | Th-228 | Ra-226 | Pb-210 | U-238 | U-234 | Th-230 | U-235 | Pa-231 | Ac-227 |
| RESIDENTIAL | UNIT 1 | 1.57 | 1.57 | 1.57 | 0.30 | 0.30 | 2.32 | 2.32 | 2.32 | 0.12 | 0.12 | 0.12 |
| | UNIT 2 | 5.53 | 5.53 | 5.53 | 0.74 | 0.74 | 5.15 | 5.15 | 5.15 | 0.26 | 0.26 | 0.26 |
| STEPAN | UNIT 3 | 3.46 | 3.46 | 3.46 | 0.74 | 0.74 | 1.74 | 1.74 | 1.74 | 0.09 | 0.09 | 0.09 |
| | UNIT 3H | 33.29 | 33.29 | 33.29 | 7.06 | 7.06 | 5.03 | 5.03 | 5.03 | 0.25 | 0.25 | 0.25 |
| MUNICIPAL PARKS | UNIT4 | 2.11 | 2.11 | 2.11 | 0.11 | 0.11 | 0.84 | 0.84 | 0.84 | 0.04 | 0.04 | 0.04 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 0.68 | 0.68 | 0.68 | 0.19 | 0.19 | 1.18 | 1.18 | 1.18 | 0.06 | 0.06 | 0.06 |
| | UNIT 6 (MISS) | 16.42 | 16.42 | 16.42 | 2.69 | 2.69 | 16.14 | 16.14 | 16.14 | 0.81 | 0.81 | 0.81 |
| | UNIT 6H | 340.28 | 340.28 | 340.28 | 72.18 | 72.18 | 99.41 | 99.41 | 99.41 | 4.97 | 4.97 | 4.97 |
| | UNIT 6B (BALLOD) | 69.81 | 69.81 | 69.81 | 0.39 | 0.39 | 84.71 | 84.71 | 84.71 | 4.24 | 4.24 | 4.24 |
| | UNIT 7 | 16.50 | 16.50 | 16.50 | 4.29 | 4.29 | 31.47 | 31.47 | 31.47 | 1.57 | 1.57 | 1.57 |
| | UNIT 7H | 10.16 | 10.16 | 10.16 | 2.11 | 2.11 | 33.43 | 33.43 | 33.43 | 1.67 | 1.67 | 1.67 |
| | UNIT 8 | 37.62 | 37.62 | 37.62 | 1.97 | 1.97 | 10.58 | 10.58 | 10.58 | 0.53 | 0.53 | 0.53 |

Shaded area indicates measured concentrations

* +D denotes that secular equilibrium was assumed to derive concentrations for associated decay products (non-shaded boxes)

** U-235 +D concentrations are 5% of U-238 value

# Table 3-4C. RME Radionuclide Concentrations in Surface Soil, pCi/g

(LESS BACKGROUND, See Table 2-1)

| LOCATION | PROPERTY UNITS | Th-232 +D* | | | Ra-226 +D | | U-238 +D | | | U-235 +D** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th-232 | Ra-228 | Th-228 | Ra-226 | Pb-210 | U-238 | U-234 | Th-230 | U-235 | Pa-231 | Ac-227 |
| RESIDENTIAL | UNIT 1 | 3.51 | 3.51 | 3.51 | 0.60 | 0.60 | 3.73 | 3.73 | 3.73 | 0.19 | 0.19 | 0.19 |
| | UNIT 2 | 11.30 | 11.30 | 11.30 | 1.25 | 1.25 | 10.58 | 10.58 | 10.58 | 0.53 | 0.53 | 0.53 |
| STEPAN | UNIT 3 | 5.18 | 5.18 | 5.18 | 0.80 | 0.80 | 2.27 | 2.27 | 2.27 | 0.11 | 0.11 | 0.11 |
| | UNIT 3H | 19.99 | 19.99 | 19.99 | 5.13 | 5.13 | 4.97 | 4.97 | 4.97 | 0.25 | 0.25 | 0.25 |
| MUNICIPAL PARKS | UNIT4 | 1.91 | 1.91 | 1.91 | 0.24 | 0.24 | 1.21 | 1.21 | 1.21 | 0.06 | 0.06 | 0.06 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 2.49 | 2.49 | 2.49 | 0.38 | 0.38 | 2.18 | 2.18 | 2.18 | 0.11 | 0.11 | 0.11 |
| | UNIT 6 (MISS) | 11.60 | 11.60 | 11.60 | 1.81 | 1.81 | 15.53 | 15.53 | 15.53 | 0.78 | 0.78 | 0.78 |
| | UNIT 6H | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | UNIT 6B (BALLOD) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | UNIT 7 | 24.73 | 24.73 | 24.73 | 2.62 | 2.62 | 28.32 | 28.32 | 28.32 | 1.42 | 1.42 | 1.42 |
| | UNIT 7H | 61.96 | 61.96 | 61.96 | 6.36 | 6.36 | 35.66 | 35.66 | 35.66 | 1.78 | 1.78 | 1.78 |
| | UNIT 8 | 28.50 | 28.50 | 28.50 | 1.90 | 1.90 | 12.31 | 12.31 | 12.31 | 0.62 | 0.62 | 0.62 |

Shaded area indicates measured concentrations

* +D denotes that secular equilibrium was assumed to derive concentrations for associated decay products (non-shaded boxes)

** U-235 +D concentrations are 5% of U-238 value

ND = No Data

# Table 3-4D. RME Radionuclide Concentrations in Subsurface Soil, pCi/g

(LESS BACKGROUND, See Table 2-1)

| LOCATION | PROPERTY UNITS | Th-232 +D* | | | Ra-226 +D | | U-238 +D | | | U-235 +D** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th-232 | Ra-228 | Th-228 | Ra-226 | Pb-210 | U-238 | U-234 | Th-230 | U-235 | Pa-231 | Ac-227 |
| RESIDENTIAL | UNIT 1 | 1.90 | 1.90 | 1.90 | 0.36 | 0.36 | 2.60 | 2.60 | 2.60 | 0.13 | 0.13 | 0.13 |
| | UNIT 2 | 7.25 | 7.25 | 7.25 | 0.86 | 0.86 | 6.70 | 6.70 | 6.70 | 0.34 | 0.34 | 0.34 |
| STEPAN | UNIT 3 | 5.20 | 5.20 | 5.20 | 1.03 | 1.03 | 2.15 | 2.15 | 2.15 | 0.11 | 0.11 | 0.11 |
| | UNIT 3H | 50.43 | 50.43 | 50.43 | 10.59 | 10.59 | 6.88 | 6.88 | 6.88 | 0.34 | 0.34 | 0.34 |
| MUNICIPAL PARKS | UNIT4 | 3.06 | 3.06 | 3.06 | 0.15 | 0.15 | 1.08 | 1.08 | 1.08 | 0.05 | 0.05 | 0.05 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 0.83 | 0.83 | 0.83 | 0.23 | 0.23 | 1.34 | 1.34 | 1.34 | 0.07 | 0.07 | 0.07 |
| | UNIT 6 (MISS) | 20.01 | 20.01 | 20.01 | 3.18 | 3.18 | 18.36 | 18.36 | 18.36 | 0.92 | 0.92 | 0.92 |
| | UNIT 6H | 526.13 | 526.13 | 526.13 | 126.39 | 126.39 | 132.38 | 132.38 | 132.38 | 6.62 | 6.62 | 6.62 |
| | UNIT 6B (BALLOD) | 184.99 | 184.99 | 184.99 | 0.86 | 0.86 | 228.19 | 228.19 | 228.19 | 11.41 | 11.41 | 11.41 |
| | UNIT 7 | 32.72 | 32.72 | 32.72 | 7.25 | 7.25 | 39.23 | 39.23 | 39.23 | 1.96 | 1.96 | 1.96 |
| | UNIT 7H | 32.34 | 32.34 | 32.34 | 5.86 | 5.86 | 107.17 | 107.17 | 107.17 | 5.36 | 5.36 | 5.36 |
| | UNIT 8 | 92.62 | 92.62 | 92.62 | 3.75 | 3.75 | 16.69 | 16.69 | 16.69 | 0.83 | 0.83 | 0.83 |

Shaded area indicates measured concentrations

* +D denotes that secular equilibrium was assumed to derive concentrations for associated decay products (non-shaded boxes)

** U-235 +D concentrations are 5% of U-238 value

To estimate radionuclide concentrations for each property unit, the arithmetic mean and the UL95 values of the arithmetic means for the radionuclide concentrations (i.e., Ra-226, Th-232, and U-238) at each property were calculated . Sample results reported as below the sample quantitation limit (non-detects) were considered in this analysis as present at the quantitation limit as a proxy concentration. Because it is assumed that the radionuclides are present in secular equilibrium, values were derived from the concentrations of these measured radionuclides for all other radionuclides in the decay series of interest.

*Chemical Data*

Chemical concentrations in soils at the Maywood operable units are presented in Appendix E. A statistical evaluation of the data was completed for the surface soils data. The measured results were assumed to be log normal. For each operable unit data set, the bias estimator of the mean and the UL95 were used to derive the concentration values that are utilized as the soil exposure point concentrations for calculation of average and RME intakes, respectively. Statistical analysis indicated that the data in all operable units were not normally distributed. Sample results reported as below the quantitation limit (non-detects) were included in this analysis at one-half the quantitation limit as a proxy concentration.

It is assumed that soil concentrations will remain constant in the future scenario risk evaluations. Because of the uncertainty associated with any estimate of exposure concentration, the upper confidence limit on the arithmetic average (i.e., UL95) is used as the RME exposure point concentration (EPA 1989b). Although this concentration does not necessarily reflect the absolute maximum concentration that could be contacted at any one time, it is regarded as a reasonable maximum estimate of the concentration likely to be contacted over time (EPA 1989b).

3.4.1.1 Exposure Point Concentrations for Incidental Soil Ingestion

Radionuclide concentrations in surface soils (to a depth of 2 ft) were used to calculate incidental soil ingestion doses. This soil depth accounts for possible limited intrusion by current and future receptors into areas where contamination also is found below the ground surface.

Exposure point concentrations utilized for chemical intake calculations for incidental soil ingestion are the arithmetic mean and UL95 surficial soil concentrations for the identified exposure scenarios. In cases where the UL95 exceeds the maximum measured concentration, the maximum

measured concentration is utilized as a proxy concentration for the RME estimate in accordance with EPA guidance (EPA 1989b).

3.4.1.2 Exposure Point Concentrations for External Gamma Radiation

Measured gamma exposure rate data were used where available. When no indoor data were available, outdoor data, corrected for shielding by building materials, were used. When no measured gamma exposure rate data were available, the RESRAD code was used to estimate them based on soil contamination levels. Exposure from external gamma irradiation is mainly from the top 0.3 m (1 ft) of soil due to gamma ray attenuation by the overlying soil at deeper depths. Therefore, the values of the data from the upper soil layer were used to calculate external gamma exposure. The RESRAD model incorporates an assumed erosion rate that exposes the subsurface soil over time. The dose reported for the future use scenarios is the higher of the present or future conditions.

Details of external gamma dose calculations are provided in Gilbert et al. (1989) and are summarized as follows:

$$Di = C_{soil,i} \times ETF \times DCFi$$

where:

$D_i$ = exposure rate from radionuclide i (mrem/yr)

$C_{soil,i}$ = UL95 soil concentration of radionuclide i (pCi/g)

ETF = environmental transport factor ($g/cm^3$) (accounts for density of soil material, thickness of contaminated zone and cover, occupancy factor, shielding factor, shape factor, area factor, and depth factor)

DCFi = external gamma dose conversion factor for radionuclide i, $(mrem/yr)/(pCi/cm^3)$.

Environmental transport factors provided in Gilbert et al. (1989) were used. It was assumed that the indoor external gamma exposure rate was reduced by 20 percent due to shielding afforded by structural materials (EPA 1991c). Direct radiation exposure is assumed to come from the top 10

cm of soil since the dose rate is reduced by a factor of about 10 from shielding of the soil. No shielding is considered for the first 10 cm of soil to assure conservatism.

3.4.1.3 Exposure Point Concentrations for Radon

Rn-222 data are available for many of the property units. Where measured results were not available, radon concentrations in outdoor or indoor air, as appropriate for the various scenarios, were estimated from the concentrations of Ra-226 in soil. The values and the models for radon concentrations indoors and outdoors as discussed below were used to calculate exposure point concentrations for radon. The results of the modeling compare favorably with the limited radon concentration data. Thoron (Rn-220) emanation from soils was not considered because of the relatively short half-life compared to Rn-222. The short half-life results in much less movement in the soil.

*Indoor Radon*

From the UNSCEAR (1988) report, the radon area exhalation rate from soil can be modeled using the equation below:

$$R = \lambda Rn \times Fr \times C_{soil,Ra} \times \rho soil \times LRn$$

where:

$R$ = radon area exhalation rate ($pCi/m^2$-sec)

$\lambda_{Rn}$ = decay constant for Rn-222 ($2.1 \times 10^{-6}$ $sec^{-1}$ or $7.6 \times 10^{-3}$ $h^{-1}$)

$F_r$ = emanating power (0.2, based on Table 13 of UNSCEAR, 1988)

$C_{soil,Ra}$ = mass activity concentration for Ra-226 (pCi/g)

$\rho soil$ = soil density in $g/m^3$ (multiply $g/cm^3$ times $10^6$ to get $g/m^3$) (1.6 $g/cm^3$)

$L_{Rn}$ = diffusion length of radon in soil = $[\Delta_{eff}/(\lambda_{Rn} x \rho_{soil,ps})]^{1/2}$

$\Delta_{eff}$ = effective bulk diffusion coefficient $\Delta_{eff}(m^2/sec)$ $(5 \times 10^{-7})$ (UNSCEAR 1988)

$\rho_{soil,ps}$ = soil porosity (0.25) (UNSCEAR 1988)$\rho_{soil.}$

simplifying to:

$R = 0.656 x C_{soil,Ra}(pCi/m^2\text{-sec})$

Assuming the house has a cracked concrete slab, the UNSCEAR (1988) model indicates that the emanation rate into the structure would be 25 percent of the soil emanation rate. The radon entry rate into the standard house, U ($pCi/m^3/hr$), is estimated using the following equation:

$U = RxKxNxS_f/V$

where:

U = Radon entry rate into hypothetical structure ($pCi/m^3$ -h)

K = Slab attenuation factor (.25)

N = 3,600 sec/h

$S_f$ = surface area of the floor in $m^2$ (100 $m^2$ = 1,076 $ft^2$) (UNSCEAR 1988)

V = volume of the house in $m^3$ (250 $m^3$) (UNSCEAR 1988)

simplifying to:

$U = 236 x C_{soil,Ra}$ $(pCi/m^3\text{-h})$

The radon concentration in a hypothetical structure, assuming the UNSCEAR standard house, can be estimated by the following:

$X_{Rn} = U/(\lambda_{Rn}+\lambda_V)$

where:

$X_{Rn}$ = indoor radon concentration ($pCi/m^3$)

$\lambda_V$ = air exchange rate for residential structures in ($1\ h^{-1}$) (UNSCEAR 1988)

simplifying to:

$$X_{Rn} = 234 x C_{soil,Ra} (pCi/m^3)$$

$$= 0.234 x C_{soil, Ra} (pCi/L)$$

The exchange rate was assumed to increase by a factor of 2 for commercial structures.

*Outdoor Radon*

The outdoor radon concentration depends on many meteorological and soil factors that control the release of radon to the atmosphere and its movement therein. The relationships are quite complex, making it difficult to estimate radon concentrations by means of modeling. The model for radon in the outdoor environment is based on the radon emanation factor from Office of Solid Waste & Emergency Response (OSWER) Directive 9285.7-01B (EPA 1991b), e.g., Rn-222 concentration in air of approximately 120 $pCi/m^3$ per pCi/g of Ra-226 in soil.

Calculated radon emanation rates and concentrations in indoor and outdoor air include only the contribution from Ra-226 in soil and do not consider contributions from building materials, underlying geologic features, or other potential sources unrelated to site contamination.

3.4.1.4 Exposure Point Concentrations for the Inhalation of Particulates

*Radiological Data*

Air concentrations of radionuclide COCs were derived from surface soil concentrations for the properties comprising the Maywood site. For the Maywood area, an ambient airborne dust loading of about 0.10 mg (100 µg) of total particulates per $m^3$ of air on the average and about 0.20 mg (200 µg) of total particulates per $m^3$ of air for the RME (Gilbert 1983; Paustenbach 1989) has been assumed. Approximately 50 percent of the dust loading originates from soil or similar material (Trijois et al. 1980). For the Maywood site, it is conservatively assumed that 100 percent of the soil origin particulates are derived from the contaminated soil. Therefore, 50 percent of the airborne dust is assumed to originate from the contaminated soil.

The respirable portion of the total particulate concentration is used as the exposure point concentration for all calculations involving the inhalation of particulates. For this assessment, 30 percent is utilized as a conservative estimate (Paustenbach 1989).

The contaminant concentration in air is estimated for each radionuclide COC as follows:

$$C_{air,\ avg.} = C_{air,\ avg.}\ (pCi/g) \times 0.1\ mg/m^3 \times 10^{-3}\ g/mg \times 0.3 \times 0.5$$

where:

$C_{air,\ avg.}$ = average soil concentration of radionuclide i (pCi/L) = operable unit data set arithmetic mean

$0.1\ mg/m^3$ = the average dust concentration in air (Gilbert 1983; Paustenbach 1989)

$10^{-3}\ g/mg$ = conversion factor

0.3 = 30 % respirable portion of dust concentration in air (Paustenbach 1989)

0.5 = 50% of total dust concentration in air originates from contaminated soil (Trijonis et al. 1980)

and

$$C_{soil,RME,i} = UL_{95}\ \text{soil concentration of radionuclide i (pCi/g)} \times 0.2\ mg/m^3 \times 10^{-3}\ g/mg \times 0.3 \times 0.5$$

where:

$C_{soil,RME,i}$ = $UL_{95}$ soil concentration of radionuclide i (pCi/L) = operable unit data set upper 95% confidence limit

$0.2\ mg/m^3$ = the RME dust concentration in air (Paustenbach 1989)

$10^{-6}\ kg/mg$ = conversion factor

0.3 = 30 % respirable portion of dust concentration in air (Paustenbach 1989)

0.5 = 50% of total dust concentration in air originates from contaminated soil (Trijonis et al. 1980).

As with the incidental soil ingestion pathway of exposure, all particulate inhalation exposure scenarios utilize surface soil data. Where the UL95 estimate exceeds the maximum measured soil concentration for the given data set, the maximum concentration is utilized as the soil concentration in the $C_{air, RME}$ calculation. The exposure point concentrations for particulates in air are shown in Appendix E.

The radionuclide exposure point concentrations for airborne radioparticulates are presented in Table 3-5.

*Chemical Data*

Air concentrations of chemical COCs were derived from surficial soil concentrations for each operable unit at the Maywood site. The methodology used is equivalent to that presented previously for radionuclides. The equations and assumptions are the same with the exception that soil concentrations are given in mg/kg and a $10^{-6}$ conversion factor is required.

3.4.1.5 Exposure Point Concentrations for the Ingestion of Homegrown Produce

*Radiological Data*

The transfer of the radionuclide COCs from soil to edible produce depends on many factors, such as plant species, pH of the soil, and chemical form of the contaminant. Radionuclide transfer was calculated using RESRAD (Gilbert, et al. 1989). The soil concentration for each radionuclide was multiplied by the soil-to-plant transfer coefficient for each contaminant to derive the exposure point concentrations for homegrown produce for current and future residential properties.

*Chemical Data*

Chemical COCs were not evaluated quantitatively for this pathway due to the unavailability of appropriate uptake factors for the chemical COCs.

## Table 3-5. Calculated Exposure Point Concentrations of Radionuclide Particulates in Near-Surface Air

(1E-18 μCi/ml)

| OPERABLE UNITS IN RI REPORT | PROPERTY UNITS IN BRA | RADIONUCLIDES IN NEAR SURFACE AIR CURRENT USE | | | | | | RADIONUCLIDES IN NEAR SURFACE AIR FUTURE USE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th-232 | | Ra-226 | | U-238 | | Th-232 | | Ra-226 | | U-238 | |
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 4.3 | 10.5 | 0.8 | 1.8 | 5.1 | 11.2 | 4.3 | 10.5 | 0.8 | 1.8 | 5.1 | 11.2 |
| | UNIT 2 | 13.6 | 33.9 | 1.6 | 3.8 | 12.7 | 31.7 | 13.6 | 33.9 | 1.6 | 3.8 | 12.7 | 31.7 |
| STEPAN | UNIT 3 | 5.2 | 15.5 | 0.9 | 2.4 | 2.5 | 6.8 | 5.2 | 15.6 | 1.1 | 3.1 | 2.6 | 6.5 |
| | UNIT 3H | 24.5 | 60.0 | 5.7 | 15.4 | 6.6 | 14.9 | 49.9 | 151.3 | 10.6 | 31.8 | 7.5 | 20.6 |
| MUNICIPAL PARKS | UNIT4 | 1.8 | 5.7 | 0.3 | 0.7 | 1.4 | 3.6 | 3.2 | 9.2 | 0.2 | 0.5 | 1.3 | 3.2 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 3.1 | 7.5 | 0.5 | 1.1 | 3.0 | 6.5 | 1.0 | 2.5 | 0.3 | 0.7 | 1.8 | 4.0 |
| | UNIT 6 (MISS) | 11.9 | 34.8 | 2.1 | 5.4 | 19.2 | 46.6 | 24.6 | 60.0 | 4.0 | 9.5 | 24.2 | 55.1 |
| | UNIT 6H | ND | ND | ND | ND | ND | ND | 510.4 | 1578.4 | 108.3 | 379.2 | 149.1 | 397.1 |
| | UNIT 6B (BALLOD) | ND | ND | ND | ND | ND | ND | 104.7 | 555.0 | 0.6 | 2.6 | 127.1 | 684.6 |
| | UNIT 7 | 27.1 | 74.2 | 2.9 | 7.9 | 36.4 | 84.9 | 24.8 | 98.2 | 6.4 | 21.8 | 47.2 | 117.7 |
| | UNIT 7H | 70.1 | 185.9 | 7.4 | 19.1 | 39.9 | 107.0 | 15.2 | 97.0 | 3.2 | 17.6 | 50.1 | 321.5 |
| | UNIT 8 | 25.6 | 85.5 | 2.2 | 5.7 | 15.8 | 36.9 | 56.4 | 277.9 | 3.0 | 11.3 | 15.9 | 50.1 |

ND=NO DATA AVAILABLE
X=MEAN
RME=REASONABLE MAXIMUM EXPOSURE

### 3.4.2 Groundwater

There are two aquifers in the Maywood area. One, the alluvial aquifer, is associated with the overburden soils and the other with the bedrock. Additional groundwater investigation has been proposed and approved.

#### 3.4.2.1 Groundwater Ingestion

*Radiological Data*

Measured radionuclide concentrations in the bedrock aquifer fall well within the range of the background data for this medium in the Maywood area. Thus, no incremental radiological dose from the bedrock aquifer was projected. The alluvial aquifer is near the surface and is not currently used as a drinking water source. The municipal water supply system makes use of the alluvial aquifer for drinking water unnecessary. However, this water is not precluded from use; therefore, 100 percent of the water consumed by a future resident was assumed to come from this source. These exposure point concentrations are shown in the exposure estimate tables in Appendix C, and in all cases are a negligible part of the total exposure.

*Chemical Data*

Data from groundwater aquifer sampling at the MISS, the Stepan property, and the Ballod property were combined for use as the exposure point concentrations for the groundwater ingestion pathway. The alluvial and bedrock aquifers were aggregated separately. Because water from the aquifers may be used, the groundwater ingestion pathway is included in the risk assessment as a complete exposure pathway. In the future use scenarios (employees and residents), 100 percent of the water consumed by an individual is assumed to be from either the alluvial aquifer or the bedrock aquifer. The arithmetic mean and UL95 concentration values from the statistical analysis of the data are utilized as the chemical concentration in water for the future employee average exposure and the RME for the future employee, respectively. The exposure point concentrations are presented in Appendix E.

Chemical contaminants which may be migrating from MISS are estimated based on the modeling and testing in support of the Toxicity Characteristic Leaching Procedure (TCLP) by EPA (*Federal Register*, Vol. 55, March 29, 1990 and Vol. 45, May 19, 1980). First, the groundwater migration velocities are calculated, (0.5 ft/yr to 153 ft/yr for the alluvial aquifer and from 0.5 ft/yr

to 1500 ft/yr for the bedrock aquifer). Therefore, it is conservative to assume the contaminants have arrived at the residential properties and reached a steady state. Second, the dilution attenuation factor (DAF) of 100 for every 500 feet down gradient away from MISS is used to calculate the concentrations downstream of the contamination source. The results are presented for both arithmetic mean and RME concentration values. The details can be found in Appendix E.

3.4.2.2 Inhalation of Contaminants from Groundwater

*Radiological Data*

Rn-222 and Rn-220 are the only radionuclides with the potential to be volatilized from water at this site. Because of the low concentrations of Ra-226 and Th-232 in groundwater, the Rn-222 and Rn-220 volatilization and contributions to indoor concentrations are projected to be negligible.

Ra-226 (but no Rn-222) concentrations were measured in groundwater. Although no generally accepted correlation exists between dissolved Ra-226 and Rn-222 levels in groundwater, a nationwide survey comparing levels of dissolved Ra-226 and Rn-222 indicates that the radon concentration in groundwater at the Maywood site could be approximately 110 times higher than the Ra-226 concentration (Longtin 1988). Thus, a ratio of 110:1 was used to estimate the concentration of Rn-222 in groundwater from measured Ra-226 concentrations.

The contribution to indoor radon levels associated with groundwater usage was estimated as follows. The concentration of Ra-226 in groundwater was multiplied by 110 to obtain the Rn-222 concentration in groundwater. The resulting radon concentration in household air was obtained using a transfer coefficient of $1 \times 10^{-4}$, relating the radon concentration in air (pCi/L of air) to that in water (pCi/L of water) (Cross et al. 1985). The results of these calculations indicate that the contributions from groundwater to radon in household air are less than 1 percent of the contribution from soil. This is consistent with results reported by others, noting the relatively small contribution water sources generally have to indoor radon levels (Cothern et al. 1986). Therefore, this source of radon was not further evaluated in this assessment.

*Chemical Data*

Inhalation of chemicals that have volatilized from groundwater may occur where there is domestic use of contaminated water such as showering. However, this was not considered a major exposure pathway in this assessment.

### 3.4.3 Surface Water and Sediments

#### 3.4.3.1 Radiological Data

Westerly Brook travels through MISS in an underground conduit where it receives site drainage. The brook surfaces downstream in a residential area before flowing into the Saddle River. There is limited accessible surface water at this site. The two creeks do not significantly recharge the groundwater system. They are mostly contained in culverts, do not enter a drinking water source, and do not impact aquatic food supply.

Radionuclide concentrations in surface water were found to be only marginally above background. The radionuclide concentrations in the small amounts of sediments present are similar to or less than in the surface soils. Thus, they are included in the assessment of impact of surface soils.

#### 3.4.3.2 Chemical Data

Two downstream surface water and sediment sampling locations exist along Westerly Brook in the residential area in Rochelle Park. Because there is a possibility that children may wade and play in the accessible portion of Westerly Brook, the inadvertent ingestion exposure pathway is included in the BRA. Surface water contaminant concentrations are utilized as the exposure point concentrations for inadvertent ingestion of COCs by children while wading and splashing in the stream. There were no chemical COCs for sediments after screening; therefore, dose and intake were not estimated. These exposure point concentrations are presented in Appendix E.

## 3.5 ESTIMATION OF CONTAMINANT DOSE AND INTAKE

The estimates of contaminant dose and intake are based on the COCs information presented in Section 2, the exposure point concentrations discussed in Section 3.4, the assumptions given in Appendix D, and chemical intake calculation methodology presented in RAGS (EPA 1989b).

*Radiological Dose*

Dose conversion factors assumed in the RESRAD modeling are presented in Appendix D. Total radiation exposures for each location, scenario, and receptor are presented in Table 3-6. The

# Table 3-6. Total Exposure Dose Summary

| CURRENT USE SCENARIO (mrem/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|
| LOCATION | PROPERTY UNIT | Employee | | Resident | | Transient | |
| | | Mean | RME | Mean | RME | Mean | RME |
| RESIDENTIAL | UNIT 1 | | | 51 | 246 | | |
| | UNIT 2 | | | 6 | 12 | | |
| STEPAN | UNIT 3 | 21 | 43 | | | 0.04 | 5 |
| | UNIT 3H | 53 | 78 | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | 0.3 | 5 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 9 | 15 | | | | |
| | UNIT 6 (MISS) | 114 | 142 | | | 3 | 24 |
| | UNIT 6H | 171 | 207 | | | 16 | 189 |
| | UNIT 6B (BALLOD) | | | | | 2 | 10 |
| | UNIT 7 | 9 | 30 | | | | |
| | UNIT 7H | 141 | 281 | | | | |
| | UNIT 8 | | | | | 3 | 18 |
| FUTURE USE SCENARIO (mrem/yr) | | | | | | | |
| LOCATION | PROPERTY UNIT | Employee | | Resident | | Transient | |
| | | Mean | RME | Mean | RME | Mean | RME |
| RESIDENTIAL | UNIT 1 | | | 51 | 246 | | |
| | UNIT 2 | | | 6 | 12 | | |
| STEPAN | UNIT 3 | 21 | 43 | | | | |
| | UNIT 3H | 55 | 85 | | | | |
| MUNICIPAL PARKS | UNIT4 | | | 32 | 54 | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | 30 | 43 | | |
| | UNIT 6 (MISS) | 116 | 146 | | | 3 | 24 |
| | UNIT 6H | 210 | 331 | | | 17 | 191 |
| | UNIT 6B (BALLOD) | | | 1060 | 2799 | | |
| | UNIT 7 | | | 45 | 123 | | |
| | UNIT 7H | | | 499 | 859 | | |
| | UNIT 8 | 193 | 475 | | | | |

RME = Reasonable Maximum Exposure

more voluminous tabulation of incremental contributions to each total dose from each relevant pathway (i.e., via soil ingestion, water ingestion, particulate inhalation, direct radiation, and radon inhalation) are presented in Appendix C.

Two point estimates are presented for radiation doses within each scenario as recommended by recent EPA guidance (EPA 1992d). The mean dose estimate represents the dose received by the hypothetical receptor, assuming mean values from the distributions of each exposure parameter. The RME assumes that the value for one or two most sensitive parameters within each pathway are the RME levels ($UL_{95}$) of the distribution for that parameter. A listing of the values and the sources for the average and RME parameters is given in Appendix C.

The radiation doses were estimated for current and future use scenarios using the RESRAD computer code (Version 4.6) for the following pathways:

- inhalation of radioactively contaminated particles;
- ingestion, including both direct incidental ingestion of soil and ingestion of contaminated locally grown produce; the milk and meat pathways were not included since their production does not occur in the area;
- drinking water ingestion (future residential groundwater usage was assumed to be 100 percent of total drinking water); and
- direct external exposure.

Measured Rn-222 concentrations were used, where available, to estimate dose. When no data were available, radon doses were estimated using UNSCEAR (1988) methodology for indoor exposure and OSWER Directive 9285.7-01B (EPA 1991c) emanation factors for outdoor exposure. The aquatic biota pathway was not included since it is not a significant contributor in the area; it was analyzed only to verify that it was not significant for any of the property units.

All of the above-listed pathways were considered for residential receptors. For employee scenarios, the ingestion of drinking water and homegrown produce was not considered. The transient scenario does not consider the ingestion of local produce and drinking water from the site and includes a reduced occupancy on the property (52 and 520 hours/year). The transient user scenario is also considered to represent a reasonable range of exposure for employees working outdoors at commercial/government property units. The DOE-owned MISS site is treated as a standard commercial site, although DOE may elect to use much more stringent control of activities at this location.

*Chemical Intake*

Chemical intake estimates are based on EPA methodology presented in RAGS (EPA 1989b) and OSWER directive 9285.6-03 (EPA 1991b). Estimated chemical-specific intakes for each primary exposure pathway being quantitatively evaluated in this BRA are presented in Appendix E.

The pathways quantitatively evaluated are those that are expected to be representative of the reasonable maximum Maywood chemical risk exposure based on evaluation of the available data, sample locations, sample frequency, and chemical contaminants screening.

Soil ingestion intakes were calculated for the current and future employee and transient at MISS and Stepan. Intakes also were calculated for inhalation of soil particulates by the current and future employee and transient at MISS and Stepan. Groundwater intakes were estimated only for future employees, and surface water and sediment intakes were estimated for the future offsite resident (child) at Westerly Brook.

Point estimates are presented for chemical intake estimates in Appendix E as recommended by recent EPA guidance (EPA 1992d). The mean dose estimate represents the most likely dose received by the hypothetical receptor, assuming mean values from the distributions of each exposure parameter. The RME assumes that the value for one or two most sensitive parameters within each pathway are the RME levels (UL95) of the distribution for that parameter. A listing of the values and the sources for the average and RME parameters is given in Appendix C.

The variables utilized in intake estimate calculations are presented with the intake calculation discussion which follows.

### 3.5.1 Scenario-Specific Assumptions and Intake Parameters

The assumptions used to estimate radiological and chemical intakes for the receptors described in Section 3.3 are discussed in Sections 3.5.1.1 through 3.5.1.3 and Appendix D. Values assumed for scenario parameters, and the guidance they are based on, are presented in Table D-1.

#### 3.5.1.1 Exposure Time, Exposure Frequency, and Exposure Duration

Exposure time, frequency, and duration determine the total time a receptor is exposed to the contaminant source. Exposure time is the number of hours per day that a receptor is present at a

specific exposure point. Exposure frequency is the number of days per year that the exposure occurs, and exposure duration is the total number of years over which exposure occurs.

Two categories of employees are assumed: those who work at properties where there are buildings and, therefore, receive indoor exposure and those who work at properties where there are no buildings. Employee occupancy in the latter category is assumed to be represented by the transient user scenario, depending on employment conditions.

For the current employee at MISS, Stepan, and the commercial properties, it is assumed that 1.75 hours per day are spent outdoors onsite (ET=1.75). An 8-hour workday is assumed with 1.75 hours including lunch, outside breaks and travel time to and from the building. The employee is assumed to work onsite 250 days a year (EF) for 25 years (ED) in the RME and for 7 years (ED) in the average exposure (EPA 1989b). Seven years is utilized as the average time spent at one job based on the ratio of 30 years at one residence as the RME and a 50th percentile of nine years at one residence as the average (EPA 1989b). No indoor chemical exposure is considered for the employee risk. The transient is assumed to travel across the property 10 hours per week for 350 days per year (Table D-1) for 30 years under RME and for 1 hour per week for 9 years on the average (residential values utilized from EPA 1989b).

The current and future resident scenarios assumed an exposure frequency of 350 days per year (EPA 1991b). The average indoor exposure time assumed was 16.4 hours per day, based on the average adult spending 115 hours per week indoors (EPA 1990).

Residential drinking water intake estimates utilize a 350 d/yr exposure frequency for an exposure duration of 30 years (RME) and 9 years (average) (EPA 1989b).

Surface water ingestion intake estimates for future residents assume an exposure frequency of 7 events (days) per year, 1 hour per event (EPA 1989b). Because the child receptor is examined in the wading scenario at Westerly Brook, a 6 year exposure duration is assumed (EPA 1989b).

### 3.5.1.2 Inhalation

An inhalation rate of 5,500 $m^3$/yr (15 $m^3$/d), which is based on the average inhalation rate over an entire day (including periods of rest and light, moderate, and heavy activity) was used in this BRA for assessment of current and future resident scenarios (EPA 1991b). An inhalation rate of

20 $m^3$ per 8-hour workday was used for assessment of current and future employee scenarios (EPA 1991b).

The inhalation rate for the transient scenario was adjusted to account for greater activity and higher inhalation rates while working outdoors. An inhalation rate of 1.0 $m^3$/h was used; this rate is based on a combination of light and moderate activity and age-adjusted inhalation rates (EPA 1989a).

3.5.1.3 Ingestion Rates

Incidental soil ingestion rates are based on recent EPA guidance (EPA 1991b). For residential scenarios, a RME soil ingestion rate of 200 mg/d is assumed for children 1-6 years of age and 100 mg/d for other ages. The average and RME soil ingestion rates recommended for employees working primarily indoors are 30 mg/d and 50 mg/d, respectively and are adjusted based on occupancy (EPA 1991b). These rates were used in this BRA for employees at Maywood and the commercial/government properties.

The average adult resident is assumed to eat 28 kg/yr of site-grown produce and the average child resident 17.5 kg/yr. The RME ingestion rate for the calculation of radiological contaminant intake from homegrown produce for the future resident adult and child scenarios was 28 kg/yr from residential gardens (EPA 1991b). Only vegetable intake is assessed because significant fruit production is unlikely in an urban setting. Also, fruits generally take up lower amounts of radionuclides and heavy metals (EPA 1991b).

A drinking water ingestion rate of 2 L/d was assumed for the RME and 1.4 L/d for the mean exposure (EPA 1991b); this pathway was assessed for the future resident and future employee scenarios (i.e., EF = 350 d/yr and 250 d/yr, respectively). One-hundred percent of drinking water was assumed to come from site groundwater.

The surface water ingestion rate utilized for chemical intake estimates for the future child wading scenario is 0.05 L/h (incidental ingestion rate while swimming).

#### 3.5.1.4 Body Weight

The standard assumption for adult body weight is 70 kg (155 lb) (EPA 1989a and ICRP 1977). A body weight of 70 kg is, therefore, used for all employee scenarios, for the adult transient, and for that portion of the future resident scenarios for which an adult was assessed. A body weight of 15 kg (33 lb) was assumed for child recreational and residential scenarios (EPA 1989b).

### 3.5.2 Exposure Calculation Equations for Soil and Home Grown Produce

#### 3.5.2.1 Radiological Dose From Soil Ingestion

Doses associated with the intake of radioactive contaminants resulting from incidental ingestion of surface soil were calculated using RESRAD (Gilbert, et al. 1989) as follows:

$$D_i = C_{soil,i} \times IR_S \times EF \times DCF_i \times CF_m$$

where:

$D_i$ = dose from radionuclide i (mrem)

$C_{soil,i}$ = soil concentration of radionuclide i (pCi/g) (arithmetic mean for average exposure and $UL_{95}$ for RME)

$IR_S$ = soil ingestion rate (mg/d) (EPA 1991b)

EF = exposure frequency (d/yr)

$DCF_i$ = ingestion dose conversion factor for radionuclide i (mrem/pCi)

$CF_m$ = conversion factor, $10^{-3}$ g/mg.

3.5.2.2 Chemical Intake Due To Soil Ingestion

The equation used to calculate chemical intake for soil ingestion was obtained from RAGS (EPA 1989b) as follows:

$$\text{Intake (mg/kg-d)} = \frac{C_S \times IR_S \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

$C_S$ = chemical concentration in soil (mg/kg) (chemical-specific arithmetic mean for average exposure and UL95 for RME)

$IR_S$ = soil ingestion rate (mg soil/d) as recommended by EPA (1991b)

CF = conversion factor ($10^{-6}$ kg/mg)

FI = fraction ingested from contaminated source (unitless): assuming that all of the ingested soil is from the contaminated source area for each scenario; therefore, FI = 1

EF = exposure frequency (d/yr): receptor/scenario-specific time spent outdoors (Table D-1)

ED = exposure duration (yr): receptor/scenario-specific (Table D-1)

BW = body weight (kg)

AT = averaging time (days): the period for which exposure is averaged, AT is a pathway specific period of exposure for noncarcinogenic effects (i.e., ED X 365 d/yr) and a 70 year lifetime for carcinogenic effects (i.e., 70 yr x 365 d/yr = 25,550 d).

Intake estimates for soil ingestion of chemical COCs are presented in Appendix E.

### 3.5.2.3 Ingestion of Home Grown Produce

*Radiological Dose*

The RESRAD code was used to calculate the radiological dose from ingestion of homegrown produce. The dose calculation is detailed in Gilbert et al. (1989) and summarized as follows:

$$D_i = C_{plant,i} \times IR_p \times EF \times DCF_i \times CF_m$$

where:

$D_i$ = dose from radionuclide i (mrem)

$C_{plant,i}$ = concentration of radionuclide i in homegrown produce (pCi/g) (Section 3.4.1.5)

$IR_p$ = plant ingestion rate (kg/d) (EPA 1991b)

$CF_m$ = conversion factor (1,000 g/kg)

EF = exposure frequency (d/yr)

$DCF_i$ = ingestion dose conversion factor for radionuclide i (mrem/pCi).

The estimated doses from ingestion of homegrown produce are included in the plant ingestion pathway for the residential receptor and presented in Appendix C.

*Chemical Intake*

As discussed in Section 3.3.1.5, chemical intake via ingestion of homegrown produce was not evaluated quantitatively because reliable uptake factors for the chemical COCs were not available.

### 3.5.3 Equations for Exposure to Water

3.5.3.1 Groundwater Ingestion

*Radiological Dose*

Radionuclide doses from ingestion of groundwater by future residents were calculated on the basis of exposure point concentrations in groundwater resulting from leaching from contaminated soils as predicted using RESRAD (Section 3.4.2.1). Scenario-specific assumptions on exposure time, exposure frequency, and exposure duration, and the assumed ingestion rates are given in Section 3.5.1.

The doses associated with intake of radioactive contaminants resulting from ingestion of groundwater were calculated using RESRAD as follows:

$$D_i = C_{gw,i} \times IR_w \times EF \times DCF_i$$

where:

$D_i$ = dose from radionuclide i (mrem)

$C_{gw,i}$ = concentration of radionuclide i in water (pCi/L) (based on maximum level in groundwater for each property)

$IR_w$ = water ingestion rate (L/d)

EF = exposure frequency (d/yr)

$DCF_i$ = ingestion dose conversion factor for radionuclide i (mrem/pCi) .

Estimated doses from ingestion of radioactive contaminants in groundwater are presented in Appendix C.

*Chemical Intake*

The following equation was obtained from RAGS for the calculation of chemical intake from residential ingestion of groundwater utilized as a drinking water source (EPA 1989b). One

hundred percent of the total drinking water ingested is considered to be from either the alluvial or the bedrock aquifer in the future resident groundwater ingestion pathway. The equation is represented as follows:

$$\text{Intake (mg/kg-d)} = \frac{C_{gw} \times IR_{gw} \times EF \times ED}{BW \times AT}$$

where:

$C_{gw}$ = chemical concentration in groundwater (mg/L) (arithmetic mean utilized as average exposure, and UL95 utilized as RME); at residential area, the value will be the concentration at MISS divided by a dilution factor of 100 for every 500 feet away from MISS.

$IR_{gw}$ = EPA recommended water ingestion rate (L/d) (Table D-1)

EF = exposure frequency (d/yr) (350d/yr), (Table D-1)

ED = exposure duration (yr) (Table D-1)

BW = body weight (kg) (Table D-1)

AT = averaging time (period over which exposure is average) AT is pathway-specific for noncarcinogenic effects (i.e., ED x 365 d/yr), and 70-year lifetime for carcinogenic effects (i.e., 70 yr x 365d/yr = 25,550d).

Intake estimates for soil ingestion of chemical COCs are in Appendix E.

3.5.3.2 Inhalation of Contaminants from Groundwater

As discussed in Section 3.4.2.2, volatilization and subsequent inhalation of radon and volatile chemicals from domestic water use (e.g., showering) were determined to be negligible contributors to exposure at the Maywood site.

3.5.3.3 Ingestion of Contaminants from Surface Water and Sediment

*Radiological Dose*

As discussed in Section 3.4.3 and Section 2, no radionuclides were identified as COCs for surface water.

*Chemical Intake*

The following equation was obtained from RAGS (EPA 1989b) for ingestion of surface water while swimming. This equation is utilized for the estimated chemical intake calculations for the future child resident and recreational user playing and wading in the accessible downstream reach of Westerly Brook.

$$\text{Intake (mg/kg-day)} = \frac{C_{sw} \times CR \times ET \times EF \times ED}{BW \times AT}$$

$C_{SW}$ = chemical concentration in water (mg/L) (mean concentration for average exposure and $UL_{95}$ for RME)

CR = EPA recommended contact rate (L/h) (Table D-1)

ET = exposure time (h/event) 1 h/event (EPA 1989b)

EF = exposure frequency (events/yr) 7 d/yr (EPA 1989b)

ED = exposure duration (years) 6 years for child (EPA 1989b)

BW = body weight (kg) (Table D-1)

AT = average time (days): a pathway-specific period over which exposure is averaged for noncarcinogenic effects (i.e. ED x 365 days/yr or 6 yr x 265 d/yr = 2190 d) and for noncarcinogenic effects a 70 year lifetime (i.e., 70 yr x 365 days/yr = 25,550 days).

The contaminant intake calculation for ingestion of sediment during the surface water scenario is the same as the equation for soil as recommended by EPA (EPA 1989b). It is as follows:

$$\text{Intake (mg/kg-day)} = \frac{C_{sed} \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

$C_{sed}$ = chemical concentration in sediment (mg/kg) (chemical-specific arithmetic mean for average exposure and $UL_{95}$ for RME)

IR = child soil ingestion rate (mg/day) (Table D-1)

CF = conversion factor ($10^{-6}$ kg/mg)

FI = fraction ingested from contaminated source (unitless). It is assumed all of the ingested sediment are from the contaminated stream sediment source; therefore, FI=1

EF = exposure frequency d/yr receptor/scenario-specific time spent wading/playing in brook

ED = exposure duration (yr) 6 years for child (EPA 1989b)

BW = body weight (kg) (Table D-1)

AT = average time (days): a pathway specific period over which exposure is averaged for noncarcinogenic effects (i.e., ED x 365 d/yr) and for carcinogenic effects a 70 year lifetime for carcinogenic effects (i.e., 70 yr x 365 d/yr = 25,550 days).

### 3.5.4 Equations for Exposure to Air

3.5.4.1 Inhalation of Radon

The doses resulting from inhalation of Rn-222 and its short-lived decay products were based on the exposure point concentrations in both indoor and outdoor air (Section 3.4.1.3), using the following method:

$$E_{Rn} = E_{RnI} + E_{RnO}$$

$$E_{RnI} = C_{Rn\text{-}I} \times ECF_{CI} \times \frac{1WL}{100\ pCi/l} \times RT_I \times 12\ months/yr \times NWCF$$

$$E_{RnO} = X_{Rn\text{-}0} \times ECF_0 \times \frac{1WL}{100\ pCi/l} \times RT_O \times 12\ months/yr \times NWCF$$

where

$E_{Rn}$ = radon exposure in working level months (WLM)

$E_{RnI}$ & $E_{RnO}$ = exposure for indoor and outdoor exposure, respectively (WLM)

$C_{Rn\text{-}I}$ & $C_{Rn\text{-}0}$ = radon concentration for indoor and outdoor, respectively (pCi/L)

$ECF_I$ & $ECF_0$ = equilibrium factors for indoor and outdoor air (.45 and .1, respectively)

$RT_I$ & $RT_O$ = fraction of the year spent indoors and outdoors at the location, respectively

NWCF = correction factor to WLM. (A WLM is defined in terms of 170 hours of exposure per month. The average month contains 730 hours, yielding a correction factor of 4.3)

WL = working level

These doses are not true radiation doses but are actually exposures expressed in WLM. The WLM unit was used because the risk of inhalation of radon decay products is typically expressed

in this unit (1 WLM is approximately equivalent to 1,000 mrem [ICRP 1985]). The estimated doses associated with the inhalation of Rn-222 decay products are presented in Appendix C.

3.5.4.2 Inhalation of Particulates

*Radiological Dose*

Radiation dose estimates and chemical intakes for the inhalation pathway were calculated using the exposure point concentrations in air discussed in Section 3.4.1.4. Dust concentrations for indoor exposure were assumed to be 40 percent of those outdoors (Alzona et al. 1979).

The RESRAD code was used to calculate the radiological dose from the inhalation of airborne radioactive particulates. The dose calculation is detailed in Gilbert et al. (1989) and summarized as follows:

$$D_i = C_{air,i} \times FA \times EF \times IR \times DCF_i \times CF_T$$

where:

$D_i$ = dose from radionuclide i (mrem)

$C_{air,i}$ = air concentration of radionuclide i ($pCi/m^3$), which is based on the soil concentration (Section 3.4.1.4)

FA = area factor, dimensionless (represents the fraction of airborne dust that is contaminated)

$CF_T$ = conversion factor (24 h/d)

EF = exposure frequency (d/yr)

IR = inhalation rate ($m^3/h$)

$DCF_i$ = inhalation dose conversion factor for radionuclide i (mrem/pCi)

The estimated doses for the identified receptors resulting from the inhalation of airborne radioactive particulates are presented in Appendix C.

*Chemical Intake*

The following equation was obtained from RAGS for the calculation of chemical intake from inhalation of airborne particulates (EPA 1989b). All exposure is assumed to occur outdoors. The OSWER guidance addresses adult exposure only for 30 years; this exposure duration is not modified as in intake estimates for soil ingestion (EPA 1991b).

$$\text{Intake (mg/kg-d)} = \frac{C_{air} \times IR_a \times ET \times EF \times ED}{BW \times AT}$$

where:

$C_{air}$ = contaminant concentration in air ($mg/m^3$) (Section 3.4.1.4)

$IR_a$ = inhalation rate ($m^3/d$) (Table D-1)

ET = exposure time (h/d) (receptor-specific time spent outdoors; Table D-1)

EF = exposure frequency (d/yr): receptor-specific (Table D-1)

ED = exposure duration (yr): receptor-specific (Table D-1)

BW = body weight (kg) (Table D-1)

AT = averaging time (period over which exposure is average days), pathway-specific for noncarcinogens (i.e., ED x 365 d/yr) and a 70-year lifetime for carcinogenic effects (70 yr x 365 d/yr = 25,550d)

Estimates of inhalation intakes for chemical COCs are presented in Appendix E.

### 3.5.5 Summary of Radiological Exposure Estimates

#### 3.5.5.1 Maximally Exposed Individuals

Total annual radiological dose estimates for the Maywood property units are given in Table 3-6. In compiling these dose tables, contributions were calculated for soil ingestion, water

ingestion, inhalation of particulates, and direct radiation. The contribution from inhalation of radon was calculated separately and added to the total of other doses to obtain the total dose. These incremental dose components are provided in Appendix C. The annual doses for the Maywood property units also are presented in coded maps for all scenarios and receptors in Figures 3-10, 3-11a, 3-11, and 3-11a.

The graphical presentation of total dose for the Maywood properties includes five ranges: <10 mrem/yr, 10-25 mrem/yr, 25-100 mrem/yr, 100-500 mrem/yr, and >500 mrem/yr. The 10 mrem/yr threshold is selected to provide an order of magnitude reduction of the primary public dose limit of 100 mrem/yr to account for potential multiple exposures. A 10 mrem/yr limit is also imposed by the EPA NESHAPs for doses from airborne radioactive material and is the threshold for reporting per DOE Order 5400.5. The 25 mrem/yr breakpoint is specified in 40 CFR 192.41(d) for maximum whole body dose to the public from thorium ore processing operations. The 100 mrem/yr limit is the primary DOE dose limit to the public from all sources of radiation, as described in DOE Order 5400.5, Chapter II. The 500 mrem/yr upper breakpoint is the maximum annual dose limit to the public (for a single year only) allowed by DOE Order 5400.5.

The significance of the exposure estimates must be kept in perspective. The modeling procedures on which the estimates are based are extremely conservative and tend to overestimate exposure.

### 3.5.5.2 Average Population Dose

The population dose from the airborne dispersion of radioactive particulates to a radial distance of 80 km (50 mi) was estimated using MICROAIRDOS. The average dose, for the estimated population of 10 million people in the area considered, is 14,000 person-rem, or 1.4 mrem/yr per person, which is considered insignificant in comparison to the natural background level.

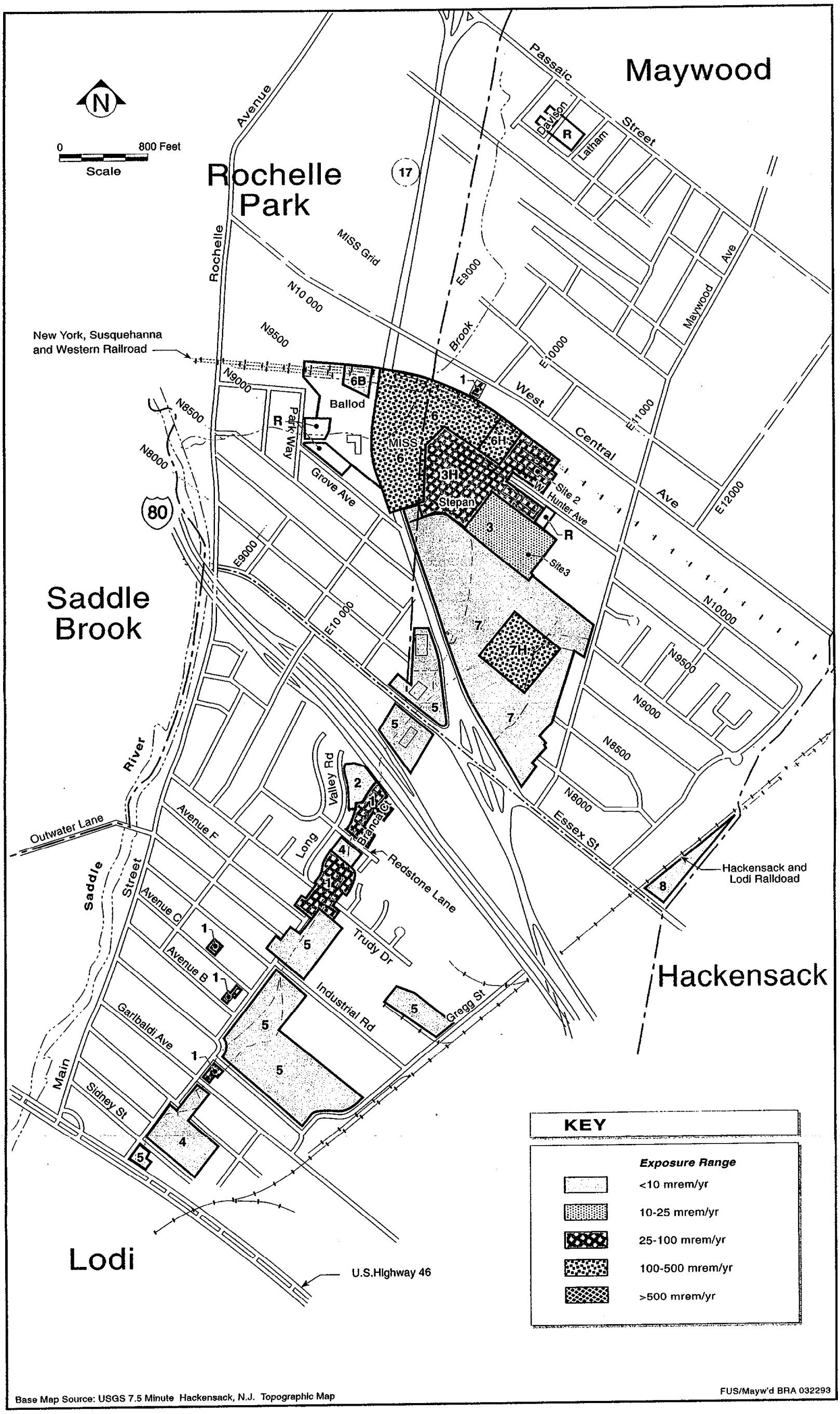



**Figure 3-10. Annual Radiological Exposure in the Current Use Scenario (Mean)**

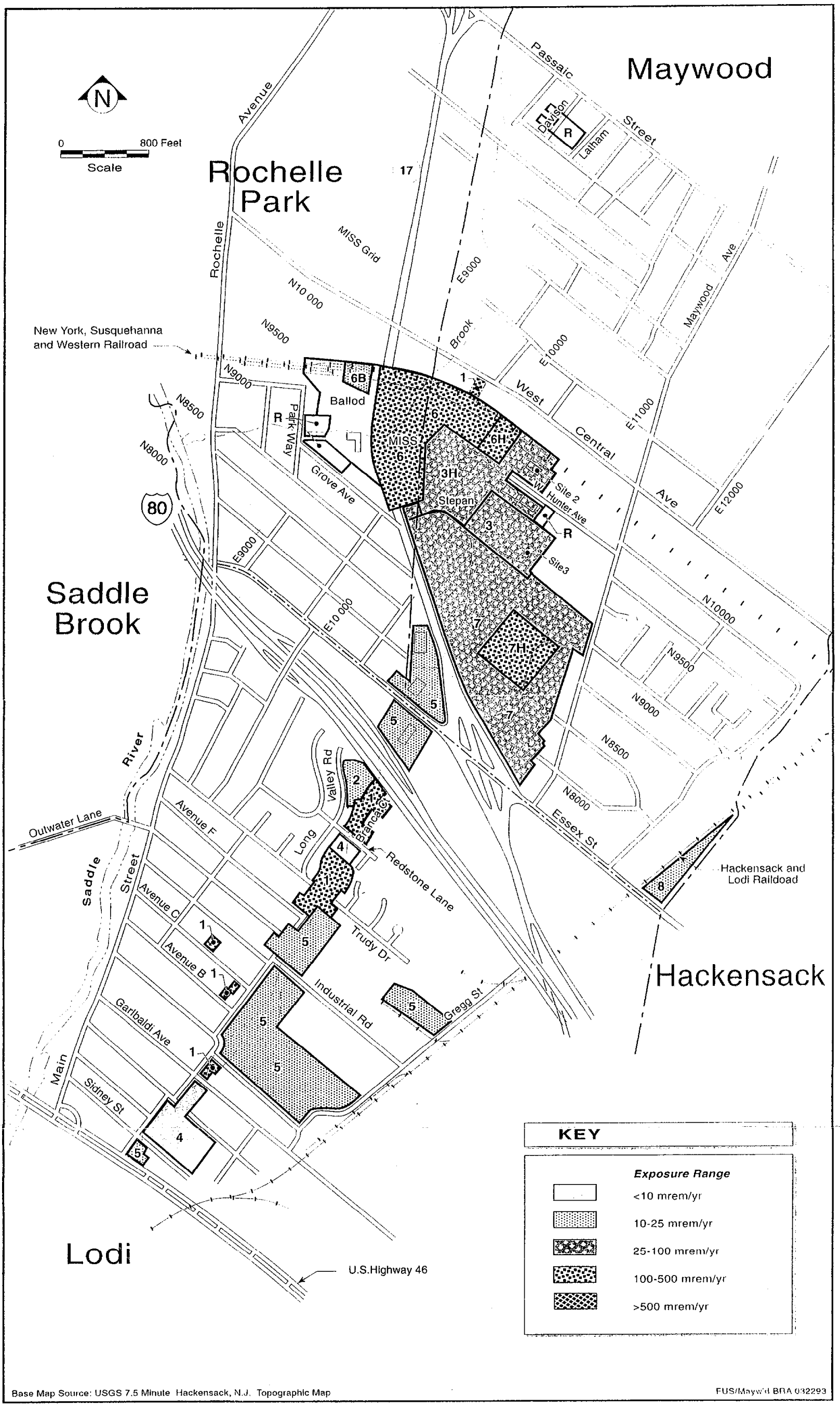



**Figure 3-10a. Annual Radiological Exposure in the Current Use Scenario (RME)**

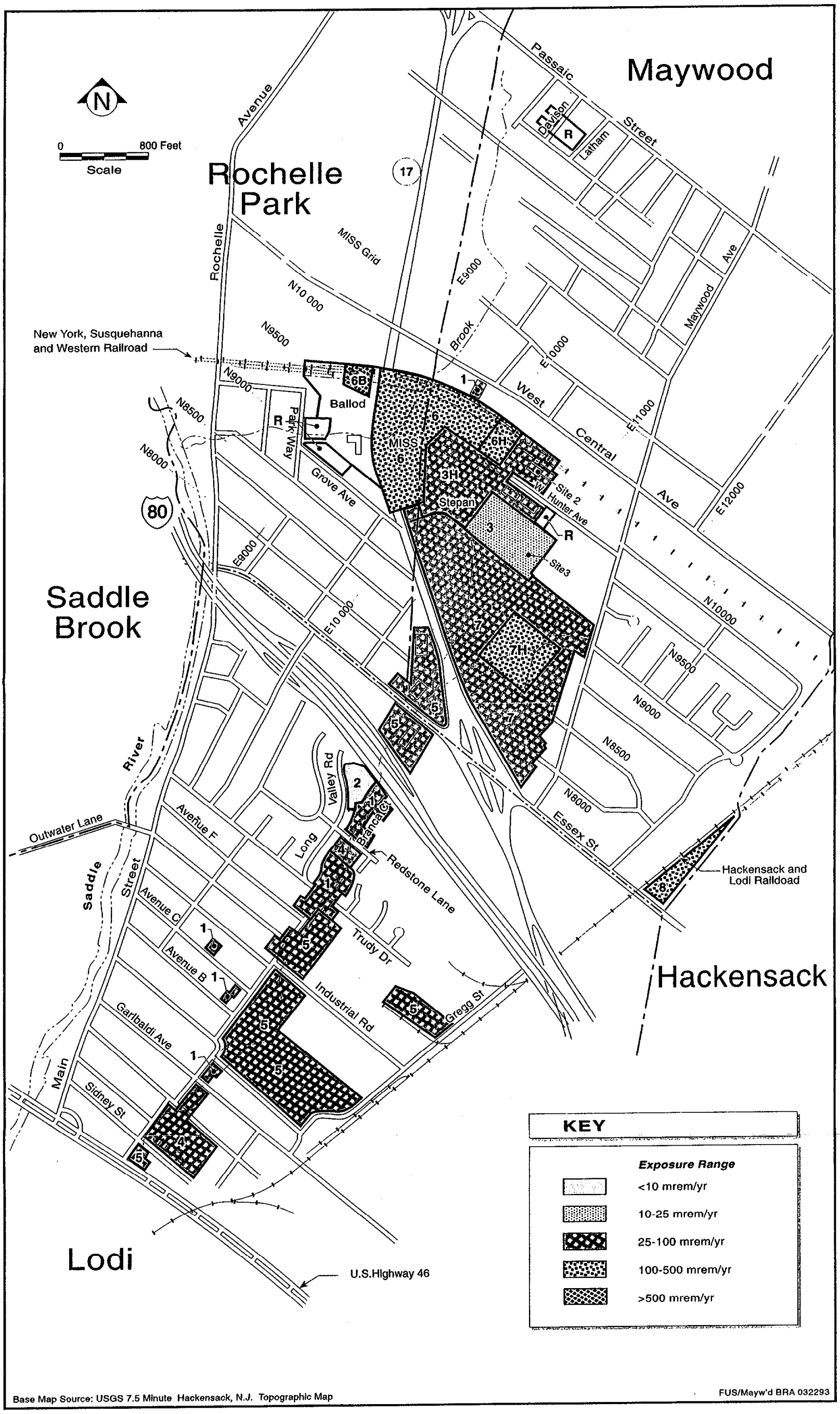



**Figure 3-11. Annual Radiological Exposure in the Future Use Scenario (Mean)**

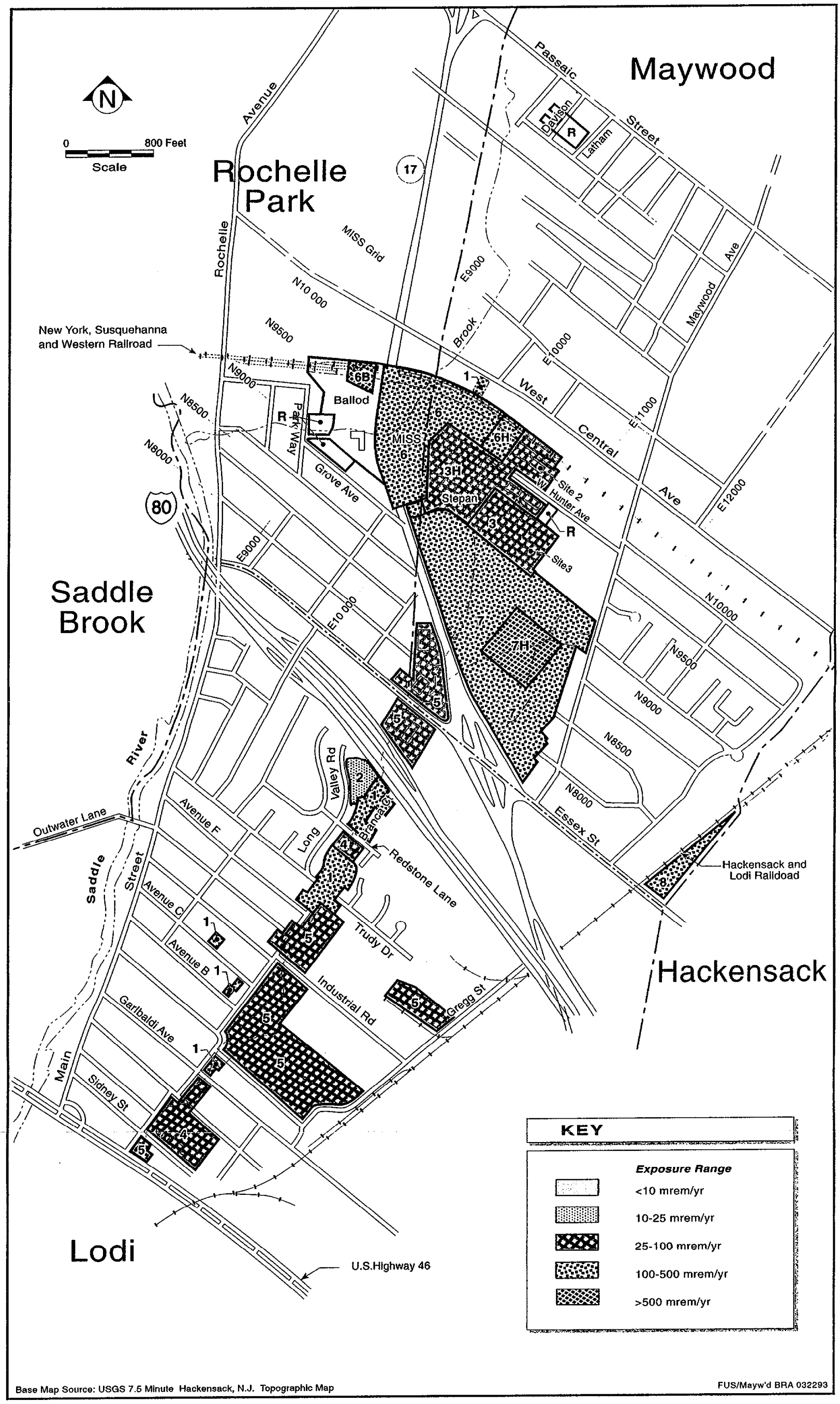



**Figure 3-11a. Annual Radiological Exposure in the Future Use Scenario (RME)**

### 3.5.6 Summary of Chemical Intake Estimates

Estimated intakes or chemical COCs are summarized in Appendix E. Estimated intakes for incidental soil ingestion were calculated for the current employee and transient at MISS and the Stepan property. Average exposure intakes and RME intakes were calculated utilizing arithmetic mean soil concentrations and UL95 soil concentrations, respectively, as the exposure point concentrations. Surface soil statistical data were utilized as the exposure point concentration for all scenarios. All current scenarios assumed an adult receptor.

Inhalation intakes included the assumptions for airborne contaminated particulate dust concentrations discussed in Section 3.4.1.4. Intakes were calculated for average exposure and the RME for the current and future employee and transient at MISS and the Stepan property.

Average and RME groundwater intakes were estimated for the future employee or resident utilizing the combined groundwater data from MISS, Stepan, and Ballod, for the alluvial and the bedrock aquifers separately. It was assumed that 100 percent of the total water intake is derived from the contaminated source.

Average and RME surface water intake was estimated for the future child resident wading and playing in Westerly Brook. A 50 mL/event contact rate was assumed, which is conservative because it is EPA's recommended contact rate for surface water ingestion while swimming.

# 4. TOXICITY ASSESSMENT

This section briefly summarizes the effects of ionizing radiation and chemicals on exposed populations. Methods used to evaluate toxicity are discussed.

## 4.1 RADIATION TOXICITY

The potential health effects associated with exposure to radionuclides at the Maywood site are due to low-level ionizing alpha, beta, and gamma radiation emitted by the members of the Th-232, U-238, and U-235 decay series (see Figures 2-1 through 2-3). Primarily, effects include an increase in the occurrence of cancer in irradiated individuals and possible genetic effects that may occur in future generations. The risk of serious genetic effects is much lower than the risk of cancer induction (EPA 1989a). Therefore, genetic effects are not the focus of this toxicity assessment, and radiological risks are evaluated only with respect to incremental cancer probabilities per EPA guidance (EPA 1989a). Non-radiological health effects of uranium are considered as appropriate in the chemical toxicity section.

Radiation-induced health effects for humans have been confirmed only at relatively high doses or high dose rates with large populations. For low doses, health effects are presumed to occur but can only be estimated statistically. Risk estimates are strictly applicable only to large populations, because the appearance of health effects after an exposure is a chance event. Predicting health effects with certainty for small populations (e.g., one person) is not possible. For purposes of radiological impact assessment, the health effects are measured by cancer incidence in the exposed population. However, risk estimates in the low-dose range are uncertain because of extrapolation from high doses and because of assumptions made on dose-effect relationships and the underlying mechanisms of carcinogenesis. Radiation effects in the exposed population cannot be readily identified since radiogenic cancers are indistinguishable from those occurring as a result of other factors. Studies of populations chronically exposed to low-level radiation, such as those residing in regions of elevated natural background, have not shown consistent evidence of an associated increase in the risk of cancer.

The exposure routes can be separated into either external or internal exposure. External exposure occurs when the radioactive material is outside the body. Internal exposure occurs when the radioactive material enters the body by routes such as inhalation or ingestion. Inhaled material can be exhaled, expelled from the lungs to be spit or swallowed and excreted, deposited in the lungs, or absorbed by the blood and relocated to systemic organs where it may be excreted over

time. Some ingested material enters the blood and is either excreted in the urine or feces or relocated to other organs and excreted over time; most insoluble ingested material is not absorbed into the blood but is excreted directly in the feces.

During the radioactive decay processes in the thorium, uranium, and actinium series, alpha, beta, and gamma radiations are released. Each type of radiation differs in its physical properties and in its ability to induce damage to biological tissue. The BEIR IV report (NRC 1988) addresses the risk from radon and alpha radiations. Alpha particles are a hazard principally when taken into the body because, in external exposure, they are unable to penetrate the dead skin cell layer of the body before reaching living tissue. Within the body, alpha particles are the most effective of the three types of radiation in damaging cells because their energy is completely absorbed by tissue. The BEIR V report (NRC 1990) addresses the risk from low linear energy transfer (LET) radiation such as gamma and beta particles. Beta particles are primarily an internal hazard; however, in cases of external skin exposure, energetic beta particles can penetrate living skin cells, representing an external hazard as well. Beta particles deposit less energy to small volumes of tissue than alpha particles and, therefore, induce much less damage than alpha particles. Gamma radiation is primarily an external hazard because it can penetrate tissue and reach internal organs without being taken into the body.

### 4.1.1 Radiation Toxicity Related to the Maywood Site

Exposure to a high dose of radiation (e.g, a thousand times the average annual background dose rate) during a short period of time (a few hours) produces detrimental effects in all the organs and systems of the body. However, such acute exposures are not credible at the Maywood site. The only possible exposures at Maywood are chronic low-level exposures. Although lethal effects in human populations for chronic low-level exposure have never been documented, the effects have been projected from animal experiments at high doses and dose rates. Studies assessing the difference between acute (short period) and chronic (long term) exposures show that radiation effects decrease dramatically during the period when a given exposure being administered is extended (NRC 1990). Thus for sites like Maywood, where all exposures are longer term and low level, there will be no immediate effects. Rather the statistical impacts of possible increases in cancer or genetic changes are the only credible potential radiation effects (NRC 1990).

The radionuclides that occur at the Maywood site include the Th-232, U-238, and U-235 decay series. The toxicity of the various radionuclides is based on:

- the types and energies of radiation they emit,
- the biological (functional) importance of the organ/tissues being irradiated,
- the radiological sensitivity of the organ/tissue being irradiated, and
- for internal exposures only - metabolic behavior in the body and biological retention characteristics in the body.

These factors were considered by the International Commission on Radiological Protection (ICRP), which established the concept of the committed effective dose equivalent (CEDE) to measure the detriment of exposure to radiation or radioactive materials. The CEDE value is calculated based on the models and criteria established by ICRP (e.g., ICRP 1977 and 1978) to allow quantification of this detriment, using all of the factors discussed above. Thus an estimate of risk from exposure to radiation or radioactive material may be made by determining the CEDE and multiplying by a dose-to-risk (e.g., cancer risk) conversion factor. The radiogenic cancer risk factor has been estimated by the National Academy of Sciences (NAS) in BEIR IV (NRC 1988) and BEIR V (NRC 1990). For detailed discussion of radiation dosimetry and toxicity, the reader is referred to publications of the ICRP (1977, 1978), NAS/NRC (1988, 1990), and UNSCEAR (1988).

### 4.1.2 Methods of Evaluating Radiation Toxicity

For this BRA, a risk factor of $6 \times 10^{-7}$/mrem (EPA 1989d) was used to estimate the likelihood of cancer induction from radiation exposure. EPA used this risk factor to develop revisions to the *National Emission Standards for Hazardous Air Pollutants* (NESHAPs) for radionuclides under Section 112 of the Clean Air Act (EPA 1989d). It is a lifetime average value and believed to be representative of conditions defined for the exposure scenarios at the Maywood site.

The BEIR V study (NRC 1990) also presents a detailed description of current data on the health risks associated with radiation exposure. A mortality risk factor of about $8 \times 10^{-7}$/mrem is estimated in the BEIR V report. However, not all radiation-induced cancers are fatal, i.e., the cancer mortality rate is about 60 percent of the cancer induction rate given on average (EPA 1989d). A cancer induction rate of about $1.3 \times 10^{-6}$/mrem for acute exposures can thus be inferred

from the results presented in the BEIR V study. However, BEIR V estimates were derived primarily from data on acute exposures (a single instantaneous exposure), and the BEIR V report suggests that it is appropriate to reduce this risk by applying a dose rate effectiveness factor of two or more in cases of continuous low-level exposure. Thus, the radiation risk factor of $6 \times 10^{-7}$ per mrem used in this report is consistent with the value recommended in BEIR V.

EPA also has developed guidance for radiological risk assessment that is generally consistent with existing guidance for assessing chemical carcinogenic risks, except that it consists of a two-phase (i.e., dual-endpoint) evaluation (EPA 1989c). For the first phase, radiation doses are calculated for all relevant radionuclides and pathways for the purpose of comparing CEDEs with established radiation protection standards and criteria. For the second phase, carcinogenic risks are calculated for the radionuclides of concern in a manner similar to existing methods for chemical carcinogens by using an age-averaged lifetime excess cancer incidence per unit intake (and per unit external exposure). To support this second evaluation, EPA has developed cancer incidence factors per unit intake that are analogous to the slope factors developed for chemical carcinogens. A preliminary evaluation, presented in Appendix G, indicates that estimates of potential health risk based on this approach would be less conservative than those presented here.

In this BRA, the risk of cancer induction from inhalation of Rn-222 decay products has been estimated by converting Rn-222 exposure (in WLM) to mrem for CEDE. National Commission on Radiation Protection and Measurements (NCRP) report number 92 (NCRP 1987) indicates that 1 WLM is equal to about 14 rem. Weighting this by the 0.12 lung weighting factor (ICRP 1978) results in a CEDE of 1,000 mrem per WLM.

## 4.2 CHEMICAL TOXICITY

### 4.2.1 Chemical Contaminants of Concern for the Maywood Site

Chemical COCs in soil and groundwater at the Maywood site are identified in Section 2 and summarized in Tables 2-4 to 2-15. Toxicological properties of the chemical COCs, including both carcinogenic and noncarcinogenic factors are summarized in Table 4-1. The table briefly describes chemical routes of exposure, critical effects, and carcinogenicity of the chemicals.

### 4.2.2 Methods of Evaluating Chemical Toxicity

Toxicity values used in the risk characterization of Maywood chemicals of concern are also presented in Table 4-1. This table includes supporting toxicological information along with source identifiers. Toxicity values used in risk calculations include the chronic reference dose (RfD) for noncarcinogenic risk and the slope factors (SFs) for the carcinogenic risk.

The chronic RfD is defined as "an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime" (EPA 1989b). If the sum of the ratios of intake to RfD value (i.e., hazard indices) for all contaminants is less than 1, noncarcinogenic toxicity is unlikely. The SF is defined as a "plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime" (EPA 1989b). The SFs multiplied by the estimated lifetime intake levels yield lifetime cancer risk estimates. Both RfD and SF values are specific to the route of exposure (e.g., either ingestion or inhalation exposure).

#### 4.2.2.1 Chemicals For Which EPA Toxicity Values are Available

The EPA Integrated Risk Information System (IRIS) database was used to provide up-to-date toxicity values to use in Maywood risk calculations. When values were not available in IRIS, the 1992 EPA Health Effects Assessment Summary Tables (HEAST) were used (EPA 1992a). A chemical may be under review or re-examination by EPA according to IRIS, and a value still may be obtained from HEAST. When values were not available in IRIS or HEAST, the Superfund Health Risk Technical Support Center-Environmental Criteria and Assessment Office (SHRTSC-ECAO) was contacted. Provisional or interim values were obtained for these COCs if they were available.

EPA RfDs are available for 40 of the chemicals of concern. Oral SFs are available for 29 of the chemicals of concern. Inhalation SFs and reference concentrations (RfCs) are available for only 12 carcinogenic and 7 noncarcinogenic chemicals of concern, respectively. Due to the potential for inaccuracy, derivation/conversion of RfCs to Rfds is not recommended (HEAST) and was not employed in the risk assessment. As noted in Table 4-1, the toxicity values for several chemical contaminants of concern have been withdrawn from IRIS or are currently under review by EPA and are not listed. Toxicity values in HEAST were used in this event, when available. When toxicity values could not be obtained from either IRIS or HEAST, the SHRTSC-ECAO was contacted.

## Table 4-1. Toxicity Values for Chemical Contaminants of Concern: Potential Carcinogenic and Noncarcinogenic Effects

| Contaminants | CAS No. | Weight of Evidence Classification(A) | Slope Factor Oral (mg/kg/day)-1 | Slope Factor Inhalation (mg/kg/day)-1 | Chemical Route | Type of Cancer/Target Organ/Species | Source |
|---|---|---|---|---|---|---|---|
| **CARCINOGENS:** | | | | | | | |
| Organic compounds: | | | | | | | |
| Acenaphthene | 83-32-9 | D | ND | ND | -- | -- | IRIS |
| Acenaphthylene | 208-96-8 | D | ND | ND | -- | -- | IRIS/SHRTSC |
| Anthracene | 120-12-7 | D | ND | ND | -- | -- | IRIS/SHRTSC |
| Benzene | 71-43-2 | A | 0.029 | 0.029 | Oral/Inhalation | Leukemia/Blood/ Humans | IRIS/HEAST |
| Benzo(a)anthracene | 56-55-3 | B2 | 7.3(c) | ND | -- | -- | IRIS/HEAST/SHRTSC |
| Benzo(a)pyrene | 50-32-8 | B2 | 7.3(c) | ND | Oral/Inhalation | Tumor/Forestomach /Mice | IRIS |
| Benzo(b)fluoranthene | 205-99-2 | B2 | 7.3(c) | ND | -- | -- | IRIS |
| Benzo(g,h,i)perylene | 191-24-2 | D | ND | ND | -- | -- | IRIS /SHRTSC |
| Benzo(k)fluoranthene | 207-08-9 | B2 | 7.3(c) | ND | -- | -- | IRIS/SHRTSC |
| Benzoic acid | 65-85-0 | B2 | ND | ND | -- | -- | SHRTSC |
| Bis(2-chloroethyl)ether | 111-44-4 | B2 | 1.1 | ND | Oral | Tumors/Liver/Mouse | HEAST |
| Bis(2-ethylhexyl)phthalate | 117-81-7 | B2 | 0.014 | ND | Oral | Carcinomas/Liver/ Mouse | IRIS |
| 2-Butanone | 78-93-3 | D | ND | ND | -- | -- | IRIS/HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Weight of Evidence Classification(A) | Slope Factor Oral (mg/kg/day)-1 | Slope Factor Inhalation (mg/kg/day)-1 | Chemical Route | Type of Cancer/Target Organ/Species | Source |
|---|---|---|---|---|---|---|---|
| Butylbenzylphthalate | 85-68-7 | ND | ND | ND | -- | -- | IRIS |
| Carbon disulfide | 75-15-0 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Chloroform | 67-66-1 | B2 | 0.0061 | 0.081 | Oral/Inhalation | Carcinoma/Liver/Mouse | IRIS/HEAST |
| Chrysene | 218-01-9 | B2 | 7.3(c) | ND | -- | -- | IRIS/HEAST |
| Dibenzo(a,h)anthracene | 53-70-3 | B2 | 7.3(c) | ND | -- | -- | IRIS |
| Dibenzofuran | 132-64-9 | D | ND | ND | -- | -- | IRIS/HEAST/SHRTSC |
| 1,1-Dichloroethene | 75-35-4 | C | 0.6 | 1.2 | Oral/Inhalation | Kidney adenocarcinomas/ Mouse | IRIS/SHRTSC |
| 1,2-Dichloroethene | 156-60-5 | D | ND | ND | -- | -- | IRIS/HEAST |
| Di-n-butylphthalate | 84-74-2 | ND | ND | ND | -- | -- | IRIS/HEAST |
| 1,2-Diphenylhydrazine | 122-66-7 | B2 | 0.8 | ND | Oral | Carcinomas & nodules/Liver/Rats | IRIS |
| Ethylbenzene | 100-41-4 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Fluoranthene | 206-44-0 | D | ND | ND | -- | -- | IRIS/HEAST |
| Flourene | 86-73-7 | D | ND | ND | -- | -- | IRIS/HEAST |
| Indeno(1,2,3-cd)pyrene | 193-39-5 | B2 | 7.3(c) | ND | -- | -- | IRIS |
| 4-Methyl-2-pentanone | 108-10-0 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Methylene chloride | 75-09-2 | B2 | 0.0075 | ND | Oral/Inhalation | Hepatocellular carcinomas/Liver/Mouse | IRIS/HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Weight of Evidence Classification(A) | Slope Factor Oral (mg/kg/day)-1 | Slope Factor Inhalation (mg/kg/day)-1 | Chemical Route | Type of Cancer/Target Organ/Species | Source |
|---|---|---|---|---|---|---|---|
| 2-Methylnaphthalene | 91-57-6 | ND | ND | ND | -- | -- | IRIS/SHRTSC |
| Naphthalene | 91-20-3 | D | ND | ND | -- | -- | IRIS/HEAST/SHRTSC |
| Nitrobenzene | 98-95-3 | D | ND | ND | -- | -- | IRIS/HEAST/SHRTSC |
| N-nitrosodiphenylamine | 86-30-6 | B2 | 0.0049 | ND | Oral | Cell carcinoma/Bladder/Rats | IRIS |
| Pentachlorophenol | 87-86-5 | B2 | 0.12 | ND | Oral | Hepatocellular adenomas and carcinomas | IRIS/HEAST |
| Phenanthrene | 85-01-8 | D | ND | ND | Oral | -- | IRIS/HEAST |
| Phenol | 108-95-2 | D | ND | ND | -- | -- | IRIS/HEAST |
| Pyrene | 129-00-0 | D | ND | ND | -- | -- | IRIS/HEAST |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | C | 0.2 | 0.2 | Oral | Hepatocellular carcinomas/Mouse | IRIS/HEAST |
| Tetrachloroethylene(a) | 127-18-4 | B2-C | 0.052(b) | 0.002(b) | ND | ND | SHRTSC |
| 1,1,1-Trichloroethane | 71-77-6 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Trichloroethylene(a) | 79-01-6 | B2-C | 0.011(b) | 0.006(b) | -- | -- | SHRTSC |
| Toluene | 108-88-3 | ND | ND | ND | -- | -- | IRIS |
| Vinyl chloride | 75-01-4 | A | 1.9(UR) | 0.3(UR) | Oral/Inhalation | Tumors/Liver & Lung/Rat | IRIS/HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Weight of Evidence Classification(A) | Slope Factor Oral (mg/kg/day)-1 | Slope Factor Inhalation (mg/kg/day)-1 | Chemical Route | Type of Cancer/Target Organ/Species | Source |
|---|---|---|---|---|---|---|---|
| Xylenes (total) | 1330-20-7 | D | ND | ND | -- | -- | IRIS |
| Inorganic Compounds: | | | | | | | |
| Aluminum | 7429-90-5 | D | DI | ND | -- | -- | IRIS/HEAST/SHRTSC |
| Antimony | 7440-36-0 | D | ND | ND | -- | -- | IRIS/HEAST/SHRTSC |
| Arsenic | 7440-38-2 | A | 1.75 | 50 | Oral/Inhalation | Lung Cancer/Human | IRIS |
| Barium | 7440-39-3 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Beryllium | 7440-41-7 | B2 | 4.3 | 8.4 | Oral/Inhalation | Tumors/Lungs/Human | IRIS/HEAST |
| Boron | 7440-42-8 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Cadmium | 7440-43-9 | B1 | ND | 6.1 | Inhalation | Lung, Trachea, Bronchus/Human | IRIS/HEAST |
| Calcium | 7440-70-2 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Cerium | 13967 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Chromium (VI) | 18540-29-9 | A | ND | 41 | Inhalation | Lung cancer/Human | IRIS/HEAST |
| Cobalt | 7440-48-4 | D | ND | ND | Oral | -- | IRIS/SHRTSC |
| Copper | 7440-50-8 | D | DI | DI | -- | -- | IRIS/SHRTSC |
| Dyprosium | 7429-91-6 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Erbium | 7440-52-0 | ND | ND | ND | -- | -- | IRIS/HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Weight of Evidence Classification(A) | Slope Factor Oral (mg/kg/day)-1 | Slope Factor Inhalation (mg/kg/day)-1 | Chemical Route | Type of Cancer/Target Organ/Species | Source |
|---|---|---|---|---|---|---|---|
| Europium | 7440-53-1 | D | ND | ND | -- | -- | IRIS/HEAST |
| Gadolinium | 7440-54-2 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Iron | 7439-89-6 | D | ND | ND | -- | -- | IRIS/HEAST/SHRTSC |
| Lanthanum | 7439-91-0 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Lead (g) | 7439-92-1 | -- | ND | ND | -- | -- | IRIS |
| Lithium | 7439-93-2 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Lutetium | 14265-75-9 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Magnesium | 7439-95-4 | D | ND | ND | -- | -- | IRIS/HEAST |
| Manganese | 7439-96-5 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Molybdenum | 7439-98-7 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Neodymium | 7440-00-8 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Nickel | 7440-02-0 | ND | ND | 0.84 (Dust) | Inhalation | Tumors/Respiratory/ Humans | HEAST/SHRTSC |
| Potassium | 7440-09-7 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Praseodysium | 7440-10-0 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Radium | 7440-14-4 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Samarium | 7440-19-9 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Selenium | 7782-49-2 | ND | ND | ND | -- | -- | IRIS/HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Weight of Evidence Classification(A) | Slope Factor Oral (mg/kg/day)-1 | Slope Factor Inhalation (mg/kg/day)-1 | Chemical Route | Type of Cancer/Target Organ/Species | Source |
|---|---|---|---|---|---|---|---|
| Silver | 7440-22-4 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Sodium | 7440-23-5 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Tellurium | 13494-80-9 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Terbium | 7440-27-9 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Thallium | 7440-28-0 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Thorium | -- | ND | ND | ND | -- | -- | IRIS/HEAST |
| Thulium | 7440-30-4 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Uranium | 7440-61-1 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Vanadium | 7440-62-2 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Zinc | 7440-66-6 | ND | ND | ND | -- | -- | IRIS/HEAST |
| Pesticides/PCBs: | | | | | | | |
| Alpha Chlordane | -- | ND | ND | ND | -- | -- | IRIS |
| 4,4-DDD | -- | ND | ND | ND | -- | -- | -- |
| Dieldrin | 60-57-1 | B2 | 16 | ND | Oral | Carcinoma/Liver/Mice | IRIS |
| Gamma Chlordane | -- | ND | ND | ND | -- | -- | IRIS |

## Table 4-1. (continued)

| Contaminants | CAS No. | Weight of Evidence Classification(A) | Slope Factor Oral (mg/kg/day)-1 | Slope Factor Inhalation (mg/kg/day)-1 | Chemical Route | Type of Cancer/Target Organ/Species | Source |
|---|---|---|---|---|---|---|---|
| Mobile Ions: | | | | | | | |
| Chloride | -- | ND | ND | ND | -- | -- | -- |
| Nitrate | -- | ND | ND | ND | -- | -- | -- |
| Phosphate | -- | ND | ND | ND | -- | -- | -- |
| Sulfate | -- | ND | ND | ND | -- | -- | -- |

## Table 4-1. (continued)

| Contaminants | CAS No. | Chronic Oral RfD (mg/kg/day) | Chronic Inhalation (mg/kg/day) | Confidence Level | Chemical Route | Critical Effect | Modifying Factors | Source |
|---|---|---|---|---|---|---|---|---|
| **NONCARCINOGENS:** | | | | | | | | |
| Organic compounds: | | | | | | | | |
| Acenaphthene | 83-32-9 | .06(a) | ND | -- | Oral | Hepatoxicity | UF=3000; MF=1 | IRIS/HEAST/SHRTSC |
| Acenaphthylene | 208-96-8 | DI/UR | ND | -- | -- | -- | -- | IRIS/HEAST |
| Anthracene | 120-12-7 | 0.3 | ND | Low | Oral | No observed effect | UF=3000; MF=1 | IRIS |
| Benzene | 71-43-2 | UR | .0002 mg/m3 (UR) | Medium | Inhalation | Hematological immunological effects, decreased body weight | UF=300 | IRIS/SHRTSC |
| Benzo(a)anthacene | 56-55-3 | ND | ND | -- | -- | -- | -- | IRIS/HEAST |
| Benzo(a)pyrene | 50-32-8 | ND | ND | -- | -- | -- | -- | IRIS/HEAST |
| Benzo(b)fluoranthene | 205-99-2 | ND | ND | -- | -- | -- | -- | IRIS/HEAST |
| Benzo(g,h,i)perylene | 191-24-2 | ND | ND | -- | -- | -- | -- | IRIS/HEAST |
| Benzo(k)fluoranthene | 207-08-9 | ND | ND | -- | -- | -- | -- | IRIS/HEAST |
| Benzoic acid | 65-85-0 | 4 | ND | Medium | Oral | No observed effect | UF=1; MF=1 | IRIS/HEAST |
| Bis(2-chloroethyl)ether | 111-44-4 | ND | ND | -- | | Decreased hemoglobin | ND | IRIS/HEAST |
| Bis(2-ethylhexyl)phthalate | 117-81-7 | 0.02 | ND | Medium | Oral | Increased relative liver size | UF=1000; MF=1 | IRIS |

## Table 4-1. (continued)

| Contaminants | CAS No. | Chronic Oral RfD (mg/kg/day) | Chronic Inhalation (mg/kg/day) | Confidence Level | Chemical Route | Critical Effect | Modifying Factors | Source |
|---|---|---|---|---|---|---|---|---|
| 2-Butanone | 78-93-3 | 0.05 | 1 mg/m3(h) | Low | Oral/Inhalation | Decreased fetal weight | UF=1000; MF=3 | IRIS/HEAST |
| Butylbenzylphthalate | 85-68-7 | 0.2 | ND | Low | Oral | Increased liver to body weight and liver to brain weight ratio | UF=1000; MF=1 | IRIS |
| Carbon disulfide | 75-15-0 | 0.1 | UR | Medium | Oral/Inhalation | Fetal toxicity/malformations | UF=100; MF=1 | IRIS |
| Chloroform | 67-66-3 | 0.01 | UR | Medium | Oral | Fatty cyst formation in liver | UF=1000; MF=1 | IRIS |
| Chrysene | 218-01-9 | DI | DI | -- | -- | -- | -- | IRIS/HEAST |
| Dibenzo(a,h)anthracene | 53-70-3 | ND | ND | -- | -- | -- | -- | IRIS/HEAST/SHRTSC |
| Dibenzofuran | 132-64-9 | 0.004(d) | UR | Low | Oral | Renal effects | UF-3000 MF=1 | IRIS/SHRTSC |
| 1,1-Dichloroethene | 75-35-4 | 0.009 | UR | Medium | Oral | Hepatic lesions | UF=1000; MF=1 | IRIS |
| 1,2-Dichloroethene (trans) | 156-60-5 | 0.02 | ND | Low | Oral | Increased alkaline phosphates | UF=1000; MF=1 | IRIS |
| Di-n-butylphthalate | 84-74-2 | 0.1 | NA | Low | Oral | Increased mortality | UF1000; MF=1 | IRIS |
| 1,2-Diphenylhydrazine | 122-66-7 | ND | DI | -- | -- | -- | -- | IRIS/HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Chronic Oral RfD (mg/kg/day) | Chronic Inhalation (mg/kg/day) | Confidence Level | Chemical Route | Critical Effect | Modifying Factors | Source |
|---|---|---|---|---|---|---|---|---|
| Ethylbenzene | 100-41-4 | 0.1 | 1 mg/m3(h) | Low | Oral/Inhalation | Liver/Kidney Toxicity | UF=1000 | IRIS/HEAST |
| Fluoranthene | 206-44-0 | 0.04 | ND | Low | Oral | Nephropathy, increased liver weight; hematological alterations | UF=3000; MF=1 | IRIS |
| Fluorene | 86-73-7 | 0.04 | ND | Low | Oral | Decreased red blood cells | UF=3000; MF=1 | IRIS |
| Indeno(1,2,3-cd)pyrene | 193-39-5 | ND | ND | -- | -- | -- | -- | IRIS/HEAST |
| 4-Methyl-2-pentanone | 108-10-0 | ND | UR | -- | -- | -- | -- | IRIS |
| Methylene chloride | 75-09-2 | 0.06 | (U) 3 mg/m3(h) | Medium | Oral | Liver toxicity | UF=100; MF=1 | IRIS/HEAST |
| 2-Methlynaphthalene | 91-57-6 | ND | ND | -- | -- | -- | -- | IRIS/HEAST |
| Naphthalene | 91-20-3 | 0.04(UR) | 0.0013 mg/m3(i) | Medium | Inhalation | Lesions in lungs and nasal cavity | UF=1000 MF=1 | IRIS/SHRTSC |
| Nitrobenzene | 98-95-3 | 0.0005 | UR | Low | -- | Hematologic, adrenal, renal and hepatic lesions | UF=10,000 MF=1 | IRIS/HEAST |
| n-nitrosodiphenylamine | 86-30-6 | 0.02(d) | ND | Low | -- | Decreased body weight, bladder lesions | UF=3000 MF=1 | IRIS/HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Chronic Oral RfD (mg/kg/day) | Chronic Inhalation (mg/kg/day) | Confidence Level | Chemical Route | Critical Effect | Modifying Factors | Source |
|---|---|---|---|---|---|---|---|---|
| Pentachlorophenol | 87-86-5 | 0.03 | UR | Medium | -- | Hepatic and renal effects | UF=100 MF=1 | IRIS/HEAST |
| Phenanthrene | 85-01-8 | ND | ND | -- | -- | -- | -- | IRIS |
| Phenol | 108-95-2 | 0.6 | NV | Low | Oral | Decreased fetal weight | UF=100; MF=1 | IRIS |
| Pyrene | 129-00-0 | 0.03 | ND | Low | Oral | Renal effects | UF=3000; MF=1 | IRIS |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | UR | ND | -- | -- | -- | -- | IRIS |
| Tetrachloroethylene(a) | 127-18-4 | 0.01 | ND | Medium | Oral | Hepatotoxicity | UF=1000; MF=1 | IRIS |
| 1,1,1-Trichloroethane | 71-55-6 | 0.09 | UR | -- | Oral | Hepatotoxicity | UF=1000 | IRIS/HEAST |
| Trichloroethylene(a) | 79-01-6 | 0.006(d) | UR | Low | Oral | Hepatotoxicity | UF=3000 | SHRTSC |
| Toluene | 108-88-3 | 0.2 | 0.4 mg/m3(h) (UR) | Medium | Oral | Increased kidney and liver weights | UF=1000; MF=1 | IRIS/HEAST |
| Vinyl chloride | 75-01-4 | NV | ND | -- | Oral/Inhalation | CNS effects | -- | IRIS/HEAST/SHRTSC |
| Xylene (total) | 1330-20-7 | 2 | UR | Medium | Oral | Hyperactivity, decreased weight, increased mortality | UF=1000; MF=1 | IRIS |

## Table 4-1. (continued)

| Contaminants | CAS No. | Chronic Oral RfD (mg/kg/day) | Chronic Inhalation (mg/kg/day) | Confidence Level | Chemical Route | Critical Effect | Modifying Factors | Source |
|---|---|---|---|---|---|---|---|---|
| Inorganics: | | | | | | | | |
| Aluminum | 7429-90-5 | 1(d) | ND | Medium | Oral | Decreased body weight, neurotoxicity | -- | IRIS/SHRTSC |
| Antimony | 7440-36-0 | 0.0004 | ND | Low | Oral | Longevity, blood glucose, chlolesterol | UF=1000; MF=1 | IRIS |
| Arsenic | 7440-36-0 | 0.0003 | ND | Medium | Oral | Hyperpigmentation, keratosis, vascular complications | UF=3; MF=1 | IRIS |
| Barium | 7440-39-3 | 0.07 | UR | Medium | Oral | Increased blood pressure | UF=3; MF=1 | IRIS |
| Beryllium | 7440-41-7 | 0.005 | ND | Low | Oral | No adverse effects | UF=100; MF=1 | IRIS |
| Boron | 7440-42-8 | 0.09 | ND | Medium | Oral | Testicular atrophy, spermatogenic arrest | UF=100 MF=1 | IRIS |
| Cadmium | 7440-43-9 | 0.0005 (water) 0.001 (food) | UR | High | Oral | Significant proteinuria | UF=100 MF=1 | IRIS |
| Calcium | 7440-70-2 | ND | ND | -- | -- | -- | -- | IRIS |
| Cerium | 13967 | No data available | | | | | | IRIS |

## Table 4-1. (continued)

| Contaminants | CAS No. | Chronic Oral RfD (mg/kg/day) | Chronic Inhalation (mg/kg/day) | Confidence Level | Chemical Route | Critical Effect | Modifying Factors | Source |
|---|---|---|---|---|---|---|---|---|
| Chromium (VI) | 18540-29-9 | 0.005 | UR | Low | Oral | No observed effects | UF=500 MF=1 | IRIS |
| Cobalt | 7440-48-4 | 0.96 adult(d,e) 0.06 child(d,e) | ND | -- | -- | Respiratory effects | -- | IRIS/SHRTSC |
| Copper | 7440-50-8 | 0.04(f) | ND | -- | Oral | Hepatic necrosis | -- | IRIS/SHRTSC |
| Dyprosium | 7429-91-6 | ND | ND | -- | -- | -- | -- | IRIS |
| Erbium | 7440-52-0 | ND | ND | -- | -- | -- | -- | IRIS |
| Europium | 7440-53-1 | ND | ND | -- | -- | -- | -- | IRIS |
| Gadolinium | 7440-54-2 | ND | ND | -- | -- | -- | -- | IRIS |
| Iron | 7439-89-6 | ND | ND | -- | Oral | Hepatic effects | -- | IRIS |
| Lanthanum | 7439-91-0 | ND | ND | -- | -- | -- | -- | IRIS |
| Lead | 7439-92-1 | UR(g) | ND | -- | -- | -- | -- | IRIS |
| Lithium | 7439-93-2 | 0.02 | ND | Medium | Oral | Impairment of renal tubular function | UF = 100 | SHRTSC |
| Lutetium | 14265-75-9 | ND | ND | -- | -- | -- | -- | IRIS |
| Magnesium | 7439-95-4 | ND | ND | -- | -- | Decreased body weight | -- | IRIS |
| Manganese | 7439-96-5 | 0.005 | 0.004 | -- | Oral/Inhalation | Respiratory and CNS effects | UF=900 | HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Chronic Oral RfD (mg/kg/day) | Chronic Inhalation (mg/kg/day) | Confidence Level | Chemical Route | Critical Effect | Modifying Factors | Source |
|---|---|---|---|---|---|---|---|---|
| Molybdenum | 7439-98-7 | .005(UR) | ND | -- | Oral | Changes in biochemical induces pain swelling in joints | UF=30 | IRIS/HEAST |
| Neodymium | 7440-00-8 | ND | ND | -- | -- | -- | -- | IRIS |
| Nickel | 7440-02-0 | 0.02 | 0.0006 mg/m3(h) | -- | Oral/Inhalation | Tumors in respiratory system, decreased body weight | UF=300 | IRIS/HEAST/SHRTSC |
| Potassium | 7440-09-7 | ND | ND | -- | -- | -- | -- | IRIS |
| Praseodymium | 7440-10-0 | ND | ND | -- | -- | -- | -- | IRIS |
| Radium | 7440-14-4 | ND | ND | -- | -- | -- | -- | IRIS |
| Samarium | 7440-19-9 | ND | ND | -- | -- | -- | -- | IRIS |
| Selenium | 7782-49-2 | 0.005 | ND | High | Oral | Clinical selenosis | UF=3 MF=1 | IRIS |
| Silver | 7440-22-4 | 0.005 | ND | Low | Oral | Argyria | UF=3 MF=1 | IRIS |
| Sodium | 7440-23-5 | ND | ND | -- | -- | -- | -- | IRIS |
| Tellurium | 13494-80-9 | ND | ND | -- | -- | -- | -- | IRIS |
| Terbium | 7440-27-9 | ND | ND | -- | -- | -- | -- | IRIS |
| Thallium | 7440-28-0 | ND | ND | -- | -- | -- | | IRIS/HEAST |
| Thorium | | ND | ND | -- | -- | -- | -- | IRIS/HEAST |

## Table 4-1. (continued)

| Contaminants | CAS No. | Chronic Oral RfD (mg/kg/day) | Chronic Inhalation (mg/kg/day) | Confidence Level | Chemical Route | Critical Effect | Modifying Factors | Source |
|---|---|---|---|---|---|---|---|---|
| Thulium | 7440-30-4 | ND | ND | -- | -- | -- | -- | IRIS |
| Uranium | 7440-61-1 | 0.003 | ND | -- | Oral | Initial body wt. loss; moderate nephrotoxicity | UF=1000 MF=1 | IRIS |
| Vanadium | 7440-62-2 | 0.007 (UR) | ND | -- | -- | none observed | UF=100 | IRIS/HEAST |
| Zinc | 7440-66-6 | UR | ND | -- | -- | -- | -- | IRIS |
| Pesticides/PCBs: | | | | | | | | |
| Alpha chlordane | -- | ND | ND | ND | -- | -- | -- | IRIS |
| 4,4 DDD | 72-54-8 | 0.005 | ND | Low | Oral | Decreased body weight; histological effects | UF=10,000 | IRIS/SHRTSC |
| Dieldrin | 60-57-1 | 0.00005 | ND | Medium | Oral | Liver lesions | UF100; MF=1 | IRIS |
| Gamma chlordane | -- | ND | ND | ND | -- | -- | -- | IRIS |
| Mobile Ions: | | | | | | | | |
| Chloride | -- | ND | ND | ND | -- | -- | -- | -- |
| Nitrate | -- | ND | ND | ND | -- | -- | -- | -- |
| Phosphate | -- | ND | ND | ND | -- | -- | -- | -- |
| Sulfate | -- | ND | ND | ND | -- | -- | -- | -- |

NOTE: IRIS toxicity values were used when available; HEAST values were used as a secondary source and the Superfund Technical Support Center provided additional provisional/interim values.

## Table 4-1. (continued)

Classifications:

- A - Human carcinogen (sufficient evidence of carcinogenicity in humans);
- B1 - Probable carcinogen (limited evidence of carcinogenicity in humans);
- B2 - Probable human carcinogen (sufficient evidence of carcinogenicity in animals, with inadequate or lack of evidence of carcinogenicity in humans);
- C - Possible human carcinogen (limited evidence of carcinogenicity in animals, and inadequate or lack of evidence of human data);
- D - Not classifiable as to human carcinogenicity.

DI - Data inadequate for quantitative risk assessment
NA - Not available
ND - No Data
NV - Not verified by EPA
UR - Values currently under review by EPA
MF - Modifying factor
UF - Uncertainty factor

a Classification is on a continuum, (B2-C) pending EPA Science Advisory Board determination.
b Toxicity values withdrawn from IRIS pending classification. Values represent provisional/interim numbers from SHRTSC-ECAO.
c Assessment values for all PAHs based on the value for benzo(a)pyrene.
d Provisional/interim values per SHRTSC-ECAO.
e Values for oral exposure, per SHRTSC guidance.
f An interim number (most conservative) provided by SHRTSC. (and RfD between 0.04 and 0.07 is recommended).
g EPA is currently developing a Lead Uptake/Biokinetic model which will provide an alternative to the RfD and the approach to risk assessment.
h Values are given in mg/m3 because only a Reference Concentration (RfC) was available. Due to the potential for inaccuracy, derivation/conversion to a dose is not recommended (HEAST) and was not employed in the risk assessment.
i Provisional RfC for occupationally exposed individuals.

Sources

HEAST, January 1992. Health Effects Assessment Summary Tables.
IRIS, July 1992. Integrated Risk Information System.
SHRTSC-ECAO, August 1992. Superfund Health Risk Technical Support Center - Environmental Criteria and Assessment Office.

#### 4.2.2.2 Chemicals For Which No EPA Toxicity Values are Available

A number of the chemical COCs presently do not have RfDs and/or SFs for determination of potential noncarcinogenic and carcinogenic health effects from oral and inhalation exposure. The possible impacts of the absence of the risk estimation for these contaminants is discussed in Section 5.3.

Chemical toxicity data for the radioactive element thorium is not available in IRIS or found in HEAST. Therefore, this element was not carried through the quantitative risk assessment.

No RfD values specific to dermal absorption are currently available. The extent of dermal uptake of a chemical can be influenced by many factors including the form of the chemical, the condition of the skin (e.g., the presence of abrasions), and the medium in which the chemical is present (e.g., water, oil-like substance, or soil). Generally, uptake from solids (e.g., soil) is much less efficient than uptake from liquids, partially because hydrated skin is more permeable than dry skin (Klaasen et al. 1986). Therefore, when soil is the contaminant source, ingestion and inhalation exposure are likely to be far more significant pathways of uptake than dermal exposure. In addition, because EPA policies are still evolving on how exposure via the dermal pathway should be estimated, dermal exposure via soil was not included in the quantitative exposure estimates derived in Section 3.

As shown in Table 4-1, EPA-derived RfD values incorporate uncertainty factors to account for data that were used but would not apply to chronic exposures in the most sensitive human subpopulations. In general, the use of these uncertainty factors provides confidence that exposure levels less than the RfD values are unlikely to cause toxic effects. However, the RfD values may actually be much lower than levels that will cause toxic effects in sensitive human subpopulations.

# 5. RISK CHARACTERIZATION

This section presents risk estimates for reasonable current use and hypothetical future use scenarios for human receptors at the Maywood site. Human receptors include residents, employees, and transients. Radiological risks and chemical risks are estimated separately. The overall human health risk from exposure to both radiological and chemical contaminants is discussed.

For the radiological assessment, risk is defined as the lifetime probability of cancer morbidity and does not include genetic or noncarcinogenic effects. For the chemical COCs, cancer risk estimates and hazard index (HI) estimates are presented, as appropriate, where toxicity values are available.

Cancer risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of pathway-specific exposure to carcinogenic contaminants. Cancer risks are related to the EPA target range of $10^{-4}$ to $10^{-6}$ for incremental cancer risk at NPL sites.

EPA does not presently use a probabilistic approach to estimate the potential for noncarcinogenic health effects (EPA 1989b). Instead, the potential for noncarcinogenic effects is evaluated by comparing the average daily exposure (intake) over a specified time period (exposure duration) with a reference dose (EPA 1989b). This ratio of exposure is called a hazard quotient (HQ). HQs for each COC are then summed to obtain an HI for the specific pathway. An HI greater than one has been defined as the level of concern for potential adverse noncarcinogenic health effects (EPA 1989b).

## 5.1 RISK CHARACTERIZATION METHODOLOGY

### 5.1.1 Radiological Risk

Exposures to low levels of ionizing radiation could result in cancer induction, genetic effects, or other detrimental health effects. The predominant health concern potentially associated with the radioactive contaminants at the Maywood site is the induction of cancer. The radiological health risks presented in this BRA are limited to this concern. This approach is consistent with EPA guidance, which notes that, generally, the risk of cancer is limiting and may be used as the sole basis for assessing the radiation-related human health risks for a site contaminated with radionuclides (EPA 1989b).

Risk from exposure to radioactive contaminants was estimated following EPA (EPA 1989d), BEIR IV (NRC 1988), and BEIR V (NRC 1990) recommendations. As discussed in Section 4, for the purposes of this BRA, a population-weighted average excess risk of cancer of $6x10^{-7}$ per mrem was assumed. The radiation doses associated with the scenarios considered in this assessment are presented in Section 3 (Table 3-6.). These doses are expressed as CEDE resulting from a 1-year exposure, in millirem/year, for all exposure routes. The risk factor, the annual dose in mrem, and the number of years of exposure are multiplied to obtain estimates of lifetime cancer morbidity risk.

EPA cancer SFs as presented in the 1992 HEAST tables (EPA 1992a) also were used to assess radiological risk. A comparison between the EPA SF methodology and the conventional approach (dose x risk) indicated a reasonable agreement between approaches for predicted risk (Appendix G). The dose/risk method was selected for presentation in this BRA because it allows for the maximum use of site-specific exposure information and is consistent with the approach mandated in DOE Order 5400.5 (DOE 1990).

The radiological risks associated with exposures to contaminants at the Maywood site are to be considered as risks produced in addition to risks from exposure to natural sources of radiation. Radiation exposure from natural sources of radioactivity results in an annual dose of about 300 mrem/yr: 200 mrem/yr from exposure to Rn-222 and its short-lived decay products and 100 mrem/yr from exposure to other natural sources of radiation (NCRP 1987). The radiological health risks given in this document are reported as incremental risks above that resulting from exposure to background radiation. This was done to facilitate comparison with EPA's target risk range, which does not include the contribution from background sources of radiation. Using the radiological cancer risk factor given above, this background dose results in a lifetime risk of cancer induction of approximately 1.3 percent ($1.3 \times 10^{-2}$). EPA has estimated that the individual lifetime risk of fatal cancer associated with background radiation, including radon, is $1 \times 10^{-2}$ (EPA 1989b).

### 5.1.2 Chemical Risk and Hazard Index

#### 5.1.2.1 Cancer Risk

The risk to an individual resulting from exposure to chemical carcinogens is expressed as the increased probability of a cancer occurring over the course of a lifetime. To calculate the excess

cancer risk, the estimated daily intake averaged over a lifetime is multiplied by a chemical-specific SF. Oral and inhalation pathway-specific SFs have been derived by EPA for certain carcinogens; some carcinogens do not have an SF available or are presently under review by EPA. All slope factors utilized in the risk estimate calculations presented in Appendix E were obtained from EPA's IRIS (EPA 1992b). If the slope factors were not available on IRIS, they were obtained from EPA's HEAST (EPA 1992a). If slope factors were not available from IRIS or HEAST, EPA's Superfund Health Risk Technical Support Center-ECAO was contacted and interim or provisional SFs obtained for use in the risk characterization where available (EPA 1992c).

The SF converts estimated daily intakes averaged over a lifetime of exposure directly to the incremental risk of an individual developing cancer (EPA 1989b). The carcinogenic risk estimate is generally an upper-bound estimate because the SF is typically derived as the upper 95 percentile confidence limit of the probability of response based on experimental animal data (EPA 1989b). Thus, EPA is reasonably confident that the "true risk" will not exceed the risk estimate derived through use of the SF and is likely to be less than that predicted (EPA 1989b). The estimation of daily intakes (averaged over a lifetime) resulting from exposure to the chemical carcinogens of concern was described in Section 3.5, and available SFs were identified in Section 4.2.

#### 5.1.2.2 Hazard Indices

The potential for adverse health effects other than cancer is evaluated as the ratio of the daily intake for the exposure period over the RfD. This ratio is called the HQ. The RfD is a provisional estimate of the daily exposure to the human population, including sensitive subgroups (with uncertainty spanning perhaps an order of magnitude). The RfD is a reference dose below which appreciable risk of deleterious health effects during a lifetime for chronic exposure, or during a portion of a lifetime for subchronic exposure would not be expected to occur (EPA 1989b). EPA has derived RfDs for both chronic and subchronic exposure periods. In accordance with Superfund guidance, chronic exposures for human beings range in duration from seven years to a lifetime; and subchronic human exposures range in duration from two weeks to seven years (EPA 1989b). Because the potential exposures considered in this BRA are for periods of more than seven years, only chronic RfDs are considered. The estimated average daily intakes resulting from exposure to the chemical COCs at the site are presented in Appendix E, and the RfDs for these contaminants are identified in Section 4.2.

The noncancer HQ assumes that there is a level of exposure (the RfD) below which it is unlikely for even sensitive populations to experience adverse noncarcinogenic health effects

(EPA 1989b). If the intake exceeds this threshold (i.e., Intake/RfD exceeds unity or 1), there may be concern for potential adverse noncarcinogenic health effects (EPA 1989b). The greater the ratio (Intake/RfD), the greater the level of concern (EPA 1989b). The HQs for each chemical addressed in the intake and exposure pathway are summed to obtain the HI, which allows assessment of the overall potential for noncarcinogenic health effects (EPA 1989b). When the HI exceeds unity (1), there may be concern for potential adverse health effects. For exposure to multiple chemicals, as at Maywood, a summed HI which exceeds unity (HI>1) indicates a potential health risk, even if no single chemical exposure exceeds its RfD (HQ<1).

## 5.2 RISK ESTIMATES FOR THE MAYWOOD SITE

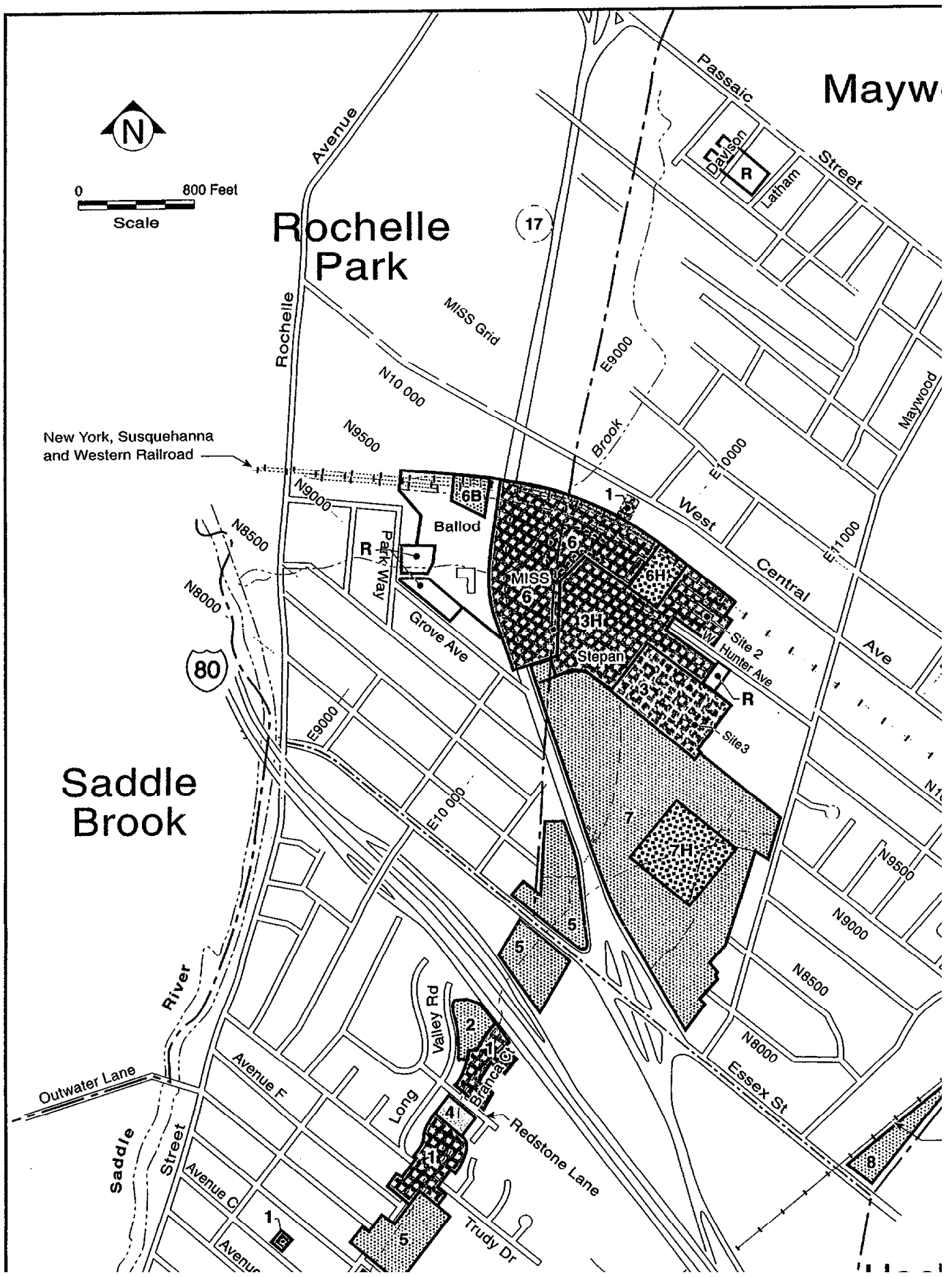
For clarity of presentation, the risk estimates resulting from potential radiological and chemical exposures are presented separately in the following sections. In each property unit and exposure scenario, estimates are presented for the average exposure conditions (mean receptor) and the reasonable maximum exposure conditions (RME receptor). Overall risk is discussed in Section 5.4.3.

### 5.2.1 Radiological Risk Estimates

The radiological risks for the Maywood Property Units are presented in shaded maps for all scenarios and receptors in Figures 5-1, 5-1a, 5-2, and 5-2a. Remedial action may be selected based on protection of human health and the environment and compliance with ARARs. The risk ranges presented on the maps are $<10^{-6}$, $10^{-6}$ to $10^{-5}$, $10^{-5}$ to $10^{-4}$, $10^{-4}$ to $10^{-3}$, and $>10^{-3}$.

Potential risks as a result of exposure to contaminants found at the Maywood site were estimated for reasonable current uses and hypothetical future uses of the site properties. Radiological risk estimates are discussed in Section 5.2.1.1 for current use and in Section 5.2.1.2 for future use.

The potential receptors and routes of exposure to contamination at the respective property units comprising the Maywood site are summarized in Section 3.2. Exposure point concentrations and doses are presented in Sections 3.4 and 3.5. The estimates of radiological risk consider exposure to contaminated soil and sediment, indoor and outdoor air, and groundwater.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E11000
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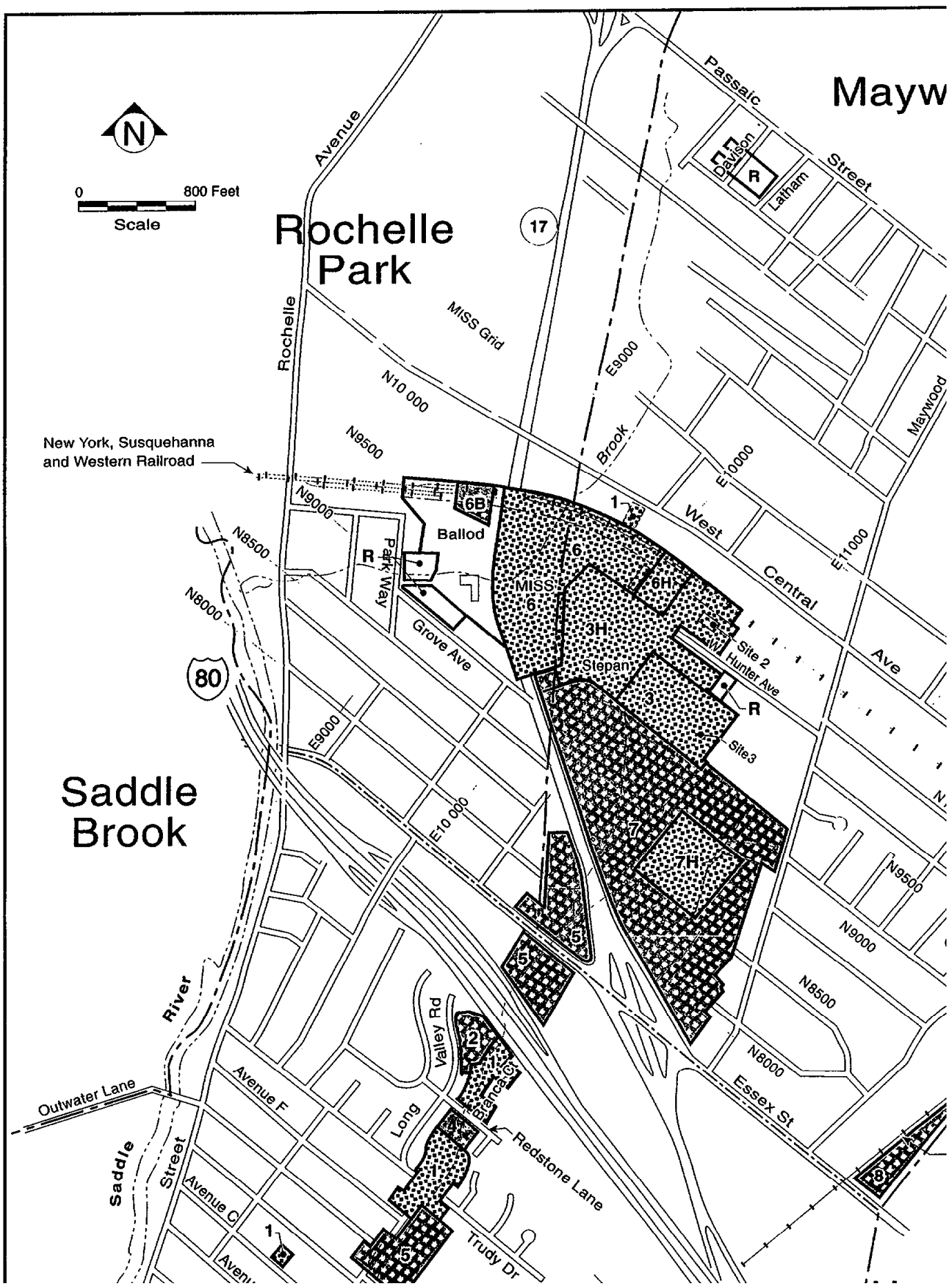
N9000
N8500
River
Valley Rd
2
Francan
N8000
Essex St
Outwater Lane
Avenue F
Long
4
Redstone Lane
Saddle
Street
Avenue C
1
5
Trudy Dr
8


N
0
800 Feet
Scale
Rochelle Park
Saddle Brook
Mayw
Avenue
Passaic
Street
Davison
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Latham
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MISS Grid
E9000
N10 000
N9500
Brook
Maywood
E10000
West
Central
Ave
E11000
New York, Susquehanna and Western Railroad
N9000
6B
1
Ballod
6
6H
MISS
3H
Site 2
Hunter Ave
Stepan
3
Site3
7
7H
5
N8500
N8000
Park Way
Grove Ave
80
E10 000
River
Valley Rd
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Redstone Lane
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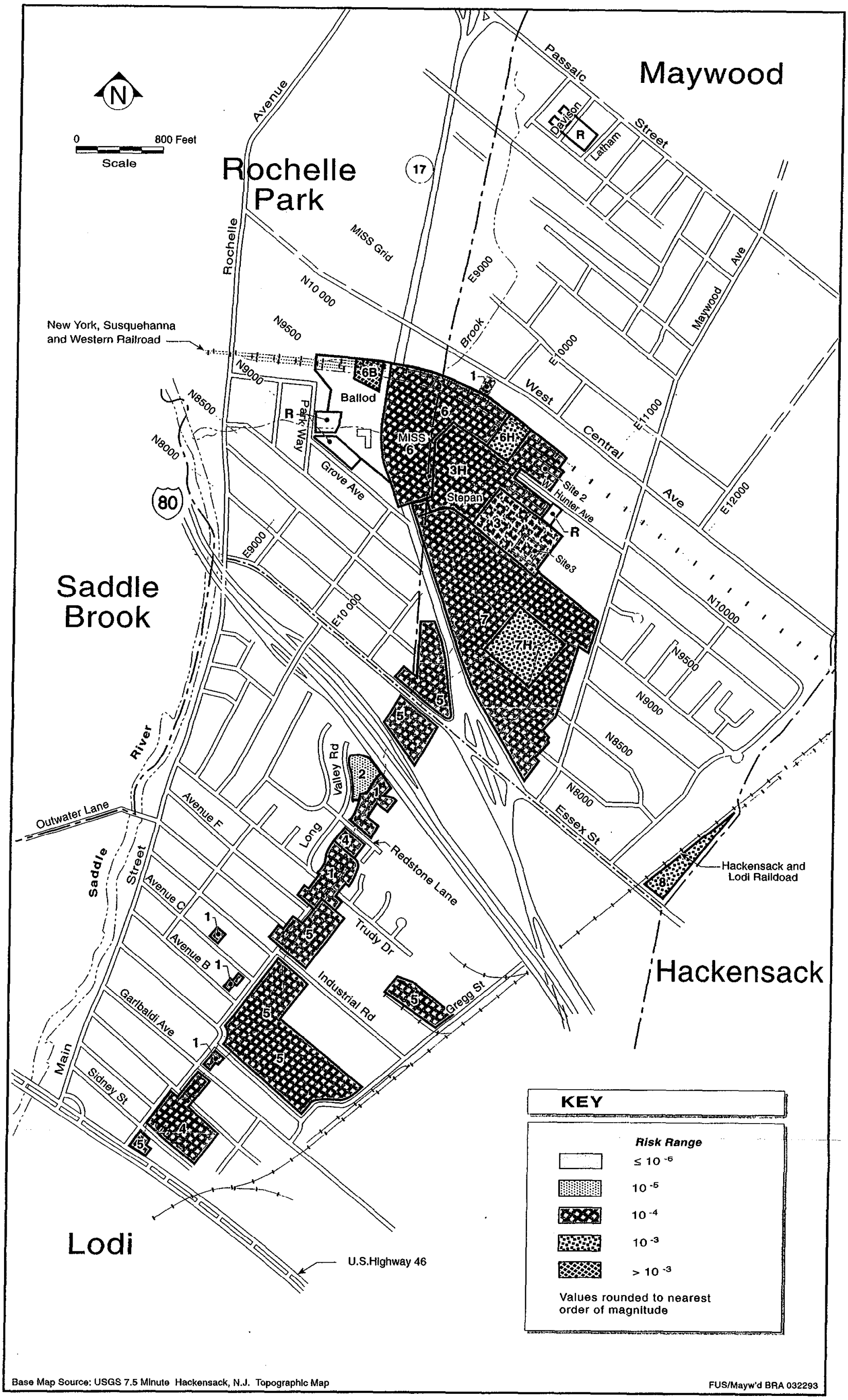



**Figure 5-2. Excess Radiological Cancer Risk for the Future Use Scenario (Mean)**

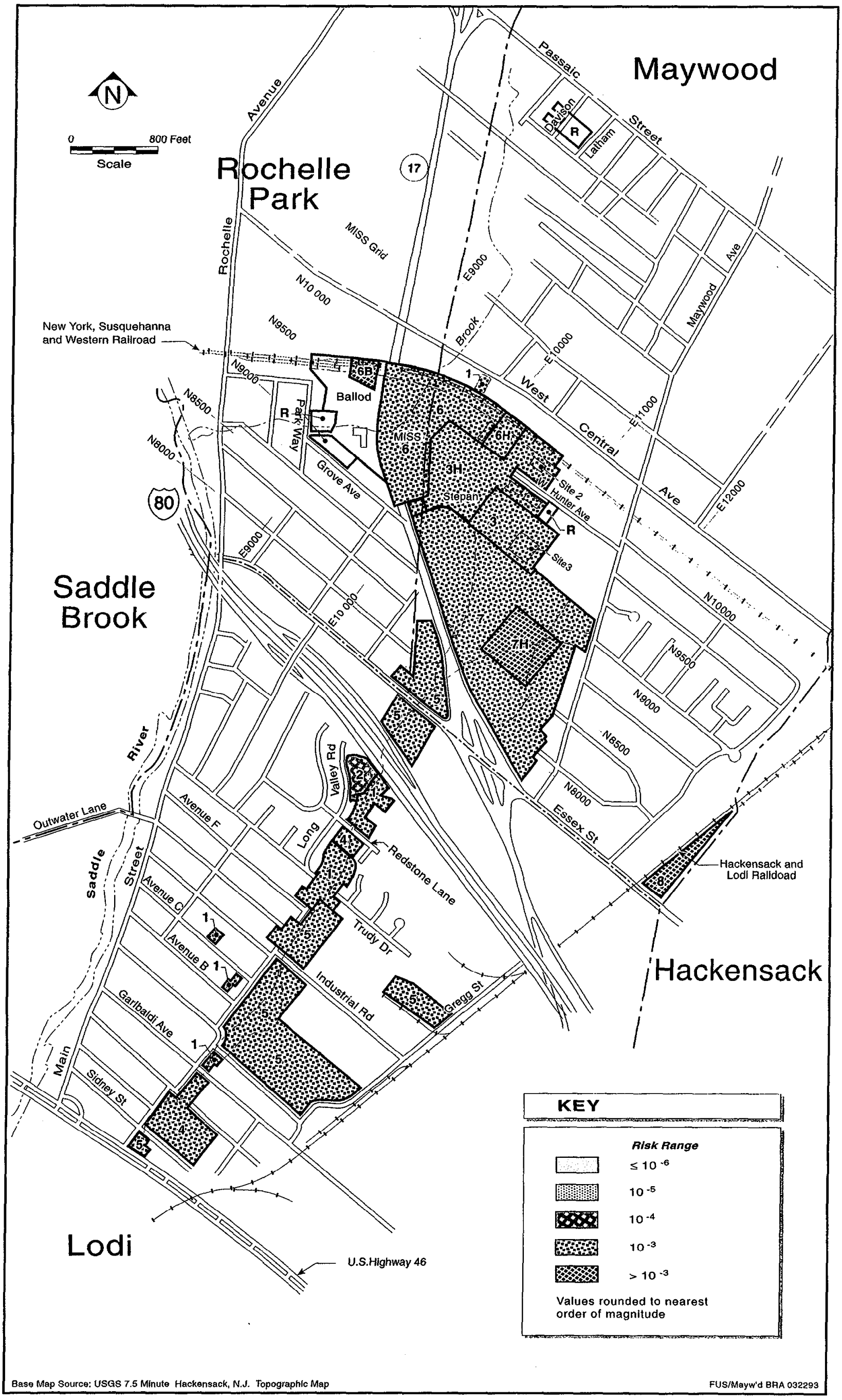



**Figure 5-2a. Excess Radiological Cancer Risk for the Future Use Scenario (RME)**

Contaminated soil has been identified in various areas at the Maywood site, as indicated by the characterization and environmental monitoring results. Air is being considered because of the potential for transport of airborne radioactive particulates from contaminated soil, radon gas from radium contaminated soil, and external gamma irradiation from contaminated soil.

5.2.1.1 Current Use Scenarios

Risk estimates for potential exposure from current site use are presented in Table 5-1. The highest estimated risks are for the RME employee and resident at Property Unit 1, the RME employee and transient at Property Unit 6H (the field on the MISS property, in front of building 76), and the RME employees at Property Units 3H (Stepan), 6 (MISS), and 7H (Sears/DeSaussure), which exceed the EPA target range by a factor of 10 or greater.

Radon and direct gamma irradiation combined contribute greater than 90 percent of the radiological risk to most receptors. The radon contribution to Property Unit 1 residents is 43 percent and 76 percent of the total risk for mean and RME conditions, respectively. Direct gamma irradiation constitutes the remainder of the Property Unit 1 risk. Residential Property Unit 2 doses approach background, with plant ingestion contributing to the majority of the risk. The radiological risks from plant ingestion are highly uncertain. The radiological risk to transient receptors at all property units is almost entirely derived from direct gamma irradiation. The exceptions to this are Property Unit 6B (Ballod) and Property Unit 8 (Scannel), which have significant radon-related risks. These radon risks are based entirely on modeled data and also are highly uncertain.

The estimated mean carcinogenic risk for employee receptors at the various property units ranges from $7x10^{-4}$ to $4x10^{-5}$. RME risks range from $4x10^{-3}$ to $2x10^{-4}$. The employees at Property Unit 7H (Sears/DeSaussure) are estimated to receive an excess carcinogenic risk of $6x10^{-4}$ and $4x10^{-3}$ for mean and RME conditions, respectively. The mean risks for residents range from $3x10^{-4}$ to $3x10^{-5}$. The RME risks range from $4x10^{-3}$ to $2x10^{-4}$. The mean risks to transients range from $2x10^{-5}$ to $2x10^{-7}$. The RME risks range from $3x10^{-4}$ to $9x10^{-5}$.

# Table 5-1. Radiological Risk Summary

| CURRENT USE SCENARIO | | | | | | | |
|---|---|---|---|---|---|---|---|
| LOCATION | PROPERTY UNIT | Employee | | Resident | | Transient | |
| | | Mean | RME | Mean | RME | Mean | RME |
| RESIDENTIAL | UNIT 1 | | | 3E-04 | 4E-03 | | |
| | UNIT 2 | | | 3E-05 | 2E-04 | | |
| STEPAN | UNIT 3 | 9E-05 | 6E-04 | | | 2E-07 | 9E-05 |
| | UNIT 3H | 2E-04 | 1E-03 | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | 2E-06 | 9E-05 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 4E-05 | 2E-04 | | | | |
| | UNIT 6 (MISS) | 5E-04 | 2E-03 | | | 2E-05 | 4E-04 |
| | UNIT 6H | 7E-04 | 3E-03 | | | 9E-05 | 3E-03 |
| | UNIT 6B (BALLOD) | | | | | 1E-05 | 2E-04 |
| | UNIT 7 | 4E-05 | 4E-04 | | | | |
| | UNIT 7H | 6E-04 | 4E-03 | | | | |
| | UNIT 8 | | | | | 2E-05 | 3E-04 |
| FUTURE USE SCENARIO | | | | | | | |
| LOCATION | PROPERTY UNIT | Employee | | Resident | | Transient | |
| | | Mean | RME | Mean | RME | Mean | RME |
| RESIDENTIAL | UNIT 1 | | | 3E-04 | 4E-03 | | |
| | UNIT 2 | | | 3E-05 | 2E-04 | | |
| STEPAN | UNIT 3 | 9E-05 | 6E-04 | | | | |
| | UNIT 3H | 2E-04 | 1E-03 | | | | |
| MUNICIPAL PARKS | UNIT4 | | | 2E-04 | 1E-03 | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | 2E-04 | 8E-04 | | |
| | UNIT 6 (MISS) | 5E-04 | 2E-03 | | | 2E-05 | 9E-05 |
| | UNIT 6H | 9E-04 | 5E-03 | | | 9E-05 | 3E-03 |
| | UNIT 6B (BALLOD) | | | 6E-03 | 5E-02 | | |
| | UNIT 7 | | | 2E-04 | 2E-03 | | |
| | UNIT 7H | | | 3E-03 | 2E-02 | | |
| | UNIT 8 | 8E-04 | 7E-03 | | | | |

RME = Reasonable Maximum Exposure

5.2.1.2 Hypothetical Future Use Scenarios

Risk estimates for potential exposure from hypothetical future property use are presented in Table 5-1. The estimated radiological risks for RME receptors at all property units exceed the EPA target risk range. Maximum estimated risks are for future RME residents at Property Units 6B (Ballod) and 7H (Sears/DeSaussure), which exceed $10^{-2}$. Dominant exposure pathway risks in the future use scenarios are similar to those in the current use scenarios in that radon and direct gamma irradiation contribute the bulk of the risk to the resident and employee receptors, with direct gamma irradiation contributing most of the risk to transients. The majority of the estimated mean carcinogenic risk for employee receptors is attributed to direct gamma irradiation and radon daughter inhalation. Direct measurements were used for direct gamma and for radon when they were available. Property Unit 8 is assumed to change from a vacant lot (current receptor=transient) to a commercial/industrial enterprise (future receptor=employee).

The risks to future residents on properties subject to land use changes (i.e. from commercial use or vacant property to residential use) are estimated to range from $6x10^{-3}$ to $2x10^{-4}$ (mean) and $5x10^{-2}$ to $8x10^{-4}$ (RME). The risks to the residents on the existing residential units (1 and 2) are expected to remain constant. The future land use for Property Unit 6H is assumed to remain unchanged.

5.2.1.3 Risk to Offsite Receptors

The projected excess cancer rate for the total population within 80 km (50 mi) around the Maywood site is approximately 600 cancers per 10 million people. This risk is estimated when the calculation is truncated at individual doses of less than 1 mrem/yr, a small percentage of natural background (<1 percent). The variation in natural background (not including radon) is on the order of 10 percent to 15 percent (NCRP 1987). Given the presumed background lifetime cancer risk from the typical 300 mrem/yr dose from natural background of one percent, for 10 million people this would be a cancer risk of 100,000 cancers from natural background radiation in the 80 km area around Maywood. Therefore, the contaminants at the Maywood site constitute a very small fraction of the total local cancer incidence rate attributed to background radiation (0.6 percent) and an even smaller fraction of the total cancer incidence rate from all sources (approximately 20 percent of the population in the U.S. develop cancer).

This population risk evaluation is intended for use in as low as reasonably achievable (ALARA) evaluations consistent with the requirements of DOE Order 5400.5 (DOE 1990) and the implementing guidance for remediation activities (Gilbert et. al. 1989). This information also can be used to support the remedial action decision based on impacts to the surrounding community (EPA 1991c). DOE Order 5400.5 (DOE 1990) mandates that DOE implement the ALARA process in all activities. The ALARA process requires that after the applicable radiation protection limits (e.g., dose) are met, the dose/risk shall be further reduced as low as reasonably achievable, taking into account technical, economic, and social factors.

### 5.2.2 Chemical Risk and Hazard Index Estimates

Estimates of risk to site receptors resulting from exposure to chemical carcinogens are presented in Table 5-2, expressed as the increased probability of a cancer occurring over the course of a lifetime. Estimates are presented for both mean and RME conditions.

Chemical-specific intakes and carcinogenic risks are tabulated in Appendix E. Risks could be estimated only for those chemicals of concern with a toxicity value currently available from IRIS (EPA 1992b) or HEAST (EPA 1992a), or from interim or provisional values available from the Superfund Health Risk Technical Support Center - ECAO and EPA Region II (EPA 1992c).

The potential for adverse noncarcinogenic health effects is expressed as chemical-specific HQs, which are tabulated in Appendix E. HQs were tabulated for all chemicals of concern where reference doses are currently available (EPA 1992b; EPA 1992a; EPA 1992c). HQs are summed for each pathway to provide a total HI for the pathway. The pathway-specific and total pathway HIs are presented in Table 5-3.

Current receptors considered in the assessment of chemical risks at the Maywood site are employees and transient visitors to the site. Soil ingestion and airborne particulate inhalation were the pathways considered for employees and transients. For the hypothetical future use scenario, employees and residents were considered to ingest groundwater, and a future resident child

**Table 5-2. Summary of Chemical Risk-Carcinogens**

| CURRENT USE SCENARIO | | | | | | |
|---|---|---|---|---|---|---|
| Location/Pathway | Employee | | Resident | | Transient | |
| | Mean | R M E | Mean | R M E | Mean | R M E |
| MISS | | | | | | |
| Soil Ingestion | 5 E-07 | 6 E-06 | | | 3 E-07 | 2 E-06 |
| Particulate Inhalation | 3 E-07 | 2 E-05 | | | 3 E-08 | 1 E-05 |
| Stepan | | | | | | |
| Soil Ingestion | 4 E-06 | 2 E-05 | | | 2 E-06 | 1 E-05 |
| Particulate Inhalation | 3 E-08 | 4 E-07 | | | 2 E-09 | 3 E-07 |
| Westerly Brook | | | | | | |
| Surface Water Ingestion | | | | | | |
| Lodi Brook | | | | | | |
| Sediment Ingestion | | | | | | |
| **FUTURE USE SCENARIO** | | | | | | |
| Location/Pathway | Employee | | Resident | | Transient | |
| | Mean | R M E | Mean | R M E | Mean | R M E |
| MISS | | | | | | |
| Soil Ingestion | 5 E-07 | 6 E-06 | | | 3 E-07 | 2 E-06 |
| Particulate Inhalation | 3 E-07 | 2 E-05 | | | 3 E-08 | 1 E-05 |
| Stepan | | | | | | |
| Soil Ingestion | 4 E-06 | 2 E-05 | | | 2 E-06 | 1 E-05 |
| Particulate Inhalation | 3 E-08 | 4 E-07 | | | 2 E-09 | 3 E-07 |
| Westerly Brook | | | | | | |
| Surface Water Ingestion | | | 2 E-07 | 4 E-07 | | |
| Lodi Brook | | | a | a | | |
| Sediment Ingestion | | | | | | |
| Alluvium Groundwater | | | | | | |
| Near Sources | 3 E-04 | 4 E-03 | 1 E-03 | 1 E-02 | | |
| 500 ft away | | | 1 E-05 | 1 E-04 | | |
| 1000 ft away | | | 1 E-07 | 1 E-06 | | |

a = Risk value was not calculated due to the absence of EPA slope factors.

**Table 5-3. Summary of Noncarcinogenic Hazard Indices**

| CURRENT USE SCENARIO | | | | | | |
|---|---|---|---|---|---|---|
| Location/Pathway | Employee | | Resident | | Transient | |
| | Mean | R M E | Mean | R M E | Mean | R M E |
| MISS | | | | | | |
| Soil Ingestion | 2 E-02 | 2 E-01 | | | 6 E-03 | 6 E-02 |
| Particulate Inhalation | a | a | | | a | a |
| Stepan | | | | | | |
| Soil Ingestion | 1 E-02 | 4 E-02 | | | 4 E-03 | 1 E-02 |
| Particulate Inhalation | a | a | | | a | a |
| Westerly Brook | | | | | | |
| Surface Water Ingestion | | | | | | |
| Lodi Brook | | | | | | |
| Sediment Ingestion | | | | | | |
| **FUTURE USE SCENARIO** | | | | | | |
| Location/Pathway | Employee | | Resident | | Transient | |
| | Mean | R M E | Mean | R M E | Mean | R M E |
| MISS | | | | | | |
| Soil Ingestion | 2 E-02 | 2 E-01 | | | 6 E-03 | 6 E-02 |
| Particulate Inhalation | a | a | | | a | a |
| Stepan | | | | | | |
| Soil Ingestion | 1 E-02 | 4 E-02 | | | 4 E-03 | 1 E-02 |
| Particulate Inhalation | a | a | | | a | a |
| Westerly Brook | | | | | | |
| Surface Water Ingestion | | | 4 E-03 | 9 E-03 | | |
| Lodi Brook | | | 6 E-03 | 2 E-02 | | |
| Sediment Ingestion | | | | | | |
| Alluvium Groundwater | | | | | | |
| Near Sources | 7 E+00 | 3 E+01 | 2 E+01 | 9 E+01 | | |
| 500 ft away | | | 2 E-01 | 9 E-01 | | |
| 1000 ft away | | | 2 E-03 | 9 E-03 | | |

a = Risk value was not calculated due to the absence of EPA reference doses.

was considered to be exposed to surface water and sediments while playing in Westerly and Lodi Brooks. Based on available data from the RI report, potential cancer risk and noncancer health hazards were estimated for reasonable current uses and hypothetical future uses (Tables 5-2 and 5-3).

5.2.2.1 Current Use Scenarios

Under the current use scenario, none of the estimated cancer risks exceeded the EPA target range (Figure 5-3). Risks for RME exposures range from $2x10^{-5}$ to $3x10^{-7}$. The potential risk from surface soil ingestion was highest for both current employees and transients at the Stepan property. The principal contributors to risk for this pathway were arsenic and PAHs at both Stepan and MISS. The potential risk from airborne particulate inhalation was higher at MISS than at Stepan. Chromium was the sole contributor to inhalation risk at MISS as was arsenic at Stepan; however, risk could not be calculated for PAHs because no inhalation SF was available.

The HIs for current employees and transients were all less than one, indicating no concern for potential adverse noncancer health effects (Figure 5-4). There were no available reference doses for estimating potential risk from particulate inhalation. The estimated HIs were essentially similar at both properties. Chromium and uranium were the principal contributors to the health hazard at MISS, and arsenic and uranium were major contributors at Stepan.

5.2.2.2 Future Use Scenarios

For the future use scenarios, none of the estimated cancer risks exceeded the EPA target range, except for ingestion of groundwater by the future employee and resident (Figure 5-5). The groundwater pathway was assumed incomplete for the future transient. Groundwater risks for shallow (alluvium) groundwater ingestion by an employee are $3x10^{-4}$ (mean) to $4x10^{-3}$ (RME) (Table 5-2). Resident risks would be slightly higher if the residence was near the source, but may be lower for residences further away. The groundwater was considered a continuum; therefore, risks were not estimated for individual properties. The risk attributable to ingestion of bedrock groundwater was approximately one order of magnitude less than that for exposure to shallow (alluvium) groundwater. The risk from groundwater ingestion principally was due to arsenic, tetrachloroethylene, and vinyl chloride.

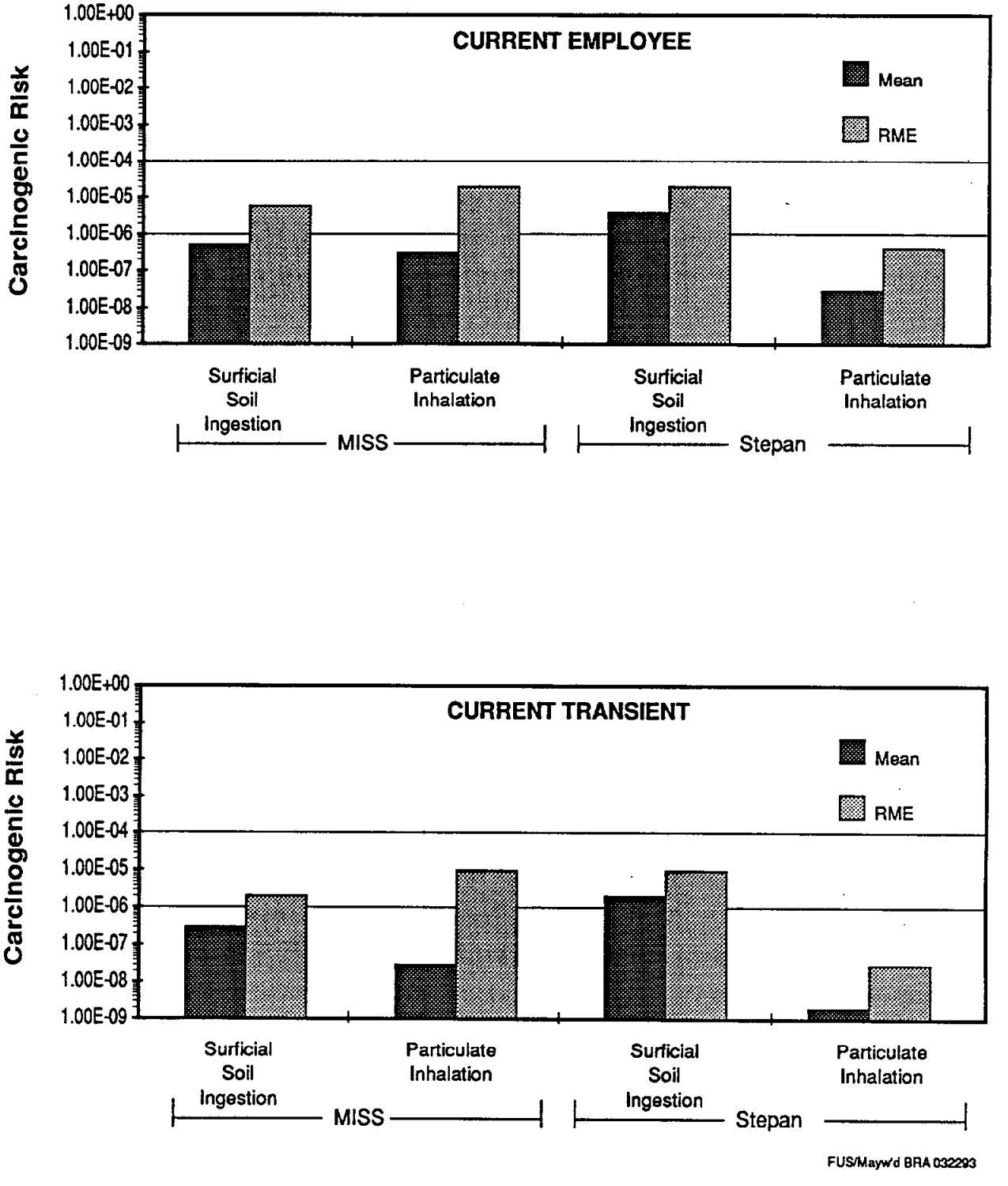



**Figure 5-3. Relative Pathway Contribution to Chemical Cancer Risk for Current Use Scenarios**

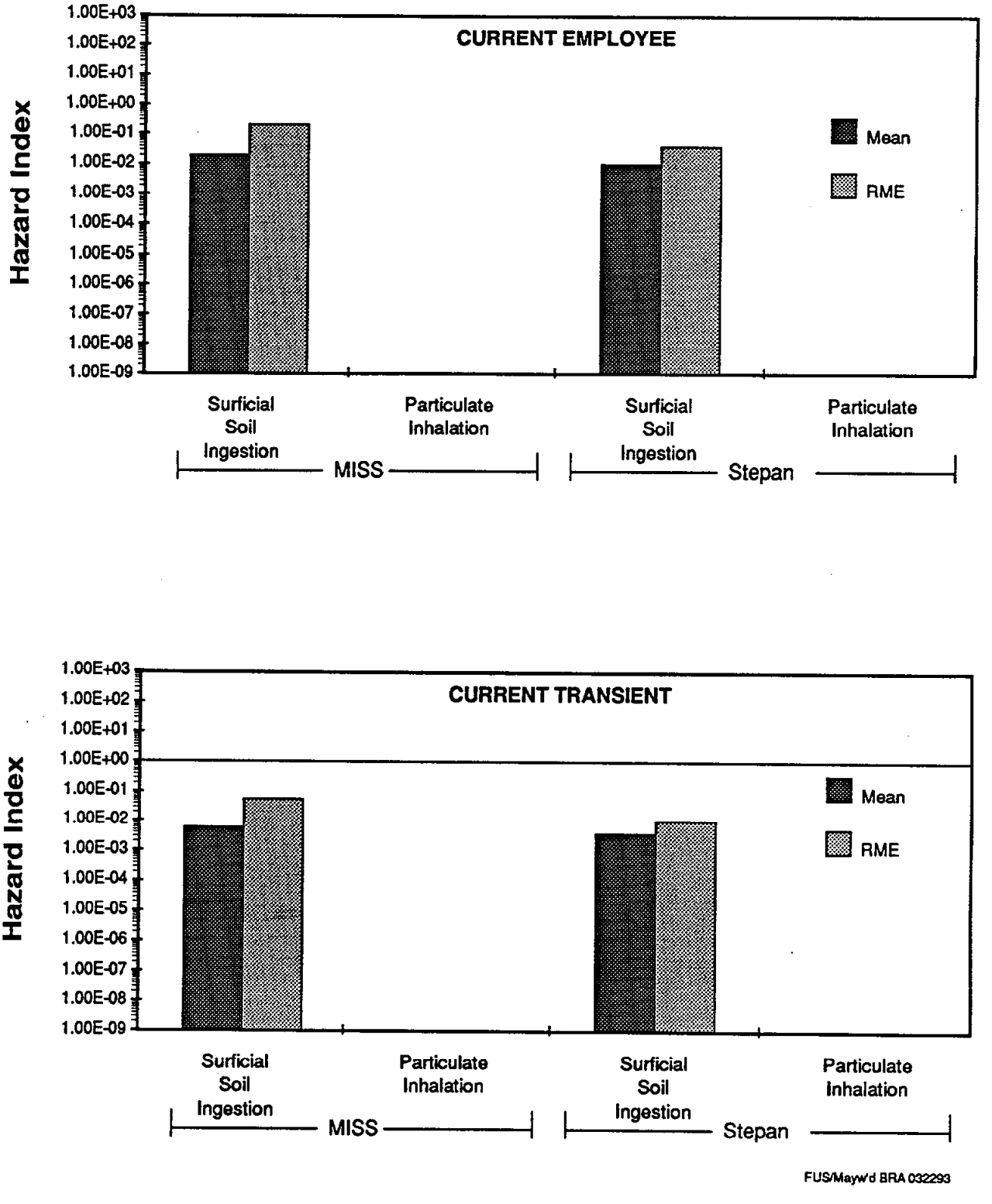



**Figure 5-4. Relative Pathway Contribution to Chemical Hazard Indices for Current Use Scenarios**

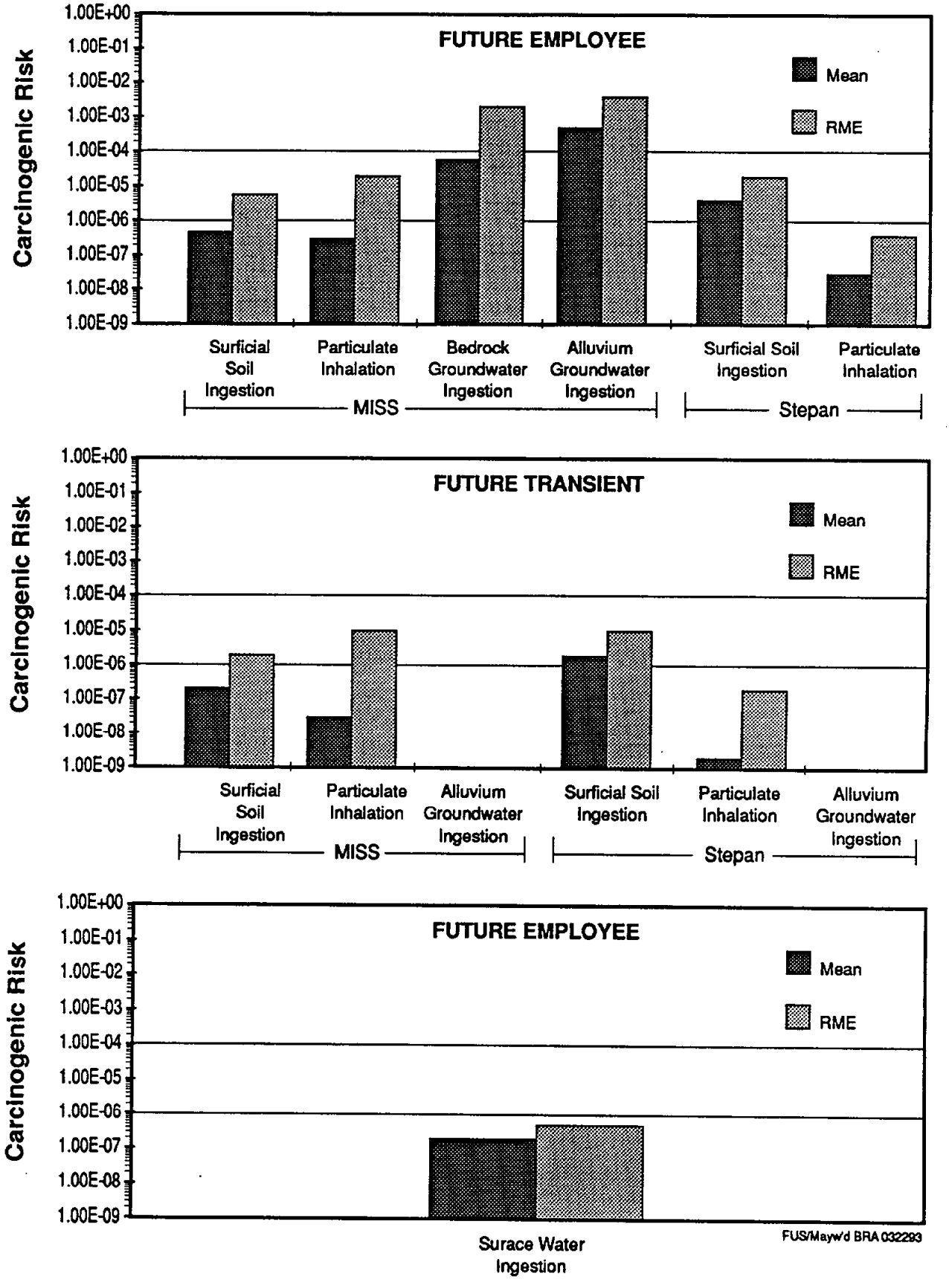



**Figure 5-5. Relative Pathway Contribution to Chemical Cancer Risk for Future Use Scenarios**

The cancer risk from soil ingestion and from particulate inhalation for future employees and transients at MISS and Stepan are the same as those for the current use scenario.

The cancer risk from average exposure to a future resident child playing in Westerly Brook was estimated to be $2x10^{-7}$ with a value of $4x10^{-7}$ for RME exposure from surface water ingestion (Table 5-2). Arsenic is the principal contributor to this risk estimate.

There were no COCs in Westerly Brook sediments or Lodi Brook surface water and no SFs for estimation of risk from sediment ingestion exposure in Lodi Brook.

The principal noncancer health hazard at the Maywood site is due to groundwater ingestion. No other complete pathways, for which HIs could be calculated, exceeded the concern threshold of one (Figure 5-6). The health hazard from ingestion of shallow (alluvium) groundwater ranged from 7 (mean) to 30 (RME) for future employees, and approximately the same for respective mean and RME exposures to bedrock groundwater. The hazard index for residents near the source would be higher, but residents further away may have lower HI. The groundwater pathway was assumed to be incomplete for the future transient. In the shallow groundwater, arsenic, chromium, lithium, and manganese contributed 50, 10, and 30 percent respectively to the HI. In bedrock groundwater, manganese accounted for approximately 90 percent of the HI.

The HIs for future employees and transients for the soil ingestion and particulate inhalation pathways at MISS and Stepan are the same as those for the current use scenario. The HI from exposure to a future resident child playing in Westerly Brook or Lodi Brook ranged from $2x10^{-2}$ to $3x10^{-3}$ indicating no concern for adverse noncancer health effects.

## 5.3 UNCERTAINTY IN THE ASSESSMENT PROCESS

The evaluation of radiological and chemical risks to human health presented in this BRA was, by necessity, based on a number of assumptions. In addition, many uncertainties are inherent to the risk assessment process. This section provides additional discussion of the rationale for the major assumptions used in this assessment and associated uncertainties, in order to address their potential impact on the results contained herein.

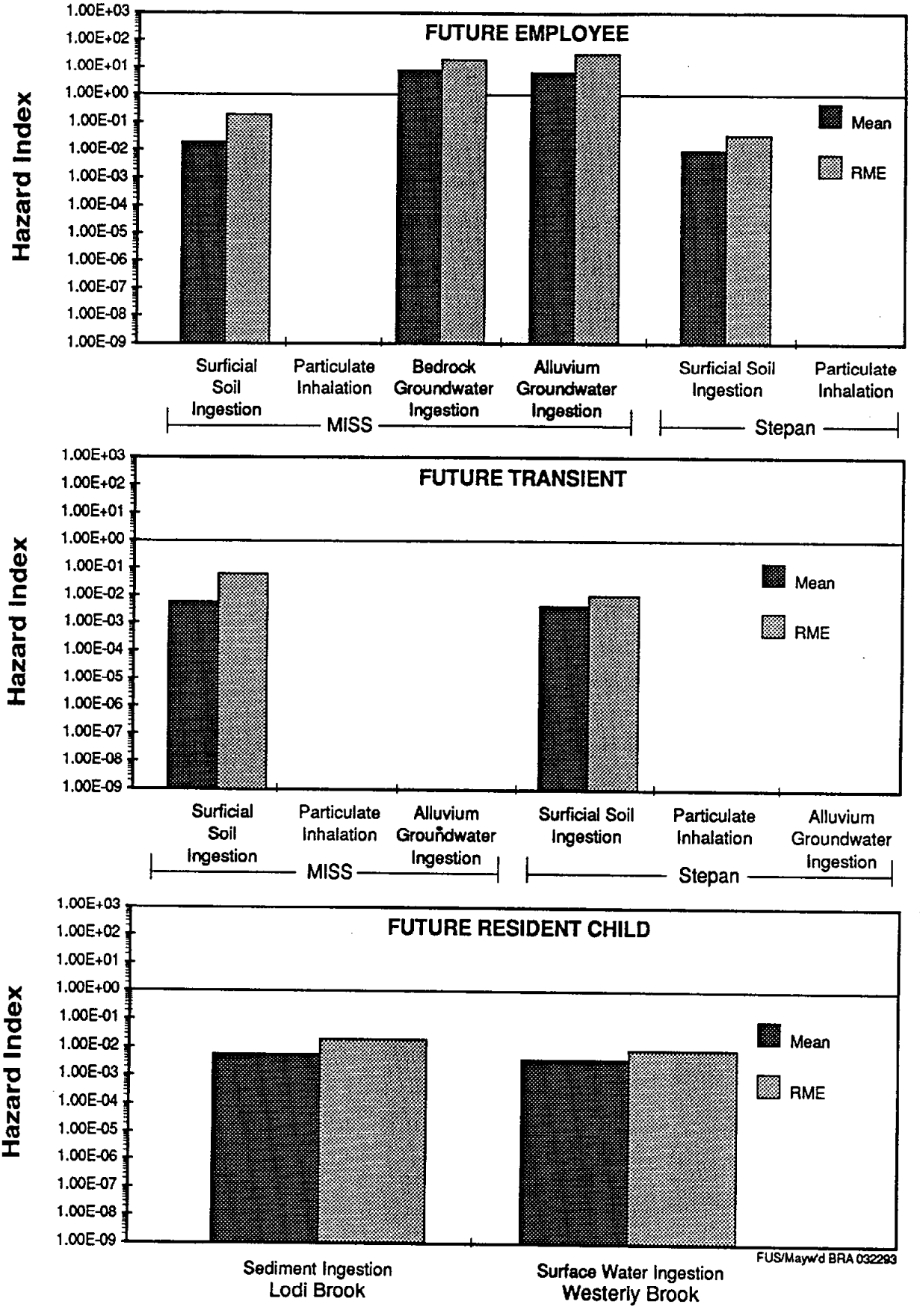



**Figure 5-6. Relative Pathway Contribution to Chemical Hazard Indices for Future Use Scenarios**

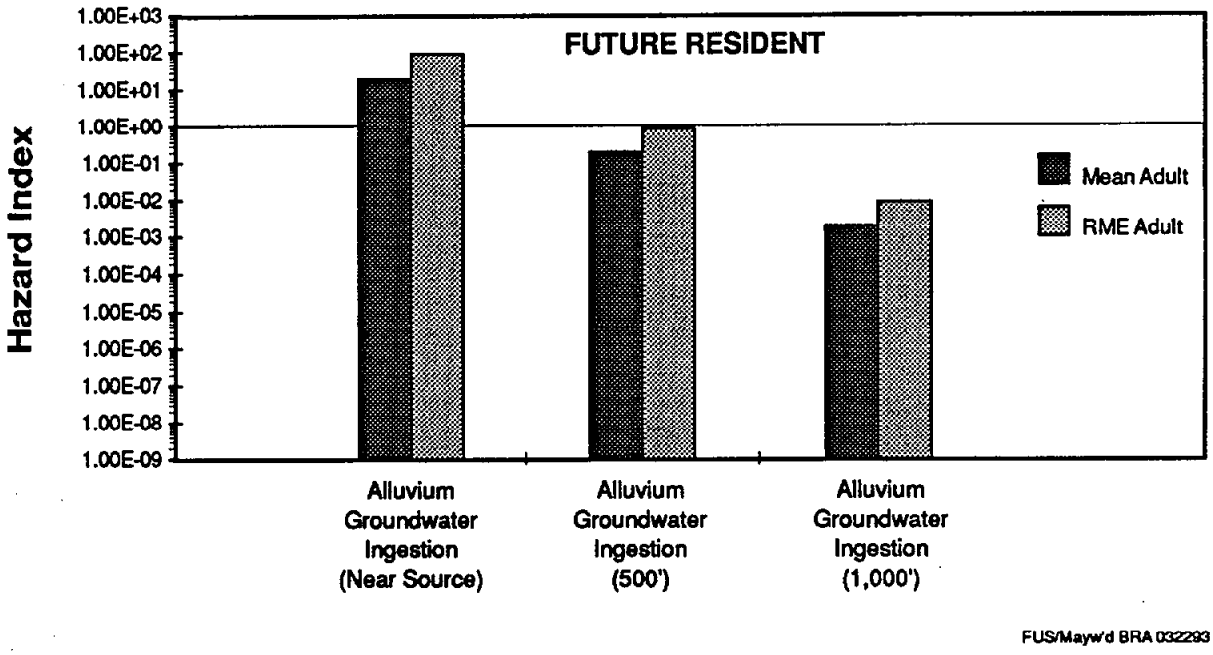



**Figure 5-7. Relative Pathway Contribution to Chemical Hazard Indices for Future Use Scenarios**

### 5.3.1 Uncertainty in Radiological Risk Estimates

#### 5.3.1.1 Contaminants of Concern (COCs)

The identification of COCs for a human health evaluation relies on information from site characterization activities and the application of a selection process. Considerable data have been collected for the site under both DOE's environmental monitoring program and the site characterization effort. The COC selection process was designed using EPA guidance to identify those contaminants that contribute most to the estimates of excess risks.

Soil is the primary focus of this assessment relative to forthcoming cleanup decisions and is considered to be fairly well characterized for radiological contaminants. The radiological risks for soil were based on reported radionuclide concentrations, as provided in the RI report and a wide range of other reports (summarized in Appendix A). Analyses were conducted for only selected radionuclides of the U-238 and Th-232 decay series. No other naturally occurring, accelerator-produced, or fission product radionuclides were considered. This approach is consistent with the history of site operations (i.e., as a thorium processing facility) and the characteristics of radionuclides in these two decay series (i.e., the half-lives of the various radionuclides).

Because not all radionuclides were reported for each sample location, a property-wide analysis may under estimate the radiological risk from exposure to a particular region of soil. Further, the majority of the properties were bias sampled at areas of elevated gamma radiation levels. Shielding by overlying materials may have attenuated the gamma activity, allowing oversight of subsurface deposits. The property unit-wide analysis considered direct gamma irradiation, ingestion, and inhalation exposures to all radionuclides of concern in soil. However, the predominant radiological risk associated with contaminated soil is from external gamma irradiation. Measured gamma exposure rates were used where available in this assessment. The uncertainty in the estimates of the radiological risk from soil as a result of lack of location-specific radionuclide concentrations and undetected subsurface deposits is expected to be low.

The limited characterization of airborne contamination could potentially affect the risk estimates. No airborne particulate concentration measurements were made, and limited radon data are available. The estimated risks associated with airborne exposure could be either over estimated or under estimated as a result. Except for radon, the uncertainty is not expected to significantly affect the results of this assessment since the particulate inhalation pathway is typically a minor contributor to the projected radiation exposure. Radon exposure is an important contributor to total

risk. Radon was not identified by the screening process directly as a COC because the limited available data indicated that average measured concentrations did not exceed twice background levels. However, radon was included in the analysis because it is a daughter of radium, which was a COC in soil.

Uncertainty is inherent in the selection of COCs for a BRA and is associated with several factors. First, limitations in data relative to locations and analytes sampled and to analytical considerations (e.g., laboratory procedures) may affect the contaminants identified for a site. The uncertainty associated with the site sampling data is considered low because the sampling plans generally targeted appropriate areas and analytes using historical information, visual observations, and both phased and biased and nonbiased characterization strategies. Uncertainty relative to sample analysis and data evaluation is also considered low because an extensive, site-specific quality assurance program has been implemented and is ongoing.

The contaminant selection screening may also introduce uncertainty. The estimated health effects could be higher if all compounds were included in the baseline assessment. To address this uncertainty, the selection process for radionuclides is designed to include all components of the measured radioactive decay series by assuming secular equilibrium Hence, the uncertainty associated with the screening step for radiological COCs is considered low.

5.3.1.2 Exposure Assessment

An exposure assessment is constructed from a number of site-specific considerations, including exposure point concentrations, scenario assumptions and intake parameters, and primary exposure pathways.

Factors that can contribute to uncertainty in exposure point concentrations include data availability and data heterogeneity. For example, limited data are available for air, including radioactive particulates and radon, and no site-specific measurements of uptake by plants are available.

In the absence of measurements needed to assess the inhalation pathway at the site, air particulate concentrations have been modeled to estimate exposure point concentrations. Although greater uncertainty is associated with the exposures calculated for this pathway, inhalation is generally a minor contributor to radiological risks associated with the site. Therefore, the effect of this uncertainty on the exposure assessment is considered small.

Substantial uncertainty is associated with the modeling used to estimate exposure for the plant ingestion pathway. The model may not appropriately estimate tissue concentrations of the various contaminants in plants. Although the RESRAD model uses conservative values for uptake and bioconcentration factors, the biological behavior of these contaminants is very much affected by site-specific conditions. Hence, large uncertainty is associated with modeling for this pathway. Since this pathway is a minor contributor to total radiological dose, the effect of this uncertainty on the exposure assessment is considered small.

Extensive data are available for radionuclide concentrations in soil, but heterogeneity in the spatial distribution of contaminants could contribute to uncertainties when estimating appropriate exposure point concentrations. The mean and UL95 confidence of the mean were used for the exposure point concentrations. This spatial averaging may over estimate or under estimate exposures for a receptor who may preferentially spend time at a particular location. The majority of the individual properties were sampled using a biased methodology. Although the majority of the receptors are expected to be mobile, and the intent of the data aggregation methodology was to identify areas of similar contaminant levels and land uses, the uncertainties related to data heterogeneity in soil remain significant and may be the most important component of total uncertainty in exposure assessment.

The method for addressing non-detects (less than values) also affects the exposure point concentrations. The inclusion of the detection limit for non-detects tends to increase the reported concentrations and resultant uncertainty. The detection limits for most analyses were low relative to background or the appropriate soil concentration guidelines. The uncertainty associated with the incorporation of non-detects is considered small.

Another source of uncertainty is associated with the assumptions used to identify scenarios and intake parameters for the exposure estimates. Site-specific factors were used to select the scenario assumptions such as the extent of exposure (i.e., the exposure time, frequency, and duration) and to identify potential receptors (e.g., employees and transients). These assumptions use information on current land use and reasonable projections of future land use that consider the time frame of the assessment. The uncertainty in the scenarios developed for the current conditions is low because the time period is relatively short; current commercial/industrial land uses are expected to continue during this period.

Residential use of MISS and the heavy commercial/industrial properties is unlikely within the time frame of this assessment because it is inconsistent with ongoing DOE activities and the surrounding land use and reasonable projections thereof. Therefore, a residential scenario is not considered appropriate for these property units.

Best professional judgment was used to define the variables used to estimate mean and RME for the identified receptors. Intake parameters used in the exposure assessment were derived from data in the literature, including EPA guidelines. Since considerable information is available with respect to reasonable assumptions for intake parameters (e.g., inhalation rates), the related uncertainty is expected to be low. Furthermore, uncertainties associated with selecting values from the typical ranges identified for these parameters are not expected to significantly affect potential exposure estimates.

The exposure pathways quantified in this BRA were determined on the basis of the site conceptual model and related characterization data. The uncertainty associated with selected pathways for this assessment is low because site characterization data support the conceptual model.

5.3.1.3 Toxicity Assessment

Standard dose conversion factors and risk estimates were used to estimate the carcinogenic hazards associated with radioactive contaminants. The health effects associated with radiation exposure have been studied for many years and are well known. The risk estimators used in this assessment are generally accepted by the scientific community as representing reasonable projections of the hazards associated with radiation exposure.

Human epidemiological data on carcinogenesis from exposure to ionizing radiation is more extensive than that for most chemical carcinogens. However, these data are based primarily upon studies of populations exposed to radiation doses and dose rates that are orders of magnitude higher than the levels of concern at the Maywood site (e.g., atomic bomb survivors, uranium mine workers, radium dial painters, thorotrast painters, etc.). Use of these data to predict excess cancer risk from low-level radiation exposure requires extrapolation based upon very uncertain dose-response assumptions. This uncertainty is evidenced by the revision in cancer risk estimates presented in the BEIR V report (NRC 1990) by a factor of 3-4 over those presented only ten years earlier in the BEIR III report (NRC 1980), due primarily to additional study of the atomic bomb survivors and reassessment of the atomic bomb dosimetry. Whereas this revision would indicate

higher radiological risks than previously predicted, the BEIR V report also states that "...epidemiological data cannot rigorously exclude the existence of a threshold in the millisievert dose range. Thus the possibility that there may be no risks from exposures comparable to the external natural background radiation cannot be ruled out. At such low doses and dose rates, it must be acknowledged that the lower limit of the range of uncertainty in the risk estimates extends to zero" (NRC 1990).

#### 5.3.1.4 Risk Characterization

Some of the procedures used and uncertainties inherent in the human health assessment process may tend to under estimate potential risks, including the use of standard dose conversion factors for estimating radiation doses that are based on adult exposures. However, most of the other assumptions built into this BRA tend to over estimate rather than under estimate potential risks.

The radiological dose conversion factors used in this assessment are based on the ICRP reference man. The reference man is an adult male weighing 70 kg. The ICRP selected such a standardized individual for their dosimetry models because their main concern is associated with worker protection; the majority of radiation workers are adult males. Although children are more susceptible to radiation exposure, such effects are significant only for young children. The uncertainty associated with using dose conversion factors developed for adults for an adolescent is low, and does not significantly impact the radiological risks presented in this document. The estimation of health effects associated with radiation doses was based on lifetime-average risk estimators for all routes of exposure. These lifetime-average risk estimators are appropriate because they reflect the likely conditions of exposure, i.e., any given age group could be exposed to the radioactive contaminants. The uncertainty associated with the risk estimates used to assess radiation toxicity in this BRA is, therefore, low.

### 5.3.2 Uncertainty in Chemical Risk Estimates

#### 5.3.2.1 Contaminants of Concern

Chemical process operations conducted at the Maywood site have little documentation. Thorium processing conducted from 1916 to 1956 is not likely to have generated the organic chemicals detected at the MISS, Stepan, and Ballod properties. Other chemical operations undoubtedly occurred at the site but are not documented. Chemical waste was disposed onsite, but not all the areas where waste may have been deposited have been sampled. The independent RI/FS

study in progress on the Stepan property may provide more insight into chemical contamination sources in the area.

Limited groundwater and surface water sampling data suggest that a few organic contaminants and metals detected in bedrock and alluvial aquifers at the Ballod property and in Westerly Brook downstream from Ballod may have their source at the MISS Operable Unit where waste burial has occurred. The upgradient monitoring wells at the MISS are free of these same analytes, whereas the onsite soils and other monitoring wells at the MISS and Stepan OUs are not. Further groundwater sampling is in progress to supplement existing characterization at the site.

The Maywood, Rochelle Park, and Lodi communities are densely populated and have a number of active industrial facilities that are potential sources of chemical contamination. These circumstances make it difficult to obtain reliable background concentrations of naturally occurring chemicals and to sort out the components of regional chemical contamination that may be inadvertently attributed to the Maywood site, thereby overestimating the risk contribution from the site.

Limitations in the available chemical data also create uncertainty in the selection of COCs, in the statistical analysis of site contamination, and in the resulting intake and risk determinations. The soil concentration measurements may not completely represent the true distribution of soil contamination at the individual properties which could over estimate or under estimate chemical risk.

The paucity of offsite sampling in mobile environmental media creates uncertainty in assessing offsite contaminant migration and potential risk. The absence of onsite ambient air sampling for chemicals introduces additional uncertainty into this route of exposure. Another limitation in the soil data is the lack of speciation data for chromium.

Uncertainty also is inherent in the selection of contaminants of concern from the baseline risk assessment. Uncertainty in site sampling data is considered low because the sampling plans generally targeted appropriate analytes based on historical information and guidance. Reasonable certainty also is assumed because of the sample data validation and QA/QC procedures applied to sample analysis and data evaluation. Eliminating contaminants in the COC screening process can lead to lower estimates of potential health effects than inclusion of all analytes. However, other than common laboratory contaminants, the only chemicals excluded from the risk assessment were those detected at very low frequencies and at concentrations approaching background.

5.3.2.2 Exposure Assessment

Factors that can contribute to uncertainty in the exposure assessment include derivation of exposure point concentrations, assumptions for scenario development and intake parameters, and exposure pathways. Limitations in onsite air measurements are noted above. The risk estimate from groundwater exposure was limited to consideration of the MISS and Stepan properties because of data availability, and limited surface water and sediment sampling was conducted in Westerly and Lodi Brooks.

Values assumed for exposure parameters (e.g., inhalation rate and exposure frequency) used in calculations for intakes were based primarily on EPA guidance (EPA 1990 and 1991b). These assumptions might result in under estimating or over estimating the intakes calculated for specific receptors, depending on the accuracy of the assumptions relative to actual site conditions and uses. For example, a 50 mL/event water ingestion rate and a 200 mg/day sediment ingestion rate were used for the child wading in Westerly and Lodi Brooks. The water ingestion rate is the EPA recommended value for incidental ingestion while swimming, and the sediment ingestion rate is the default value for child soil ingestion. Both of these assumptions overestimate intake, and thus risk, for the wading scenario.

Since offsite groundwater data is not yet available, a simple model was used to estimate the reduction in concentration in contaminants as the groundwater flows away from the source areas. From this simple model it appears that the risks and hazard indices may be within an acceptable range when the receptor is beyond 500 ft from the source.

Two potential pathways for the scenarios in this assessment, the dermal pathway and the ingestion of homegrown produce pathway, were not evaluated. This assessment does not include an estimation of the exposure through these pathways because of the evolving nature of EPA's policies on quantifying these pathways for the COCs included in this BRA and because of the uncertainties in the values (i.e., dermal adsorption coefficients and soil-to-plant uptake factors) necessary to calculate or estimate these pathways. Also, the produce ingestion pathway is not compatible with the assumed current and future land use at the affected properties. The omission of these potential exposure pathways may result in a minor underestimation of chemical risks, but is not expected to significantly affect the assessment.

The identification of potential receptors was based on site-specific reasonable current use and hypothetical future land use. Site-specific receptors were identified to the extent possible and exposure parameters tailored to these receptors to minimize uncertainty in the postulated scenarios and exposure assessment.

5.3.2.3 Toxicity Assessment

Uncertainty also is inherent in the toxicity values utilized in characterizing the carcinogenic and noncarcinogenic risks. Such uncertainty is chemical-specific and is incorporated into the toxicity value during its development. For example, an uncertainty factor may be applied for interspecies and intrahuman variability, for extrapolation from subchronic to chronic duration of exposure, or for epidemiological data limitations. These uncertainties are identified in Section 4.0.

A number of identified COCs are currently under EPA review with the possibility of changed reference doses, slope factors, or carcinogenic weight of evidence. Interim and provisional toxicity values were used, where available, when values could not be obtained from IRIS or HEAST. Additional uncertainty in risk estimates is introduced when all COCs do not have valid toxicity factors for use in quantitative estimates. Inhalation slope factors and reference doses in particular were largely unavailable for the COCs in the particulate pathway. Toxicity values could not be obtained for some COCs, thereby precluding their inclusion in the quantitative risk estimates. The resulting risk estimates do not include the incremental chemical-specific risks from these COCs, and therefore may underestimate risk, although the magnitude of this underestimation is not quantifiable.

The lack of chemical speciation data for chromium and assumption that all chromium is chromium (VI) overestimates the contribution to risk from this metal. In addition, a single factor was used to estimate the risk for all PAHs present, another potentially conservative assumption.

Arsenic, tetrachloroethylene and vinyl chloride were the principle contributors to carcinogenic risk from groundwater ingestion. Arsenic and vinyl chloride are known human carcinogens (Class A) that accounted for approximately 30 percent of the risk, whereas tetrachloroethylene which is only a probable to possible human carcinogen (Class C) contributed approximately 70 percent of the risk.

5.3.2.4 Risk Characterization

Some of the procedures used and uncertainties inherent in the human health assessment process may tend to underestimate potential risk. However, assumptions built into this BRA tend to overestimate rather than underestimate potential risks, including conservative assumptions for the exposure scenarios. For example, contamination is assumed to remain constant over time. Fate and transport mechanisms were not considered in the exposure evaluation for chemical COCs. Actual concentrations may change over time, which would influence the intake and related risk values. Thus, actual risks are likely to be lower than those presented in this assessment.

For COCs, oral RfDs were available for most of the toxicologically important chemicals, but few inhalation RfDs were available, precluding effective estimation of this pathway contribution to health hazard. In addition, toxicity factors are not available for any of the rare earth element COCs. Although lead exposure causes significant toxic effects and lead may also be carcinogenic, toxicity factors are not available; they are currently under review by EPA. Recent draft guidance from EPA (1992e) suggest a quantitative method for estimating detrimental environmental lead levels (uptake/biokinetic model), but this method is not yet approved for use.

Finally, for this assessment, it was assumed that the toxic and carcinogenic effects of the chemical COCs are additive. This assumption could result in the underestimation of risks because concurrent exposure to several contaminants might have synergistic toxic effects, (i.e., exposure to two of the metals concurrently might induce a greater toxic effect than that expected if the separate effects were simply added). Conversely, concurrent exposure to some of the metals might also mitigate the toxic effects of exposure to individual metals.

## 5.4 SUMMARY OF HEALTH RISK CHARACTERIZATION

### 5.4.1 Radiological Risk

The radiological health risks considered are limited to induction of cancer. Risk to radioactive contaminants was estimated following EPA (EPA 1989d), BEIR IV (NRC 1988), and BEIR V (NRC 1990) recommendations. A population-weighted average excess cancer risk of $6 \times 10^{-7}$ per mrem was assumed.

For the current use scenario, reasonable maximum risk exceeds the target range for current residents at the I-80 South right-of-way and Long Valley Road (Property Unit 1), for current

transients at the field on the MISS property, in front of Building 76 (Property Unit 6H), and current employees at Stepan (Property Units 3 and 3H), MISS (Property Unit 6) and Sears/DeSaussure (Property Unit 7H).

For the hypothetical future use scenario, RME risk estimates for all receptor exceed the target risk range. The dominant exposure pathways are similar to those in the current use scenario with radon and direct gamma irradiation contributing most of the risk to the resident and employee receptors and direct gamma irradiation contributing most of the risk to transients.

The projected excess cancer rate for the total population within 80 km (50 mi) around the Maywood site is approximately 600 cancers per 10 million people. This constitutes a very small fraction of the total local cancer incidence rate attributable to background radiation, 100,000 cancers per 10 million people.

### 5.4.2 Chemical Risk

Chemical cancer risk and health hazard were estimated for chemicals of concern based on EPA risk assessment guidance (EPA 1989b, 1992d). The cancer risk from exposure to contaminants is expressed as the increased probability of developing cancer over a 70-year lifetime. The potential for adverse noncarcinogenic health effects is expressed as a hazard index, the sum of chemical-specific hazard quotients.

Under the current use scenario, none of the estimated cancer risks exceeded the EPA target risk range for employees or transients at MISS or Stepan. The principal contributors to risk from soil ingestion were arsenic and PAHs at both properties. For airborne particulate inhalation, chromium was the sole contributor to risk at MISS as was arsenic at Stepan, although no inhalation slope factors were available for PAHs.

The hazard indices for current employees and transients at MISS and Stepan were all less than one, indicating no concern for potential adverse noncancer health effects. Chromium, lithium, and uranium were the principal contributors to health hazard at MISS with arsenic and uranium the principal contributors at Stepan.

For the hypothetical future use scenario, none of the estimated cancer risk exceeded the EPA target range, except for groundwater ingestion. Groundwater contamination was considered as a continuum, therefore separate risks were not calculated for individual properties. The risk

attributable to ingestion of bedrock groundwater was approximately an order of magnitude less than that projected for the shallow (alluvium) groundwater.

The cancer risk from soil ingestion and particulate inhalation for future employees and transients at MISS and Stepan are the same as the current use scenario and did not exceed the EPA target risk range. The estimated cancer risk for a future resident child ingesting surface water while playing in Westerly Brook was not significant (less than $1x10^{-6}$). There were no COCs in Westerly Brook sediment or Lodi Brook surface water and no slope factors for estimating exposure through sediment ingestion from Lodi Brook.

The principal noncancer health hazard under the hypothetical future scenario is due to groundwater ingestion. The hazard indices are greater than one for residents near the sources or for future employees. No other complete pathways for which HIs could be calculated exceeded the concern threshold of one. In shallow (alluvium) groundwater, arsenic, chromium and manganese contributed principally to the hazard index, while manganese accounted for approximately 90 percent of the HI for the bedrock groundwater.

### 5.4.3 Overall Health Risks

To lend perspective for overall site risk, radiological and chemical carcinogenic risks for current and hypothetical future receptor scenarios were combined (summed). Since insufficient data are available to calculate chemical risks for all property units, the summation encompasses only the MISS and Stepan properties. Aggregate cancer risk is $6x10^{-3}$ for employee RME exposure at MISS. The aggregate risk is lower for Stepan employees.

# 6. ECOLOGICAL RISK ASSESSMENT

The environmental evaluation process is outlined in the *Risk Assessment Guidance for Superfund Vol. II Environmental Evaluation Manual Interim Final* (EPA 1991c). The *Environmental Evaluation Manual* does not provide a step-by-step approach to risk assessment as does the *Human Health Evaluation Manual.* Instead, it discusses an overall framework for considering environmental effects and identifies sources of pertinent information. Although environmental evaluations and human health evaluations are different processes, they share certain chemical data and information. The phrase "environmental evaluation" was patterned after "human health evaluation." However, the term "ecological risk assessment" (ERA) is common usage and will be used throughout this ERA. A discussion of the scientific basis for assessing ecological effects is found in *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document* (EPA 1989c).

The ERA for the Maywood BRA is structured according to the general framework for ecological assessments in the Superfund Program (EPA 1991b). This ERA comprises four interrelated activities: problem formulation (Section 6.1), exposure assessment (Section 6.2), effects assessment (Section 6.3), and risk characterization (Section 6.4). Because of the qualitative nature of the characterization of biota and habitats at risk and the screening of contaminants, the assessment of potential impacts to wildlife and vegetation from exposure to contaminants must be based largely on the toxicological effects reported in the literature for many of the contaminants of ecological concern and expected mechanisms of transport and biological uptake. Where toxicity data were available, a semiquantitative characterization of the risk to Maywood biotic communities from exposure to the ecological COCs was based on the ratio of environmental concentrations to toxicity threshold concentrations (Barnthouse et al. 1986). The ratio or quotient method is often used in ERAs.

## 6.1 PROBLEM FORMULATION

The conceptual model of the Maywood site, which identifies the potential contaminants and their sources, is presented in Section 2. In this ERA, the ecological resources at the site, COCs, and exposure pathways are identified, and the nature and relative magnitude of the risk to these resources, especially animals is characterized. This is done on a location by location and medium by medium basis.

### 6.1.1 Objective

The objective of the ERA is to define and evaluate the risk of adverse effects on the biotic environment from exposure to the contaminants at the Maywood site. A qualitative habitat characterization identifies the biotic components of the ecosystem, potential receptors, and likely exposure pathways. Field measurements of contaminant concentrations and published toxicity data for aquatic and terrestrial organisms allow a semiquantitative estimate of risk using the ratio or quotient method. This information is used to characterize the relative magnitudes of risks to ecological resources from contaminated media at the various Maywood operational units.

### 6.1.2 Scope

Identifying and assessing the risks to local biota and habitats on the Maywood properties exposed to site contaminants is feasible, even though environmental and toxicological data are limited. Concentration data exist for metals, rare earths and organics in environmental media at Maywood properties: soils at MISS, Stepan, commercial/government and residential units; groundwater at the MISS/Stepan/Ballod area; and surface water and sediments in Westerly and Lodi Brooks. Surface water and sediment data are unavailable for the wetland at the Sears property. No rigorous site-specific biological studies have been conducted. A reconnaissance study of biota was performed in 1984 (ANL 1984). This reconnaissance was updated in August 1992, and together with a jurisdictional survey of the wetland on the Sears property (CH2M Hill 1992), forms the basis of the habitat characterization (Section 6.1.4). Site contaminants that qualify as COCs for quantitative risk assessment (Section 2.3.1) are further screened for assessment as ecological COCs (Section 6.1.4). A contaminant qualifies as an ecological COC if its environmental concentration exceeds a toxicity-threshold concentration and if it meets mobility and persistence criteria. Similar joint considerations of toxicity, mobility, and persistence have been used to establish soil quality criteria (24 NJR 396 1992). Emphasis is given to both aquatic and terrestrial organisms exposed to contaminants in Maywood property soils, groundwater and the surface waters and sediments of Westerly and Lodi Brooks. The relative risks to classes of organisms exposed by various means to contaminants at the Maywood site locations are estimated using ratios of the environmental concentrations of contaminants (corrected or uncorrected for exposure differences) to toxicity threshold concentrations obtained from published data in AQUIRE (1992) and other environmental and toxicological data bases.

### 6.1.3 Habitat Characterization

The Maywood site consists of several property units in the borough of Maywood and township of Rochelle Park in Bergen County, New Jersey. These include MISS, the Stepan Company property, other commercial and governmental vicinity properties, and several residential properties (Figure 1-2). For the ERA, Westerly and Lodi Brooks and the Saddle River are also considered as habitats for offsite organisms. The Maywood area has undergone intensive development for commercial, industrial, or residential uses. An overview of the Maywood site is given below (Section 6.1.3.1). Section 6.1.3.2 discusses threatened or endangered species. The habitats on each property are discussed separately in Section 6.1.3.3, and Section 6.1.3.4 summarizes the habitat characterization.

#### 6.1.3.1 Overview of Current Situation

The Maywood site is located within the glaciated portion of the Appalachian Oak Forest Section of the Eastern Deciduous Forest Province (Bailey 1978). With the exception of the Saddle River, past agricultural and urban developments have converted the majority of the forest habitat, to urban habitat. Before recent removal actions on the Ballod property and MISS, these areas supported an early successional community dominated by grasses and forbs, with scattered shrubs and trees (e.g., aspen, elm, and oak). The residential properties contain plant species common to landscaped yards such as grasses (fescue and blue grass), garden vegetables, flowers, evergreen shrubs, and trees (ANL 1984). Figures 6-1 and 6-2 document the existing mix of habitats, comprised of grass/trees, shrubs/weeds, hydrophytic and riparian (stream) vegetation, transportation corridors/paved lots, and structures. Plants and animals live in or around all these habitats.

Commonly occurring wildlife species across the entire site are those adapted to suburban and urban environments. Bird species include house sparrow (*Passer domesticus*), red-winged blackbird (*Agelaius phoeniceus*), common crow (*Corvus brachyrhynchos*), common grackle (*Quiscalus quiscula*), starling (*Sturnus vulgaris*), mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), and wood thrush (*Hylocichla mustelina*). Mammalian species include Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus*), meadow vole (*Microtus pennsylvanicus*), raccoon (*Procyon lotor*), eastern cottontail rabbit (*Sylvilagus floridanus*), opossum (*Didelphis marsupialis*), and eastern gray squirrel (*Sciurus carolinensis*). Woodchucks (*Marmota monax*) and their burrows have been observed recently at MISS. A small number of

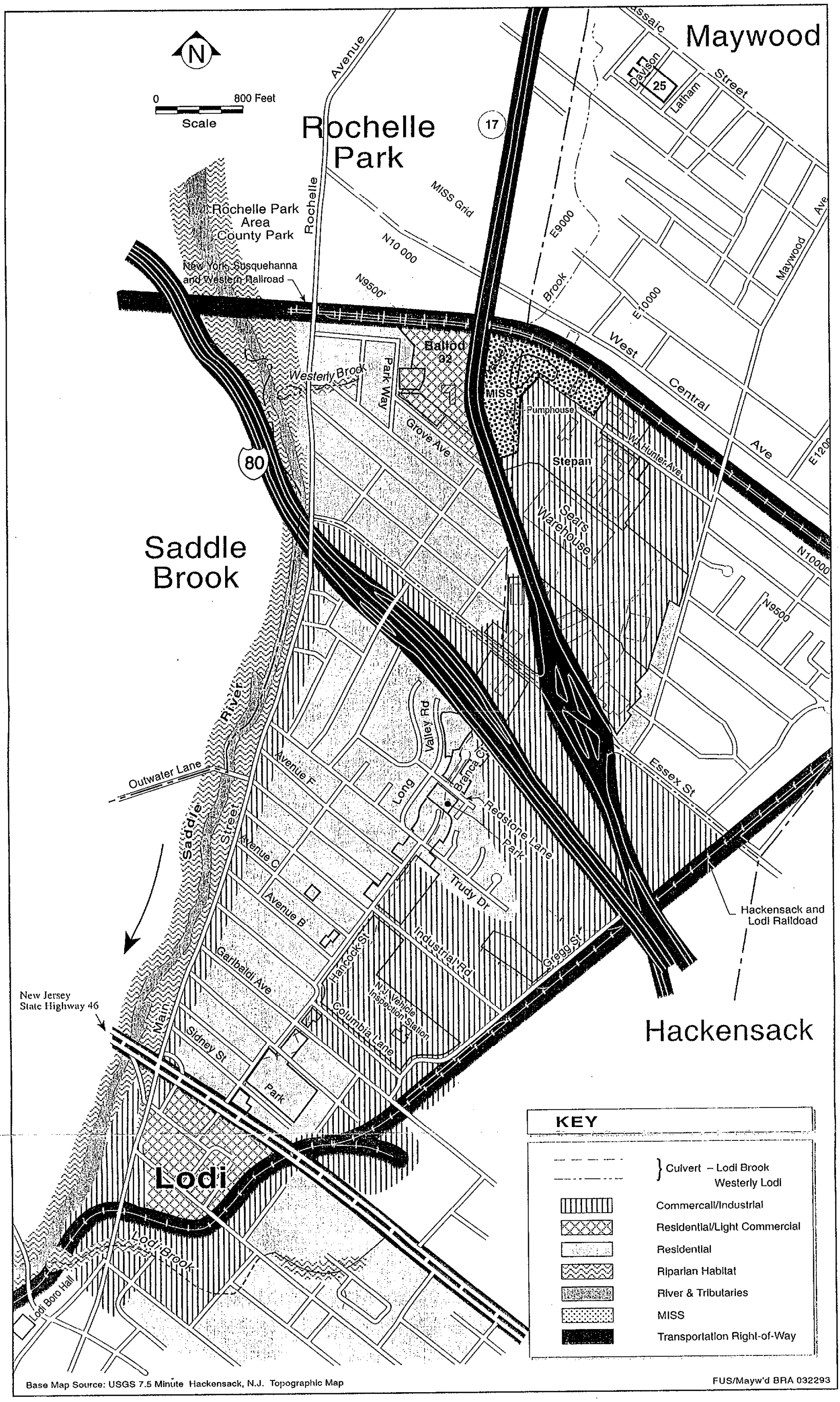
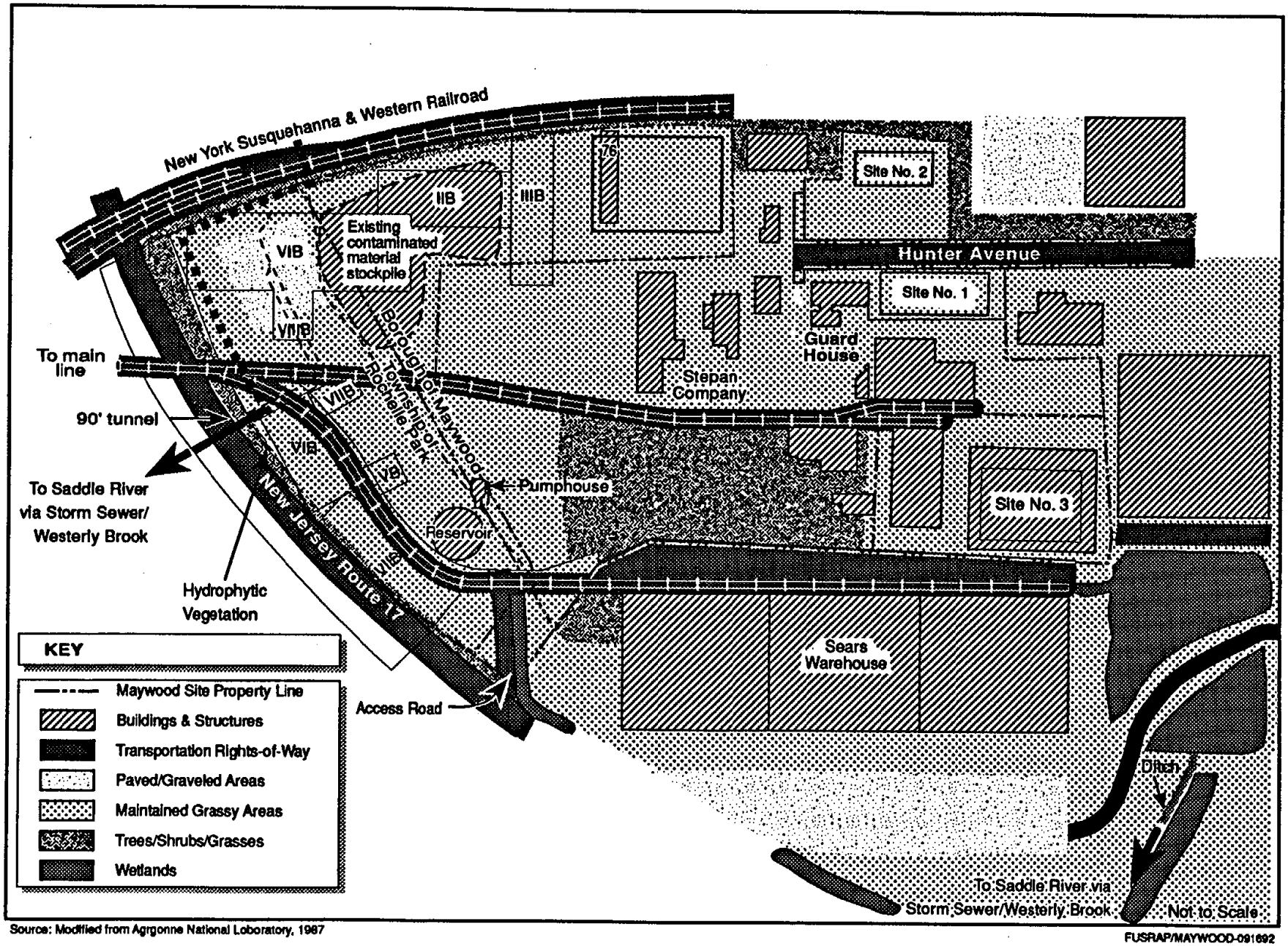



**Figure 6-1. Overview of Habitats at the Maywood Site**




Source: Modified from Argonne National Laboratory, 1987

**Figure 6-2. Closeup of Habitats in MISS, Stepan Company, other Commercial/Government, and Residential/Recreational Properties**

reptile and amphibian species, [e.g., eastern garter snake (*Thamnophis sirtalis*) and American toad (*Bufo americanus*)] probably inhabit the area (ANL 1984).

Aquatic habitats are limited to drainage ways, small temporary ponds, Westerly and Lodi Brooks, and the Saddle River. Westerly Brook traverses MISS but does not actually constitute an aquatic habitat because it is encased in concrete pipe beneath the site. Similarly, much of Lodi Brook is incorporated into a subsurface storm drain system. However, surface-feeding ducks [e.g., mallard (*Anas platyrhynchos*) and black duck (*Anas rubripes*)], were observed on the Saddle River and in accessible portions of Westerly Brook. Mosquito larvae, beetles, bugs, snails, isopods, midges, aquatic worms, and other invertebrates typically occur in these in-stream and temporary pond habitats (ANL 1987).

6.1.3.2 Threatened or Endangered Species

The Maywood site contains no known federally- or state-listed threatened or endangered inhabitants (either rare plants, animals, or natural communities) (Chezik 1989). Because of the transient nature of some species, such as the bald eagle (*Haliaeetus leucocephalus*), limited consideration should be given to those species listed as endangered and threatened that may visit Bergen County. Table 6-1 lists federal and state threatened or endangered species that may occur in Bergen County and the area surrounding the project site. Table 6-2 shows threatened or endangered species potentially occurring within a 4.8 km (3 mi) radius of the Maywood site for animals, and within a 1.6-2.4 km (1-1/2 mi) radius of the Maywood site for plants.

Critical habitats for federally-listed species are administratively protected. However, since there are no known listed species on the site, there are no administratively protected habitats or unique habitats on the site. As shown in Figure 6-2, the majority of the Maywood space is dominated by homes/yards, transportation corridors, parking lots, industrial buildings, and several patches of natural habitat, including wetlands.

6.1.3.3 Maywood Habitat and Wildlife Survey

During August 24–26, 1992, a two-person team from SAIC (reported here) conducted a qualitative wildlife species and habitat survey. Most of the survey was performed on foot, although some observations were from an automobile. The weather was warm (29 to 32 °C or

## Table 6-1. Federally and State Listed Threatened and/or Endangered Species Known to Have Occurred in Bergen County, NJ

| Common Name | Scientific Name | Admininistrative Status |
|---|---|---|
| **Birds** | | |
| American Bittern | *Botaurus lentiginosus* | ST |
| Bald Eagle | *Haliaeetus leucocephalus* | FE; FT; SE |
| Barred Owl | *Strix varia* | ST |
| Cooper's Hawk | *Accipiter cooperii* | SE |
| Grasshopper Sparrow | *Ammodramus savannarum* | ST |
| Great Blue Heron | *Ardea herodias* | ST |
| Northern Goshawk | *Accipiter gentilis* | ST |
| Northern Harrier | *Circus cyaneus* | SE |
| Osprey | *Pandion haliaetus* | ST |
| Pied-Billed Grebe | *Podilymbus podiceps* | SE |
| Red-Headed Woodpecker | *Melanerpes erythrocephalus* | ST |
| Red-Shouldered Hawk | *Buteo lineatus* | ST |
| Savannah Sparrow | *Passerculus sandwichensis* | ST |
| Sedge Wren | *Cistothorus platensis* | SE |
| Short-Eared Owl | *Asio flammeus* | SE; SS |
| Upland Sandpiper | *Bartramia longicauda* | SE |
| Vesper Sparrow | *Pooecetes gramineus* | SE |
| **Reptiles** | | |
| Bog Turtle | *Clemmys muhlenbergii* | FC2; SE |
| Timber Rattlesnake | *Crotalus horridus* | SE |
| Wood Turtle | *Clemmys insculpta* | ST |
| **Amphibians** | | |
| Longtail Salamander | *Eurycea longicauda* | NA |
| **Fish** | | |
| Brook Trout | *Salvelinus fontinalis* | ST |
| **Plants** | | |
| Beaked Sedge | *Carex rostrata* | NA |
| Minute Duckweed | *Lemna perpusilla* | NA |
| Virginia Bunchflower | *Melanthium virginicum* | NA |
| Spreading Globe Flower | *Trollius laxus* | NA |
| Narrow-Leaved Vervain | *Verbena simplex* | NA |

NA = Not Available
SS = State Stable
FT = Federally Threatened
FC2 = Candidate for Listing
ST = State Threatened
FE = Federally Endangered
SE = State Endangered

## Table 6-2. Federally and State Listed Rare Species and Natural Communities Found in the General Vicinity of the Project Site

| Common Name | Scientific Name | Administrative Status |
|---|---|---|
| **Birds** | | |
| Grasshopper Sparrow | *Ammodramus savannarum* | ST |
| **Reptiles** | | |
| Bog Turtle | *Clemmys muhlenbergii* | FC2; SE |
| **Plants** | | |
| Beaked Sedge | *Carex rostrata* | NA |
| Minute Duckweed | *Lemna perpusilla* | NA |
| Virginia Bunchflower | *Melanthium virginicum* | NA |
| Spreading Globe Flower | *Trollius laxus* | NA |
| Narrow-Leaved Vervain | *Verbena simplex* | NA |

NA = Not Available
SE = State Endangered
ST = State Threatened
FC2 = Candidate for Listing

85 to 89°F] and humid, mostly sunny with a moderate to heavy haze. Areas on MISS and most vicinity properties were visited, but access could not be gained to the Sears vicinity property. A detailed, jurisdictional wetland survey, which included the Sears property, was performed in April 1992 by CH2M Hill. A final administrative determination can be made only by the U.S. Army Corp of Engineers and the NJDEPE. The wildlife and habitat characteristics of these wetlands, in particular, could have ecological, recreational, or aesthetic value from a regional perspective, which is not considered explicitly in this assessment.

*Wetlands and Hydrophytic Habitat*

Vegetation is the most conspicuous feature of wetlands and one that can be most readily identified in the field. Based on site reconnaissance, the hydrophytic vegetation at the Sears property was deemed the principal area at the Maywood site that warranted additional investigation as potential wetlands. Wetlands make up 7 percent, or 4,083 ha (10,084 acres), of Bergen County. Of this area, 2,558 ha (6,319 acres), or 43 percent is comprised of forested palustrine wetland, and 33 percent is classified as estuarine emergent wetland. The palustrine wetland is described best as freshwater marshes, bogs, swamps, and bottomland forests. The common water regimes include those designated as permanently flooded, semi-permanently flooded, seasonally flooded, and temporarily flooded. The estuarine wetlands consist of tidal brackish waters and contiguous wetlands where ocean water is at least occasionally diluted by freshwater runoff from the land. Therefore, they possess an increased salinity over that found in a palustrine environment (Cowardin et al. 1979). The hydrophytic vegetation at Maywood is part of the palustrine resource in Bergen County.

The Sears property wetlands received detailed attention during the survey performed by CH2M Hill (1992). This property contains several areas of hydrophytic vegetation (Figures 6-3 and 6-4), including several ditches with associated stands of reeds and cattails. These five scattered areas of palustrine emergent wetland total about 0.32 ha (0.8 acres). Additionally, two larger areas of hydrophytic vegetation exist at the Maywood Avenue end of the Sears property. These areas are considered palustrine forested wetland. The larger of these areas covers 1.23 ha (3.04 acres). Moving west toward the Sears building, the deciduous forest grades into an area of palustrine emergent wetland (reeds), which in turn becomes a mowed area. The smaller area of forested wetland, south of the entrance road, covers 0.17 ha (0.425 acres). The dominant plants in these forested areas are red maple (*Acer rubrum*), American sycamore (*Platanus occidentalis*),

American elm (*Ulmus americana*), and sweetgum (*Liquidambar styraciflua*). Wetlands on the Sears property as identified by CH2M Hill total about 1.7 ha (4.1 acres).

Stands of reeds (*Phragmites* spp.) and cattails (*Typha latifolia*) occurred along several ditches within the MISS property during the SAIC survey. These strips of habitat most likely support muskrat (*Odontra fibethecus*), and probably serve as travel corridors for this and other wildlife species, although no individuals or runs were observed during the SAIC survey. Adjacent cover generally consists of mowed field on one side and transportation right-of-way on the other. This right-of-way supports late successional stage old-field habitats of saplings, small trees, shrubs, and associated herbaceous understory plants.

The wetland habitats on the Sears property, especially the largest two, likely support muskrat and possibly some marsh-dwelling bird species. Most phragmites stands were extremely dense. During the wildlife and habitat survey, the Sears property was observed from an adjoining property, where the buildings and parking lots are constructed on fill material. Several groundhogs and their burrows were seen within the bank of this fill material.

*Streams and Riparian Habitat*

The two small streams (Westerly Brook and Lodi Brook) and much of the Saddle River, their receiving stream, are fairly inaccessible to humans. Access to the streams and associated riparian habitat is restricted by private property, fencing at most public properties (transportation rights-of-way, including bridge crossings), and the physical configuration (steep banks). Riparian habitat provides much of the wildlife habitat in the area as well as corridors between islands of habitat. Due to access limitations, there was little evidence of direct human use of these areas (e.g., paths and litter). All three watercourses had numerous drain pipes and culverts of varying sizes leading into them. Most of these drains were dry, indicating that they most likely carry surface runoff. Comments concerning water quality are based on visual inspection of color, opacity, smell, appearance of substrate, and presence or absence of a surface sheen.

Westerly Brook provides an open stream habitat, from its confluence with the Saddle River to Stann Street, passing beneath Rochelle and Becker Avenues in large box culverts. This section is about 210 m (690 ft) long and flows to the west. The stream's flow cross-section was approximately 7.5 to 13 cm (3 to 5 in.) deep by 0.3 to 1 m (1 to 3 ft) wide. The stream bed contained mostly small rocks (1 to 2.5 cm or 0.5 to 1 in.) with some larger cobble-sized rocks. The stream channel is steep-sided and largely covered with riprap, some of which has been

**Figure 6-3. Hydrophytic Vegetation on Sears Property (looking north toward the Stepan property from Sears Entrance Road)**

**Figure 6-4. The Same Area of Sears Property (viewed from the northeast overlooking the hydrophytic vegetation habitat)**

mortared. Downstream from Rochelle Avenue, the channel is deep (up to 2.5 m or 8 ft) and narrow. The right bank (property at 91 Rochelle Avenue) has been extensively rebuilt with rock and concrete after a substantial portion of the bank collapsed during a heavy rain after first being weakened by groundhog burrows. The last 9 to 13.5 m (10 to 15 yd) of this bank is riprapped with marble and granite spall (Figure 6-5). Several types of invertebrates (e.g., gastropods, isopods, and chironomids) were observed within the stream on the rock substrate. A few small fish, probably cyprinids, were noted but not identified. Riparian habitat (trees and shrubs) is well established, providing good cover for passerines, gray squirrels, and raccoons. Cardinals (*Cardinalis cardinalis*), cat birds (*Dumetella carolinensis*), blue jays (*Cyanocitta cristata*), American robins, and chipping sparrows (*Spizella passerina*) were observed along and in the stream. Quiet pools supported a good growth of duckweed (*Lemna* spp.). Several active groundhog burrows were dug into the stream bank near the mouth. The water quality appeared to be fair with a slightly grayish cast, clear, and with only a slight septic odor. The mostly rock substrate was covered with a light coat of algae and some silty sediment.

Lodi Brook exists as stream habitat that is open in at least two segments south of U.S. Highway 46, both flowing west. One segment flows along and beneath Church Street between Essex and Massey Streets, for about 225 m (250 yd). This section lies within a residential area, bordered on the left bank by the backyards of single-family houses and on the right by a mobile home park. Riparian habitat consists of well-established trees, some shrubs, and moderate to heavy groundcover in a fairly narrow band. Several unidentified dead crayfish were observed in this stretch of the stream, although the water quality of this section appeared to be fair to good. More detailed observation of instream fauna was not performed. A local resident, whose home was within 7.5 m (8 yds) of the stream, said that muskrats, raccoons, and opossums were prevalent in the area. The latter two species often create a problem by scattering household refuse. According to the resident, relatively large fish, 25 to 30 cm (10 to 12 in.) long, are present within the stream when the water level is high. Several gray squirrels were observed along the stream and in residential yards.

Another segment of approximately 45 m (50 yd) runs from Graham Lane to its confluence with the Saddle River near Arnot Street. Commercial buildings and associated parking lots border the left bank, while the right bank supports riparian habitat of small trees and shrubs with a dense herbaceous groundcover. This habitat lies between the stream and the Saddle River. Human access to this portion of the stream is restricted. The water quality of this segment appeared poor, with a cloudy blue-gray color and a slight surface sheen in some areas.

**Figure 6-5. Westerly Brook Near its Confluence with the Saddle River (looking upstream toward Rochelle Avenue)**

The Saddle River flows south toward the Passaic River and maintains a fairly even depth and width through the observed area (from Rochelle Park Area County Park downstream to the Lodi Boro Hall). The reach along the Rochelle Park Area County Park (upstream of Westerly Brook) is 15 to 25 m (50 to 80 ft) wide and 20 to 30 cm (8 to 12 in.) deep, with a mostly sand to silty-sand substrate. Many pigeons (*Columba livia*) use the park area. A population of Canada geese (*Branta canadensis*), black ducks, and unidentified gulls (an estimated 80 geese, 150 ducks, and 30 gulls) also were observed here (Figure 6-6). This abundance is probably a result of frequent feeding by park visitors. Ducks and geese were not observed on lower reaches, but are expected to spend some time there. Several unidentified sandpipers were also seen on sandbars in this area.

The reach from Railroad Avenue south to Outwater Lane is only 12 to 15 m (40 to 50 ft) wide and 0.3 to 1 m (1 to 3 ft) deep. This reach receives the flow from Westerly Brook (Figure 6-7). The substrate is mostly sand. Occasional stands of yellow pond lily (*Nuphar luteum*) grow next to the bank. Many large carp (*Cyprinus carpio*), several schools of shad (most likely *Alosa spp.*), and abundant but unidentified small fish and fry were observed within this reach. Two local teenagers, encountered during this survey, said they often fished the river for bass (undetermined species). Tracks of great blue herons (*Ardea herodias*) were observed along the sandy bank, along with tracks of a smaller unidentified heron. Muskrat tracks were fairly common. Groundhog runs and burrows were observed within the floodplain.

The reach from Outwater Lane downstream to the park surrounding Lodi Boro Hall is largely residential on the west bank and consists of riparian vegetation on the east bank between the stream bank and Main Street. This section of stream is more narrow and winding than the previously described reaches, with a more rocky substrate (Figure 6-8). The west bank becomes progressively more industrial and the east bank more commercial in nature from the vicinity of U.S. Highway 46 downstream to Lodi Boro Hall, a distance of 0.5 to 0.6 km (0.3 to 0.4 mile). The water quality of this section appears poor by the time the stream passes beneath Arnot Street, exhibiting a dark gray-green color with a surface sheen in the quieter areas.

*Commercial/Industrial*

The land surrounding the MISS pile provides a large continuously vegetated habitat at the site (Figures 6-9 and 6-10). This area consisted mostly of maintained grass which had been recently mown. Groundhogs and their burrows were numerous. Eastern cottontails were also observed. Mourning doves, starlings, and American robins were the predominant birds seen.

**Figure 6-6. The Saddle River at Rochelle Park Area County Park (looking upstream)**

**Figure 6-7. The Saddle River Viewed From the Mouth of Westerly Brook (with I-80 in the background)**

**Figure 6-8. The Saddle River, Looking Downstream, at the Confluence of Westerly Brook (note foreground rubble)**

**Figure 6-9. Southern Corner of the MISS Property (with the Stepan property in the background)**

**Figure 6-10. The MISS Site, Overlooking a Portion of Burial Area B**

MISS is bordered on two sides by a highway and a railroad right-of-way, which provides some habitat diversity in the form of narrow strips of trees, shrubs, and groundcover. As in any industrial landscape, there are several small patches of habitats that receive little activity or attention, allowing them to develop successionally beyond adjacent maintained areas. These habitats provide cover for many species of small mammals and birds.

Other commercial and industrial properties in the area present minimal wildlife habitat because most contain large expanses of paved or graveled parking lots in conjunction with their buildings (see Figure 6-2). Most landscaping (when present) is of a small-scale, highly-maintained ornamental nature. Some areas do contain transportation rights-of-way that provide minimal amounts of early successional-stage habitat.

Neighborhoods range from heavily landscaped yards with well-established trees and shrubs, which provide well-defined habitat structure, to sparsely landscaped yards consisting mostly of grass lawns. The neighborhood in the area of Westerly Brook provides an example of the former suburban habitat, which supports gray squirrels, rabbits, and several passerine bird species. The neighborhood along Hancock Street and other streets are examples of the latter type of suburban habitat (Figures 6-11 and 6-12). Similar species of mammals and birds, but considerably fewer individuals, were observed in this neighborhood.

J. F. Kennedy Park is a baseball diamond with a large, well-maintained outfield. The park presents little habitat except as a feeding area for birds, with perching/roosting habitat provided by the trees lining the streets. Jet Age Park on Redstone Lane provides a habitat of maintained lawn with several large trees. Squirrels and several species of birds, including crows, were observed using this area.

#### 6.1.3.4 Habitat Summary

Habitat provided by the Maywood site and surrounding and downstream properties is typical of urban areas. Native habitat is generally found in small areas that have been overlooked or under-utilized. The native habitat generally consists of early to late old-field stages, usually along transportation rights-of-way or unused corners of commercial or industrial properties. Westerly and Lodi Brooks are underground for most of their length, surfacing near the Saddle River, where riparian vegetation is found along the banks of both brooks. Wildlife encountered during this survey was typical of urban areas, with a few species colonizing what habitat is available. The groundhog is successful in the Maywood area. Although several species of birds


**Figure 6-11. The Neighborhood Along Trudy Drive (looking southeast from the intersection of Trudy Drive with Shady Lane)**

**Figure 6-12. The Neighborhood Showing Urban Habitat Along Long Valley Road (facing the MISS Site from Hancock Street at Trudy Drive)**

were observed, the overall impression was that populations were low. The most productive habitat is that afforded by the Saddle River, its floodplain, and the wetland near the Sears property.

### 6.1.4 Contaminants of Ecological Concern

Ecological COCs are those substances detected at the Maywood properties with the potential to pose a hazard to the biota. According to EPA (1991b), factors determining whether a contaminant should qualify as an ecological COC include: environmental concentration, frequency of occurrence, background levels, bioavailability, physical and chemical properties (e.g., solubility), potential for bioaccumulation, toxicity, and effects. Potential COCs at the Maywood properties were first identified from a comparison of site and background concentrations, the frequency of occurrence, and sample quantification limits (see Section 2), and these were then screened as ecological COCs on the basis of their solubility, or mobility, persistence, and toxicity.

Mobility and persistence criteria bring considerations of the physical and chemical properties of contaminants into the ecological risk assessment process (EPA 1991b). The NJDEPE similarly based proposed soil-quality criteria for semivolatile organics on water solubility, biodegradability, and toxicity or carcinogenicity (24 NJR 396 1992). Moreover, they weighed solubility by a factor of 4 relative to biodegradation and toxicity. The higher a contaminant's solubility in water, the greater the concentration the contaminant will attain in exposed surface or groundwater, and the more likely it is that it will be transported offsite, e.g., the Saddle River, where it can expose and affect additional ecological resources. The longer a contaminant persists, the greater the probability that organisms will be exposed to it. A balanced screening process based on environmental concentrations recognizes the potential for contaminants to become concentrated in the environment or in organisms with time. The process also recognizes the possibility that a contaminant currently exceeding toxicity concentrations may not persist at high concentrations long enough to pose a continuing risk to ecological receptors.

Each of the technical environmental questions — mobility, persistence, and toxicity — has a rationale in the COC screening process. The rationale consists of definitions, order of preference in using information, thresholds and screening rules. A threshold is a numerical value used as a decision criteria; will it be mobile, will it persist, will it have an effect. This information is provided below.

### 6.1.4.1 Screening Rationales

Thresholds for toxicity, mobility, and persistence were chosen using available data in standard reference texts and compilation databases. For toxicity, two modes of exposure (direct contact for aquatic organisms, oral ingestion for terrestrial organisms) were recognized for each potential COC. Single thresholds were chosen for each of two measures of mobility (water solubility, soil sorption), and two measures of persistence (degradation half-life, bioconcentration factor). Toxicity, mobility, and persistence data for the potential COCs at the Maywood site are given in Table 6-3.

*Toxicity*

Toxicity-threshold values for each potential COC found at Maywood were based on toxicity data obtained from government sources (NOAA 1990) or toxicological databases: IRIS (EPA 1992b), HSDB (1992), AQUIRE (1992), RTECS (1992). Published toxicity data were used in the following order of preference:

- U.S. government standards,
- concentrations showing no effect,
- chronic toxicity concentrations, and
- acute toxicity concentrations.

In all cases, the appropriateness of study methods, chemical species, and test organism relative to the Maywood site were considered. Thresholds based on chronic or acute toxicity data were set below the published values to compensate for the uncertainty introduced by using laboratory toxicity data for organisms other than those found at the Maywood site. Values were chosen for computational convenience. For example, the single datum found for the chronic oral toxicity of selenium was for laboratory mice. Accordingly, the toxicity threshold was arbitrarily set at 100 mg/kg, below the published TDLo of 134 mg/kg.

The first choice for toxicity thresholds was U.S. government-established standards, such as EPA Water Quality Criteria – Aquatic (WQCAQ) for concentrations in water, and National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) for sediment concentrations (Long and Morgan 1990). When these values were available, they were used to set thresholds for the appropriate media, regardless of other, perhaps conflicting, data.

## Table 6-3. Maywood Ecological Risk Assessment Contaminant Screening Data

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| **Potential Ecological Contaminants of Concern** | **Acute Toxicity Level (µg/L)** | **Chronic Toxicity Level (µg/L)** | **Acute Oral Toxicity Level (mg/kg)** | **Chronic Oral Toxicity Level (mg/kg)** | **Water Solubility (mg/L)** | **Soil Sorption ($K_{oc}$)** | **Degradation or Decay Half-Life (d)** | **Bioconcentration Factor (BCF)** |
| **RADIONUCLIDES** | | | | | | | | |
| Radium | NA | NA | NA | NA | NA | high (mobile if soil coarse or acid)[e] | 16,024[e] | NA |
| Thorium | NA | NA | Acute toxicity very low.[a]<br><br>1,220 (intraperitoneal LD50, nitrate) [a] | 1,000 daily (dog, 46 days, growth depression | insoluble[e] | high[e] | 1.41x $10^{10}$y[e] | 2 orders of magnitude over levels in vegetation[e] |
| Uranium | NA | NA | Oral toxicity of U compounds is rather low.[a] | .2/day (dogs, 1 yr, adverse growth effects) [a]<br><br>10,000-40,000 (rat, LD50, 30 days, soluble form)[a] | insoluble[e] | high[e] | 4.51x$10^{9}$y U-238 | 1 order of magnitude over background levels in vegetation[e] |
| **RARE EARTHS AND METALS** | | | | | | | | |
| Aluminum | NA | NA | 770 (mice, LD50, $ALCl_3$)[a]<br><br>190 (guinea pigs, LDLo, $AlCl_3$)[a]<br><br>980 (mice, LD50, $Al(SO_4)$[a] | 1,400 (chickens, caused rickets)[c] | NA | Concentration in soil in range of 150-600 g/kg[c] | NA | NA |

## Table 6-5 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| **Potential Ecological Contaminants of Concern** | **Acute Toxicity Level (µg/L)** | **Chronic Toxicity Level (µg/L)** | **Acute Oral Toxicity Level (mg/kg)** | **Chronic Oral Toxicity Level (mg/kg)** | **Water Solubility (mg/L)** | **Soil Sorption ($K_{oc}$)** | **Degradation or Decay Half-Life (d)** | **Bioconcentration Factor (BCF)** |
| Arsenic | 190 (4d) (As III)[e]<br><br>10000 µg/L Black Sea mussel, LC50); quite sensitive to sublethal concentration as reflected by physiological changes.[c] | 100 (fish)[e]<br><br>1.9E+2µg/L (As III) (IRIS WQCAQ) | 8-500 $As_2O_3$[a]<br><br>763 (rat, oral LD50)[c]<br><br>145 (mouse, oral LD50)[c]<br><br>0.58 developmental abnormalities [c] | 0.6 (rat, oral TDLo, 35 wk prior to copulation, fertility effects)[c]<br><br>280 (mouse, oral, 8 weeks, mutations)[d] | insoluble as elemental As[a]<br><br>$As_2O_3$ 1.2 g/kg[a] | NA | NA | 44 (fish)[e] |
| Barium | 50,000[e] | 2,000 (MCL) | 5 (rabbit, $BaCl_2$)[a] | 2 (rabbit) [a] | 2.46 mg/L $BaSO_4$ at 25°[a] | NA | Persistent in SW[e] | 4° |
| Beryllium | 1.3E+2µg/L lowest effect concentration (IRIS WQCAQ) | 5.3E+0µg/L lowest effect concentration (IRIS WQCAQ) | 30µMol/L (mouse, DNA damage)[d] | 5,000 no effect level [a]<br><br>5 mg/L (rat, oral, NOAEL) (0.54 mg/kg bw/day) (IRIS) | metal and oxides insoluble to slightly soluble[a] | NA | NA | NA |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| Potential Ecological Contaminants of Concern | Acute Toxicity Level (µg/L) | Chronic Toxicity Level (µg/L) | Acute Oral Toxicity Level (mg/kg) | Chronic Oral Toxicity Level (mg/kg) | Water Solubility (mg/L) | Soil Sorption ($K_{oc}$) | Degradation or Decay Half-Life (d) | Bioconcentration Factor (BCF) |
| Boron | 115,000-246,000 (Daphnia, LC50, 48 h, as boric acid)[g] | 6,400 (Daphnia, no effect, 21 d, as borid acid)[g] | 250 (cat, oral LD50)[c] | 350 mgB/kg feed NOAEL (dog, 2 yr [IRIS]; rat[g], 2 yr, as borax)<br><br>525 mgB/kg feed NOAL (rat, 2 yr, as boric acid)[g]<br><br>1,170 mgB/kg feed (dog, oral, 2 yr, LOAEL) (IRIS) | metal insluble[a]<br><br>oxides slightly soluble, 0.72 mg/L[a]<br><br>260,000 (NaBO2) | NA | NA | 1,000[a] |
| Cerium | NA | NA | 2,750 nitrate[a]<br><br>1,000 oxides[a] | 10,000 (oral, 12 week, no effect level)[a] | most salts insoluble (Lange's) | NA | NA | NA |
| Chromium | 98 (4 d) CrIII 11 (4 d) CrVI (Hardness of 40 mg/L)[e]<br><br>9.8E+2µg/L CrIII (hardness dependent) (IRIS)<br><br>1.6E+1µg/L CrVI (1h average) (IRIS) | 100 (fish) CrVI[e]<br><br>1.2E+µg/L (hardness dependent (IRIS)<br><br>1.1E+1µg/L CrVI (4-day average) (IRIS) | 1,500 (rat, oral LD50, soluble chromates)[a] | 1,000mg/day (cat, oral, no adverse effects, chromium phosphate)[a]<br><br>1,468 mg/kg/day (rat, oral, NOEL, 5% chromic oxide) (IRIS)<br><br>2.4 mg/kg/day CrVI (rat, oral 1 yr, NOAEL) (IRIS) | insoluble[e]<br><br>1670000 (CrO3) | NA | NA | 16 (fish); higher uptake in ultra-basic soils; to 1E+3 in shrubs; to 1E+6 in snails[e] |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| **Potential Ecological Contaminants of Concern** | **Acute Toxicity Level (µg/L)** | **Chronic Toxicity Level (µg/L)** | **Acute Oral Toxicity Level (mg/kg)** | **Chronic Oral Toxicity Level (mg/kg)** | **Water Solubility (mg/L)** | **Soil Sorption ($K_{oc}$)** | **Degradation or Decay Half-Life (d)** | **Bioconcentration Factor (BCF)** |
| Copper | 5.4 (4 d, hardness of 40 mg/L)[e]<br><br>250 (larval fathead minnow, LD50)[c]<br><br>9.2E+0µg/L (hardness dependent) (IRIS WQCAQ) | 3 (fish)[e]<br><br>fathead minnow larvae 123 (28 day)[c]<br><br>6.5E+0 µg/L (hardness dependent) IRIS WQCAQ) | 140 rat, $CuCl_2$)<br><br>159 (rabbit, $CuCo_3$, $Cu(H_2O)$[a] | 1.21 (rat, oral TDLo 22 wk)[d]<br><br>70 (EH-L)[h] | insoluble but pH sensitive[e]<br><br>chloride and nitrate soluble, carbonate, phosphate insoluble (Lange's Handbook of Chemistry) | high in organic matrix[e] | NA | 200 (fish)[e] |
| Iron | NA | NA | 98.6 Fe powder[a]<br><br>400 (mouse, $FeCl_2$)[d]<br><br>20,000 (guinea pig, oral LD50)[d] | 800 mg/d (dog, no effect level, $FeCl_2$)[a] | insoluble[a]<br><br>ferric and ferrous salts soluble (Lange's) | NA | NA | NA |
| Lanthanum | NA | NA | NA | 10,000 (rat, oral, no effect level, 12 week)[a] | NA | NA | NA | NA |
| Lead | 1.0 (4 d) (hardness of 40 mg/L[e]<br>8.2E+1µg/L (1-hour average) (IRIS WQCAQ) | 5,000 (fish)[e]<br><br>50 (aquatic vertebrates)[e]<br><br>3.2E+0 µg/L (4-day average) (IRIS WQCAQ) | 160 (pigeon, LDLo)[d]<br><br>50-600 (acute single dose, lead salts)[a] | 790 (rat, oral, multi-generation)[c]<br><br>1 (rats, no effect level)[c]<br><br>0.5 (pregnant sheep, effects )[c] | 0.03 (hard)<br>0.5 (soft)[e]<br><br>insoluble[a]<br><br>2000-10000 mg/L soluble forms in soil[a] | high in organic or clay matrix[e] | NA | 49 (fish (log 1.4-1.7 fish; log 2.7-3.2 invertebrates)[c] |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| **Potential Ecological Contaminants of Concern** | **Acute Toxicity Level (µg/L)** | **Chronic Toxicity Level (µg/L)** | **Acute Oral Toxicity Level (mg/kg)** | **Chronic Oral Toxicity Level (mg/kg)** | **Water Solubility (mg/L)** | **Soil Sorption ($K_{oc}$)** | **Degradation or Decay Half-Life (d)** | **Bioconcentration Factor (BCF)** |
| Manganese | NA | NA | 9,000(rat, oral LD50)[d] | 600 (rat, oral LD50)[c] | insoluble[a] salts soluble (Lange's) | NA | 14 days | NA |
| Nickel | 1.4E+3µg/L (total nickel) (IRIS WQCAQ) | 1.6E+2µg/L (total nickel) (IRIS WQCAQ) | 5 (guinea pig, rat, LDLo)[a] | 1,000 no effect[a]<br>25 (rat, $NiSo_4$)<br>5 no effect, acetate[a]<br>2.5-100 (Ni fungal inhibitor)[c] | insoluble NIO/Ni[a] | NA | NA | NA |
| Selenium | 20 (IRIS WQCAQ) | 5 (IRIS WQCAQ) | 6,700 (rat, roal LD50)[d] | 134 (mouse, oral TDLo, multi-generation)[d] | insoluble[a] | NA | NA | NA |
| Vanadium | NA | NA | 11 (albino mice, oxides)[a] | 10 minimum toxic diet concentration[c] | insoluble as metal[a] | NA | NA | NA |
| Zinc | 49 (4 d) (hardnesof 40 mg/L); 0 (IRIS WQCAQ) | 2,000 (fish); 110 (IRIS WQCAQ) | 250 (guinea pig, LDLo, $ZnF_2$)<br>1,190 (rat, oral LD50, zinc nitrate hexahydrate)[a] | 10 (rat, oral, no effect level)[a]<br>50 (rat, oral, reproductive effects)[a] | insoluble as metal[a] | NA | Persistent in SW[e] | 47 (fish), [e] 16,700 (oyster), 85 (clam), 500 (mussel)[c] |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| Potential Ecological Contaminants of Concern | Acute Toxicity Level (µg/L) | Chronic Toxicity Level (µg/L) | Acute Oral Toxicity Level (mg/kg) | Chronic Oral Toxicity Level (mg/kg) | Water Solubility (mg/L) | Soil Sorption ($K_{oc}$) | Degradation or Decay Half-Life (d) | Bioconcentration Factor (BCF) |
| **ORGANICS** | | | | | | | | |
| Acenaphthene | NA | NA | NA | 175 daily (mouse, oral, NOAEL, 90 days) (IRIS)<br><br>350 daily (mouse, oral, LOAEL, 90 days, liver effects) (IRIS) | insoluble[f] | NA | NA | NA |
| Acenaphthylene | NA | NA | NA | NA | 3.93 (distilled water), 16.1[c] | 950-3315[c] | 12-121 (aerobic)[c] | 129-575 (calculated)[c] |
| Anthracene | 5,000 (trout, no effect, 24 h)[f] | NA | NA | 1000 daily (mouse, oral, NOAEL, 90 days) (IRIS) | 0.075[f] | NA | NA | 3500 (mayfly, 28 h)<br>760 (Daphnia)[a] |
| Benz(a)anthracene | 1,000 (bluegill, LC87, 6 mo) | NA | NA | 180 (rat, oral, oncogenic effects )[d] | NA | NA | NA | 10,109 (cladoceran, 24 h) |
| Benzo(b)fluoranthene | NA | NA | NA | NA | 0.0012[c] | high | NA | 7.6E05 (invertebrates) |
| Benzo(k)fluoranthene | NA | NA | NA | NA | 7.6E-07[c] | high (log 6.5 est.)[c] | >700[c] | 9.3E04 (fish, calc.)[c] |
| Benzo(a)pyrene | >1,000 sandworm, LC50, 96 h) | NA | 50 mg/kg bw (rodents, oral LD50) | 100.0 mg (rat, oral, no effect)<br><br>1,000 (rat, oral birth defects)[a] | NA | NA | NA | 36,656 (northern pike, bile and gallbladder, 19.2 h)<br><br>82,231 (snail, 3 days) |
| Benzo(g,h,i)perylene | NA | NA | NA | NA | insoluble[c] | 1E06[c] | persistent[c] | (log4-5)[c] |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| **Potential Ecological Contaminants of Concern** | **Acute Toxicity Level (µg/L)** | **Chronic Toxicity Level (µg/L)** | **Acute Oral Toxicity Level (mg/kg)** | **Chronic Oral Toxicity Level (mg/kg)** | **Water Solubility (mg/L)** | **Soil Sorption ($K_{oc}$)** | **Degradation or Decay Half-Life (d)** | **Bioconcentration Factor (BCF)** |
| Benzoic Acid | NA | NA | 1,700 (rat, oral, LD50)[d] | NA | 2,700[b] | low[b] | <8[b] | <10 (algae), 0.4 (trout, mosquito) |
| Bis(2-ethylhexyl) phthlate | 4.0E+µg/L (IRIS WQCAQ) | 3.6E+2µg/L (IRIS WQCAQ) | NA | 19 mg/kg bw/day (guinea pig, rat, oral, liver effects) (IRIS) | NA | NA | NA | NA |
| 2-Butanone (methylethylketone) | 5E06 (goldfish, LC50, 24 h)[f] | NA | 3,300 (rat, oral, single dose) | NA | 353,000[f] | NA | NA | NA |
| n-butylbenzylphthalate | 6,200 (bluegill, LC50, 24 h), 43,000 (96 h)[c]; 940 (WQCAQ LEC IRIS) | 3 (WQCAQ LEC IRIS) | NA | NA | 2.9[c] | 68-350[c] | <14[c] | 663 (bluegill)[c] |
| Chlordane | 2.4 (WQCAQ IRIS) | 0.0042 (WQCAQ IRIS) | NA | 0.0005 ER-L | NA | NA | NA | NA |
| Chrysene | >1,000 (sandworm, LC50, 96 h) | NA | NA | 450 (mouse, oral cytological effects)[d] | NA | NA | NA | 248-361 (pink Shrimp, 28 days) |
| Dibenzo(a,h)-anthracene | >1,000 (sandworm, LC50, 96 h) | NA | NA | 200 (rat, oral, oncogenic effects) [d] | NA | NA | NA | NA |
| Dibenzofuran | NA | NA | NA | NA | 0.01[c] | 4,600-6,350[c] | persistent[c] | 1,100 (minnow)[c] |
| 1,1-Dichloroethane (1,1-dichoroethylene) | NA | NA | NA | NA | NA | NA | NA | NA |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| Potential Ecological Contaminants of Concern | Acute Toxicity Level (µg/L) | Chronic Toxicity Level (µg/L) | Acute Oral Toxicity Level (mg/kg) | Chronic Oral Toxicity Level (mg/kg) | Water Solubility (mg/L) | Soil Sorption ($K_{oc}$) | Degradation or Decay Half-Life (d) | Bioconcentration Factor (BCF) |
| 1,2-Dichloroethane (ethylene dichloride) | 18,000 (IRIS WQCAQ LEC) | 2,000 (IRIS WQCAQ LEC) | 680 (rat, oral, single dose)[f] | 95 (rat, gavage, LD100, 38 (rat, oral TD)[d] | 8,690[f] | NA | NA | NA |
| Di-n-butylphthalate | 9.4E+µg/L LEC (IRIS WQCAQ) | 3.0E+µ/L LEC (IRIS WQCAQ) | NA | 125 daily (rat, oral, 1 yr, NOAEL (IRIS)<br><br>600 mg/kg bw/day (rat, oral, 1 yr, LOAEL) (IRIS) | 13 at 25°C (IRIS) | 160-6,400[b] | short lived[b] | 12 (minnow), 21 (calc.)[b] |
| Fluoranthene | 500 (sandworm, LC50, 96 h)<br><br>3.98E+3µg/L (IRIS WQCAQ) | NA | 2,000 mg/kg bw (rodents, oral LD50) | 125 daily (mouse, oral, 13 wk, NOAEL) (IRIS)<br><br>250 daily (mouse, oral, 13 wk, LOAEL) (IRIS) | NA | NA | NA | 379 (rainbow trout, liver, 21 days) |
| Fluorene | 500 (bluegill, LC12, 30 days)<br><br>820 (rainbow trout, LC50, 96 h)<br><br>910 (bluegill, LC50, 96 h) | NA | NA | 125 daily (mouse, oral NOALE, 13 wk) (IRIS)<br><br>250 daily (mouse, oral, LOAEL, 13 wk, blood effects) (IRIS) | NA | NA | NA | 200-1,800 (bluegill, 30 days) |
| Ideno(1,2,3-cd)pyrene | NA | NA | NA | NA | 0.062[c] | 20,000[c] | persistent[c] | 59,000[c] |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| Potential Ecological Contaminants of Concern | Acute Toxicity Level (µg/L) | Chronic Toxicity Level (µg/L) | Acute Oral Toxicity Level (mg/kg) | Chronic Oral Toxicity Level (mg/kg) | Water Solubility (mg/L) | Soil Sorption ($K_{oc}$) | Degradation or Decay Half-Life (d) | Bioconcentration Factor (BCF) |
| Methylene Chloride | 125,000 (algae)[f]<br><br>1,100 (freshwater organisms, no effect level)[c]<br><br>193,000 (fathead minnows, LC50, 96 h)[c]<br><br>99,000 (fathead minnows, EC50, 96 h)[c] | NA | 2,000 (rabbits LD50)[a]<br><br>1,275 (rat, oral, DNA damage)[d]<br><br>1,600 (rat, oral, LD50)[d] | 190 (rat, LTEL) | 13,000[b]<br><br>2 g/100 mL (20,000 mg/L at 20°)[a] | 48[b] | 0.25[b] | 5[b] |
| Napthalene | 33,000 (algae, growth effects, 1d) 150,000 (fish, Tim, 96 h), 1,000 (96 h)[c], 8 (crab, TD100)[c], 2,300 (IRIS WQCAQ) | 620 (IRIS WQCAQ) | NA | 1,000 (rat, oral, eye degeneration)[c], 490 (rat, oral LD50, 533 (mouse, oral, LD50), 1,200 (guinea pig, oral LD50)[d] | 30[f] | 871-2400[c] | <8[c] | 131 cladoceran, 310 bluegill[a], 40-1000[c] |
| Nitrobenzene | 42,600 (bluegill, LC50, 48 h)[c]; 27,000 (WQCAQ LEC IRIS) | NA | NA | NA | 1780[c] | 31-200[c] | <14[c] | 6 (guppy), 24 (green alga)[c] |
| n-nitrosodiphenylamine | NA | NA | NA | NA | NA | NA | NA | NA |
| Pentachlorophenol | 190-247 (various age fish, LC50, 96 h)[f] | NA | 70-100 (rabbit, oral, LD50)[f], 27078 (rat, oral, LD50)[f] | NA | 14 | NA | NA | NA |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| Potential Ecological Contaminants of Concern | Acute Toxicity Level (µg/L) | Chronic Toxicity Level (µg/L) | Acute Oral Toxicity Level (mg/kg) | Chronic Oral Toxicity Level (mg/kg) | Water Solubility (mg/L) | Soil Sorption ($K_{oc}$) | Degradation or Decay Half-Life (d) | Bioconcentration Factor (BCF) |
| Phenanthrene | 600 (sandworm, LC50, 96 h)<br><br>3.0E+1µg/L (IRIS WQCAQ) | 6.3E+0µg/L (IRIS WQCAQ | 700 (rodents, oral LD50)[a] | | insoluble[a] | NA | NA | 325 (cladoceran, 24 h) |
| Phenol | 16,000 (Daphnia, LD0)[f], 5,000 (trout, lethal concentration 3 h)[f], 46,000 (goldfish, LD50, 24 h)[f] | 2560 (IRIS WQCAQ LEC) | 530 (rat, oral, single dose), 400-600 (rabbit), 100 (cat), 500 (dog)[f], 317 (rat, oral, LD50), 270 (mouse oral, LD50)[d] | 60 (IRIS NOAEL) | 82,000 | NA | <8[f] | NA |
| Pyrene | NA | NA | NA | 75 daily (mouse, oral, NOAEL, 13 wk (IRIS)<br><br>125 daily (mouse, oral, LOAEL 13 wk, kidney effect) (IRIS) | insoluble[a] | NA | NA | 2,702 (cladoceran, 24 h) |
| 1,1,2,2-tetrachloroethylene (tetrachlorothehene) | 9,320 (WQCAQ LEC IRIS) | 2,400 (WQCAQ LEC IRIS) | 700 (dog, oral, toxic dose) | NA | 2,900 | NA | NA | NA |

## Table 6-3 (continued)

| | Biological Effects | | | | Environmental Fate | | | |
|---|---|---|---|---|---|---|---|---|
| | Aquatic | | Terrestrial | | Mobility | | Persistence | |
| **Potential Ecological Contaminants of Concern** | **Acute Toxicity Level (µg/L)** | **Chronic Toxicity Level (µg/L)** | **Acute Oral Toxicity Level (mg/kg)** | **Chronic Oral Toxicity Level (mg/kg)** | **Water Solubility (mg/L)** | **Soil Sorption ($K_{oc}$)** | **Degradation or Decay Half-Life (d)** | **Bioconcentration Factor (BCF)** |
| Toluene | 13,000 (bluegill, LC50, 96 h)[c]<br><br>7,300 (striped bass, LC50, 96 h)[c]<br><br>17,500 (IRIS WQCAQ) | NA | 636 (rat, oral LD50)[d]<br>3.0 mL/kg (14-day-old rat, LD50) | 590 (rat, no effect)[a] | 534.8 at 25°[b]<br><br>insoluble[a] | 37-160 (various soils)[b] | 8 days[b] | 11 (fish)[e] |
| Trichloroethene (trichloroethylene) | 100,000 (Daphnia, no effect)[f] | NA | NA | NA | 1.1 | NA | NA | NA |
| Vinyl Chloride | NA | NA | NA | NA | NA | NA | NA | NA |
| Xylene | 13,000 (goldfish, LD50, 24 h)[f] | NA | 4,300 (rat, oral, LD50)[a] | 250 (IRIS NOAEL) | 146[b] | 25.4-204[c] | persistent (anaerobic)[b] | 21 eels, 62 clams, 132 fish (pred.)[b] |

NA = data not available
[a]Clayton and Clayton, 1981
[b]Howard, 1990
[c]HSDB, 1992
[d]RTECS, 1992
[e] SAIC, 1992
[f]Verschueren, 1977
[g]FWS, 1989-91

The lowest published concentrations showing "no effect", e.g., No Observed Adverse Effect Level (NOAEL), were the first choice for toxicity thresholds when a U.S. government water quality criterion or sediment quality value was unavailable. This is a conservative threshold for species that are equally or less sensitive than the tested species.

When NOAELs were unavailable, thresholds were based on the lowest published toxicity concentrations available. In many cases where WQCAQ were not specified, "chronic" lowest effect concentrations (LEC) were available and used to establish thresholds. For organisms exposed to contaminants in ambient waters, toxicity is often quantified by the LC50, the concentration of toxicant at which 50 percent of the exposed organisms die, specified over a test duration. For this ERA, "acute" or short-term toxicity is defined to be that occurring over 96 hours or less; "chronic" or long-term toxicity is longer than 96 hours. Acute and chronic oral LD50s, the concentration of toxicant in the diet that causes 50 percent mortality, or similar measures of toxicity were used to set threshold concentrations for contaminants in soils and sediments.

When chronic toxicity data were used, toxicity thresholds were set below chronic toxicity values as described above. This approach to using chronic toxicity values is conservative but reasonable, because there is often uncertainty about where the threshold lies in relation to the NOAEL for the organisms actually found at the Maywood sites.

When only acute toxicity values were available, acute toxicity values were modified for use as threshold values. The acute value was divided by 45, according to the Rule of 57 (Michigan Water Resources Commission 1986), and the toxicity threshold was set at or below the quotient. Using this rule to calculate chronic aquatic toxicity thresholds theoretically protects 95 percent or more of all fish and aquatic invertebrate families from adverse effects 80 percent of the time. Thresholds were set below this quotient to compensate for the uncertainty introduced by using a fixed safety factor and toxicity data for organisms other than those found at the Maywood site.

Using Michigan Rule 57 as a guide, acute oral toxicity values also were divided by 45 as a basis for establishing a chronic oral toxicity threshold. The assumption is that the empirical relationship observed between acute and chronic toxicity over a wide range of contaminants and a diversity of aquatic organisms is a reasonable first approximation for terrestrial organisms exposed to the same or similar contaminants. The resulting value was further reduced for safety and computational convenience.

The available toxicity data for 54 of the 62 potential COCs, including government standards, are given in Table 6-3. Information is not included for essential nutrients (calcium, potassium and sodium), metals (lithium), transuranic (gadolinium) and organics [bis(2-chloroethyl)ether, carbon disulfide, and 1,2-diphenylhydrazine). The toxicity threshold concentrations established using these data are given in Table 6-4. Aquatic thresholds are for surface and groundwater exposure. Oral thresholds are for ingestion of soil and sediment. Threshold values other than government standards reflect the paucity of directly pertinent wildlife toxicity data and uncertainty about NOAELs for the organisms and potential COCs at Maywood. In all cases, the primary consideration was to choose a conservatively low threshold value because of these uncertainties.

*Mobility*

Mobility is indicated by water solubility and soil sorption. That is, the organic carbon-water partition coefficient ($K_{OC}$). A threshold of 1 mg/L was chosen to represent the level of water solubility above which a potential toxicant is considered sufficiently mobile in water to present a potential hazard to aquatic organisms in surface water or organisms exposed to groundwater. This is the midpoint ($1 \times 10^0$), on a logarithmic scale, of the range of solubility in the NJDEPE soil quality criteria (24 NJR 396 1992). All substances identified in Table 6-3 as insoluble are included with those having water solubility <1 mg/L. In addition to water solubility, a soil sorption $K_{OC}$ of 1,000 was used as a threshold above which a contaminant would not be considered a hazard via aquatic exposure pathways. All those listed in Table 6-3 as high are considered to be above threshold. This threshold value was chosen following a review of the comments on soil adsorption and mobility of contaminants with varying $K_{OC}$s (Howard 1990).

*Persistence*

Persistence is indicated by the bioconcentration factor (BCF) and the degradation half-life of a substance in water, soils, or organisms. A value of 14 days was selected for the degradation half-life threshold (Gillette 1983), at or above which a substance is considered persistent. A degradation half-life of 14 days means that a contaminant with a concentration at a Maywood site that is 100 million times greater than an the established toxicity threshold will exceed the threshold by no more than 50 million times after 14 days, 25 million after 28 days, etc. It will thus exceed the threshold by no more than a factor of 10 in little over one year, and will be below the threshold within two years. All substances identified in Table 6-3 as being "persistent" are included with those having a half-life > 14 days. The BCF is the tissue concentration of a

## Table 6-4. Maywood Ecological Risk Assessment Contaminant Screening

| Potential Ecological COC | Environmental Media | Toxicity Threshold Concentration | | Decision Criteria | | | Ecological COC | Operable Unit |
|---|---|---|---|---|---|---|---|---|
| | | Aquatic Dermal µg/L | Oral mg/kg | Environmental Concentration Aquatic or Oral | Mobility Solubility or Adsorption | Persistence Half-life or BCF | | |
| **RADIONUCLIDES** | | | | | | | | |
| Radium | Surface and groundwater | NA | | NA | Y | Y | Y | All sites |
| | Soils and sediments | | NA | NA | Y | Y | Y | All sites |
| Thorium | Surface and groundwater | NA | | NA | N | Y | Y | All sites |
| | Soils and sediments | | NA | NA | N | Y | Y | All sites |
| Uranium | Surface and groundwater | NA | | NA | N | Y | Y | All sites |
| | Soils and sediments | | NA | NA | N | Y | Y | All sites |
| **METALS AND RARE EARTHS** | | | | | | | | |
| Aluminum | Surface and groundwater | NA | | Y | N | NA | Y | MSB |
| Arsenic | Surface and groundwater | 190 | | Y | NA | N | Y | MSB |
| Barium | Surface and groundwater | 1,000 | | N | Y | N | N | |
| | Soils and sediments | | 1.0 | Y | NA | N | Y | C/G, Res. |
| Beryllium | Surface and groundwater | 5 | | N | N | NA | N | |
| Boron | Surface and groundwater | 6,400 | | N | N | Y | N | |
| Cerium | Surface and groundwater | | NA | NA | NA | NA | Y | MSB |

**Table 6-4 (continued)**

| Potential Ecological COC | Environmental Media | Toxicity Threshold Concentration | | Decision Criteria | | | Ecological COC | Operable Unit |
|---|---|---|---|---|---|---|---|---|
| | | Aquatic Dermal µg/L | Oral mg/kg | Environmental Concentration | Mobility | Persistence | | |
| | | | | Aquatic or Oral | Solubility or Adsorption | Half-life or BCF | | |
| Chromium | Surface and groundwater | 11 (VI) 120 (III) | | Y | N | Y | Y | MSB |
| | Soils | | 2.4 (VI) 1,000 (III) | Y(VI), N (III) | NA | Y | Y | MISS, Stepan, C/G |
| Copper | Surface and groundwater | 6.5 | | Y | N | Y | Y | MSB |
| | Soils | | 1.0 | Y | N | Y | Y | MISS, C/G |
| Gadolinium | Surface and groundwater | NA | | NA | NA | NA | Y | MSB |
| Iron | Surface and groundwater | NA | | NA | N | NA | Y | MSB |
| Lithium | Surface and groundwater | | NA | NA | NA | NA | Y | MSB, Westerly Brook, Lodi Brook |
| Lanthanum | Soils and sediments | | 10,000 | N | NA | NA | N | |
| | Surface and groundwater | NA | | NA | NA | NA | Y | MSB |
| Lead | Surface and groundwater | 3.2 | | Y | N | Y | Y | MSB |
| | Soils | | 1.0 | Y | Y | Y | Y | MISS, Stepan, C/G, Res. |
| Manganese | Surface and groundwater | NA | | NA | N | Y | Y | MSB |
| Nickel | Surface and groundwater | 160 | | N | N | NA | N | |
| Selenium | Surface and groundwater | 5 | | N | N | NA | N | |
| Vanadium | Surface and groundwater | NA | | NA | NA | NA | Y | MSB |

## Table 6-4 (continued)

| Potential Ecological COC | Environmental Media | Toxicity Threshold Concentration | | Decision Criteria | | | Ecological COC | Operable Unit |
|---|---|---|---|---|---|---|---|---|
| | | Aquatic Dermal µg/L | Oral mg/kg | Environmental Concentration: Aquatic or Oral | Mobility: Solubility or Adsorption | Persistence: Half-life or BCF | | |
| Zinc | Surface and groundwater | 110 | | Y | N | Y | Y | MSB |
| | Soils | | 10 | Y | NA | Y | Y | Res. |
| **ORGANICS** | | | | | | | | |
| Acenapththene | Soils | | 175 | N | N | NA | N | |
| Acenaphthylene | Soils | | NA | NA | NA | NA | Y | MISS |
| Anthracene | Soils | | 1,000 | N | NA | Y | N | |
| Benz(a)antrhacene | Soils | | 180 | N | NA | Y | N | |
| Benzo(b)fluoranthene | Soils and sediments | | NA | NA | N | Y | Y | MISS, Stepan |
| Benzo(k)fluoranthene | Soils and sediments | | NA | NA | N | Y | Y | MISS, Stepan |
| Benzo(a)pyrene | Soils | | 100 | N | NA | Y | N | |
| Benzo(g,h,i)perylene | Soils and sediments | | NA | NA | N | Y | Y | MISS, Stepan |
| Benzoic acid | Soils and sediments | | 35 | N | Y | N | N | |
| Bis(2-chloroethyl)ether) | Surface and groundwater | NA | | NA | NA | NA | Y | MSB |
| Bis(2-ethylhexyl) phthalate | Soils and sediments | | 10 | N | NA | NA | N | |
| | Surface water | 360 | | N | NA | NA | N | |
| 2-butanone | Soils and sediments | | 50 | N | Y | Y | Y | MISS |
| n-butylbenzylphthalate | Soils and sediments | | NA | NA | Y | Y | Y | MISS, Stepan, C/G |

**Table 6-4 (continued)**

| Potential Ecological COC | Environmental Media | Toxicity Threshold Concentration | | Decision Criteria | | | Ecological COC | Operable Unit |
|---|---|---|---|---|---|---|---|---|
| | | Aquatic Dermal µg/L | Oral mg/kg | Environmental Concentration | Mobility | Persistence | | |
| | | | | Aquatic or Oral | Solubility or Adsorption | Half-life or BCF | | |
| Carbon disulfide | Soils and sediments | | NA | NA | Y | Y | Y | MISS |
| | Surface and groundwater | NA | | NA | NA | NA | Y | MISS |
| Chlordane | Soils | | NA | NA | NA | NA | Y | MISS |
| Chrysene | Soils | | 400 | N | NA | Y | N | |
| Dibenz(a,h)anthracene | Soils | | 200 | N | NA | NA | N | |
| Dibenzofuran | Soils | | NA | NA | N | Y | Y | MISS |
| 1,1-dichloroethene | Surface and groundwater | NA | | NA | NA | NA | Y | MSB |
| 1,2-dichloroethene | Surface and groundwater | NA | | NA | NA | NA | Y | MSB, Westerly Brook |
| Di-n-butylphthalate | Soils and sediments | | 125 | N | Y | N | N | |
| Fluoranthene | Soils | | 125 | N | N | Y | N | |
| Fluorene | Soils | | 125 | N | NA | Y | N | |
| Ideno(1,2,3-cd)pyrene | Soils and sediments | | NA | NA | N | Y | Y | MISS, Stepan |
| Methylene Choride | Surface and groundwater | 2,000 | | N | Y | N | N | |
| Naphthalene | Soils | | 100 | N | Y | N | N | |
| Nitrobenzene | Soils | | NA | NA | Y | N | Y | MISS |
| n-nitrosodiphenylamine | Soils and sediments | | NA | NA | Y | Y | Y | MISS |
| Pentachlorophenol | Soils and sediments | | 0.5 | N | Y | NA | N | |
| Phenanthrene | Soils | | 10 | Y | N | Y | Y | Stepan |
| Phenol | Soils and sediments | | 60 | N | Y | N | N | |
| | Surface water | 2,000 | | N | Y | N | N | |

## Table 6-4 (continued)

| Potential Ecological COC | Environmental Media | Toxicity Threshold Concentration | | Decision Criteria | | | Ecological COC | Operable Unit |
|---|---|---|---|---|---|---|---|---|
| | | Aquatic Dermal µg/L | Oral mg/kg | Environmental Concentration Aquatic or Oral | Mobility Solubility or Adsorption | Persistence Half-life or BCF | | |
| Pyrene | Soils | | 75 | N | N | Y | N | |
| 1,1,2,2-tetrachloroethane | Surface and groundwater | NA | | NA | Y | NA | Y | Westerly Brook |
| Tetrachloroethylene | Soils and sediments | | NA | NA | NA | NA | Y | Stepan |
| | Surface and groundwater | 2,000 | | N | NA | NA | N | |
| Toluene | Soils | | 100 | N | Y | N | Y | MISS, Stepan |
| | Surface water | 17,500 | | N | Y | Y | Y | Westerly Brook |
| Trichloroethylene | Soils and sediments | | NA | NA | Y | NA | Y | Stepan |
| | Surface water | 2,000 | | N | Y | NA | N | |
| Vinyl chloride | Surface and groundwater | | NA | NA | NA | NA | Y | MSB |
| Xylenes (total) | Soils and sediments | | 250 | N | Y | Y | Y | MISS, C/G |

MSB = MISS/Stepan/Ballod groundwater
C/G = commercial/government vicinity properties
Res. = residential vicinity properties
Y = Yes
N = No

substance divided by its concentration in the environment. A threshold of 100 was chosen for BCF. A BCF above 100 indicates that a toxicant can become magnified in organisms more than 100 times over the concentration in the ambient environmental medium. Thus, a contaminant with an environmental concentration 100 times less than an organism's toxicity threshold can, nevertheless, pose a potential hazard to that organism because its prey may contain contaminant at or above the toxicity-threshold concentration.

6.1.4.2 Screening of Potential COCs

Not all the 62 potential COCs were screened for inclusion as ecological COCs. The three radionuclides (radium, thorium, uranium) are ecological COCs by virtue of their environmental concentrations (2 X background) and the uncertainty concerning their effects on ecological receptors. Three essential biological minerals — calcium, potassium, and sodium — were not screened, rather it was assumed that they were not COCs for the Maywood site. These essential elements can be toxic in certain chemical forms and at very high concentrations, but government standards either do not exist or the data on which to base a toxicity threshold for these elements are unknown.

The remaining 56 potential COCs were screened according to the following rules:

1. If the mean environmental concentration at the site does not exceed the toxicity-threshold concentration level, both a mobility and a persistence threshold must be exceeded for the contaminant to qualify as a COC.

2. If the mean environmental concentration at the site exceeds the toxicity-threshold concentration, then it must also exceed either a mobility or a persistence threshold to qualify as a COC.

3. In those cases where there is no mobility or persistence data, the determination depends only on the toxicity-threshold concentration.

4. In those cases where a toxicity-threshold concentration could not be established, the contaminant is defined as a COC.

Rule 1 ensures that contaminants currently below toxic concentrations at the site, but having the potential to increase in concentration through their persistence and biomagnification, are

considered in the ERA. For example, some forms of lead are both soluble and persistent. Even if average concentrations of lead at MISS were below chronic toxicity levels, it could, over a sufficient period of time accumulate and concentrate in organisms (BCF > 100 in some invertebrates) to such an extent that body burdens could exceed the toxicity concentrations for predator receptors, such as raccoons. Lead qualifies as a COC at one or more Maywood properties because its mean environmental concentration exceeds toxicity-threshold concentrations. Even though their environmental concentrations were below their toxicity-threshold concentrations, three contaminants, (2-butanone, toluene and xylenes) qualified as COCs because of Rule 1.

Rule 2, generally removes from the risk assessment those contaminants that currently exceed toxic thresholds and are immobile and will not persist. For the reasons discussed above, these contaminants are unlikely to pose a continuing threat to organisms at the site or nearby, because they will be reduced by at least 8 orders of magnitude in 56 weeks given a half-life of at least 14 days. No contaminant in this Maywood ERA was removed from further consideration as an ecological COC because it did not meet the mobility and persistence criteria. Chemicals did not meet both these conditions because, generally, chemicals that are highly soluble in water are also more highly degradable and do not bioconcentrate in organisms. Chemicals that bioconcentrate greatly in organisms are generally the hydrophobic, lipophilic substances. Benzo(b)fluoranthene, for instance, has a water solubility of 0.0012 mg/L and a reported BCF of 760,000. For comparison, the solubility of benzoic acid in water is 2,700 mg/L and its BCF in trout is 0.4. Chemical contaminants that are immobile and not persistent are unlikely to exceed background concentrations, because the time between release and measurement is generally long enough for the chemical to have significantly degraded.

Rule 3 reflects the fact that toxicity is the primary consideration. Because most chemical contaminants are not both mobile and persistent, practicality argues against giving COC status to contaminants with environmental concentrations below toxicity thresholds solely because of the lack of mobility or persistence data.

Rule 4 ensures that dangerous contaminants are not ignored strictly for lack of toxicity data. This is a conservative assumption.

By this screening process, 40 of the 56 potential COCs in Table 6-3 qualify as ecological COCs in one or more environmental medium in Maywood operational units. For example, arsenic qualifies as a COC in MISS/Stepan/Ballod groundwater because its mean concentration

(204 µg/l) exceeds the aquatic toxicity threshold (190 µg/l) and there is insufficient information regarding its solubility in water. Arsenic does not qualify as a COC in Westerly Brook surface waters, on the other hand, because its mean concentration was only (6.5 µg/l). Table 6-4 indicates for each potential COC whether it does (Y) or does not (N) meet each criterion for environmental media, the final determination of its status, and the properties for which it is an ecological COC.

The ecological COCs for Maywood are:

*Radionuclides* *(this assumes associated decay products in secular equilibrium; see Table 2-3)

- Radium
- Thorium
- Uranium

*Metals*

- Aluminum
- Arsenic
- Barium
- Cerium
- Chromium
- Copper
- Gadolinium
- Iron
- Lanthanum
- Lead
- Lithium
- Manganese
- Vanadium
- Zinc

*Organics*

- Acenaphthylene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(g,h,i)perylene
- Bis(2-chloroethyl)ether
- 2-butanone
- n-butylbenzylphthalate
- Carbon disulfide
- Chlordane
- Dibenzofuran
- 1,1 dichloroethene
- 1,2 dichloroethene
- 1,2-diphenylhydrazine
- Indeno(1,2,3-cd)pyrene
- Nitrobenzene
- n-nitrosodiphenylamine
- Phenanthrene
- 1,1,2,2-tetrachloroethane
- Tetrachloroethylene
- Toluene
- Trichloroethylene
- Vinyl chloride
- Xylene

Each COC is examined further in terms of exposure characterization (Section 6.2), ecological effects assessment (Section 6.3), and ecological risk characterization (Section 6.4).

## 6.2 EXPOSURE ASSESSMENT

Exposure assessment includes quantification of release, migration, and fate of contaminants, characterization of receptors, and quantification of concentrations at the point where organisms are actually exposed (EPA 1991b). Environmental concentrations of the potential ecological COCs at the Maywood site (Table 2-34) are given in Table 6-5. This exposure assessment characterizes receptors by the different possible pathways and modes of exposure to contaminants at the Maywood site.

To estimate the relative risk to classes of ecological receptors exposed by different modes and pathways both onsite and offsite, the environmental concentrations of contaminants must be adjusted according to how these exposure pathways and modes attenuate or enhance the exposure to contaminants (Section 6.4). Some classes of receptors are exposed by multiple routes, and their risks are likely to be greater than those organisms exposed to contaminants at less than the full environmental concentration. For example, carnivorous fish, such as minnows, are exposed to contaminants in ambient water and in their prey. Subterranean animals such as burrowing rodents, on the other hand, are primarily exposed to contaminants via direct contact with and ingestion of soils, which constitute only a fraction of their diet. They may also be exposed by inhalation of volatized contaminants, but this pathway is not considered explicitly in this ERA. The resulting exposure concentrations are used to characterize the risk to the nonhuman populations (Section 6.4). This approach to ecological pathway analysis recognizes the potential for contaminant residues to bioconcentrate (concentrate in aquatic organisms exposed to contaminants in water), bioaccumulate (concentrate in aquatic and terrestrial organisms from dietary as well as abiotic sources), and biomagnify (systematic concentration as chemicals are passed from prey to predator), the approach also recognizes the possibility that organisms are exposed to environmental concentrations less than that measured in media.

Contaminant sources at the Maywood site include surface soils at MISS, Stepan, commercial/government, and residential vicinity properties as defined in Section 2. Alluvial groundwater at the MISS/Stepan/Ballod properties unit is currently contaminated with some chemicals. Soil contaminants may leach into surface water and sediments in Westerly and Lodi Brooks. Alluvial transport of contaminated water, sediments, and soil from these properties potentially can contaminate sediments and surface waters in downstream reaches of Westerly and Lodi Brooks and the Saddle River (Figure 6-1). When evaluating the exposure of aquatic and terrestrial biota to COCs from Maywood sources, contaminants in surface water, soils and sediments are the primary sources of risks.

## Table 6-5. Environmental Concentrations of Maywood Potential COCs

| Ecological COC / Operable Unit | Soils and Sediment | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| | mg/kg | | | | µg/L | |
| **METALS AND RARE EARTHS** | | | | | | |
| Aluminum | | | | | | |
| MISS/Stepan/Ballod (MSB) | | | | | 7678 | 12856 |
| Arsenic | | | | | | |
| MSB | | | | | 204 | 459 |
| Westerly Brook | | | | | 6.5 | 77.6 |
| Barium | | | | | | |
| Comm./Govt. | 98.1 | 1006 | 101 | 201 | | |
| Residential | 113 | 250 | | | | |
| MSB | | | | | 171 | 260 |
| Beryllium | | | | | | |
| MSB | | | | | 1.54 | 2.17 |
| Boron | | | | | | |
| MSB | | | | | 401 | 600 |
| Cerium | | | | | | |
| MSB | | | | | 125 | 163 |
| Chromium | | | | | | |
| MISS | 54.0 | 36127 | 23.5 | 342 | | |
| Stepan | 21.9 | 41.8 | | | | |
| Comm./Govt. | 19 | 53.4 | 16.6 | 823 | | |
| MSB | | | | | 189 | 316 |
| Copper | | | | | | |
| MISS | 45 | 126 | 21.7 | 58.3 | | |
| Comm./Govt. | 46.2 | 165 | 29.3 | 44.5 | | |
| MSB | | | | | 98.2 | 139 |
| Gadolinium | | | | | | |
| MSB | | | | | 109 | 121 |
| Iron | | | | | | |
| MSB | | | | | 32875 | 45850 |
| Lanthanum | | | | | | |
| Comm./Govt. | | | 39.4 | 163 | | |
| MSB | | | | | 117 | 141 |

## Table 6-5 (continued)

| Ecological COCs / Operable Unit | Soils and Sediments | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| | mg/kg | | | | µg/L | |
| Lead | | | | | | |
| MISS | 102 | 345 | | | | |
| Stepan | 93.4 | 141 | | | | |
| Comm./Govt. | 79.5 | 7000 | | | | |
| Residential | 345 | 1048 | | | | |
| MSB | | | | | 280.0 | 42.3 |
| Lithium | | | | | | |
| MSB | | | | | 1223 | 2138 |
| Lodi Brook | | | | | 218 | 218 |
| Westerly Brook | | | | | 243 | 1210 |
| Manganese | | | | | | |
| MSB | | | | | 2314 | 4271 |
| Nickel | | | | | | |
| MSB | | | | | 121 | 270 |
| Selenium | | | | | | |
| MSB | | | | | 3.7 | 5.2 |
| Vanadium | | | | | | |
| MSB | | | | | 27.0 | 36.4 |
| Zinc | | | | | | |
| Residential | 233 | 683 | | | | |
| MSB | | | | | 305 | 573 |
| | | | | | | |
| ORGANICS | | | | | | |
| Acenaphthene | | | | | | |
| MISS | | | 0.21 | 0.26 | | |
| Acenaphthylene | | | | | | |
| MISS | | | 0.20 | 0.27 | | |
| Anthracene | | | | | | |
| MISS | 0.20 | 0.47 | 0.20 | 0.28 | | |
| Stepan | 2.90 | 6.66 | 0.64 | 7.67 | | |
| Benzo(a)anthracene | | | | | | |
| MISS | 0.27 | 0.79 | 0.23 | 0.42 | | |
| Stepan | 3.23 | 9.74 | 0.60 | 33.1 | | |
| Comm./Govt. | 0.32 | 1.90 | 0.26 | 0.65 | | |

## Table 6-5 (continued)

| Ecological COCs / Operable Unit | Soils and Sediments | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| | mg/kg | | | | µg/L | |
| Benzo(b)fluoranthene | | | | | | |
| MISS | 0.29 | 0.83 | 0.22 | 0.40 | | |
| Stepan | 3.38 | 8.41 | 0.62 | 35.1 | | |
| Benzo(k)fluroanthene | | | | | | |
| MISS | 0.25 | 0.77 | 0.22 | 0.37 | | |
| Stepan | | | 0.61 | 35.1 | | |
| Benzo(a)pyrene | | | | | | |
| MISS | 0.26 | 0.74 | 0.23 | 0.38 | | |
| Stepan | 3.83 | 10.2 | 0.63 | 48.0 | | |
| Benzo(g,h,i)perylene | | | | | | |
| MISS | 0.28 | 0.47 | 0.24 | 0.33 | | |
| Stepan | 2.68 | 5.90 | 0.62 | 6.62 | | |
| Benzoic acid | | | | | | |
| MISS | | | 1,01 | 1.42 | | |
| Bis(2-chloroethyl)ether | | | | | | |
| MSB | | | | | 6.7 | 13.8 |
| Bis(2-ethylhexyl)phthalate | | | | | | |
| MISS | 0.21 | 0.76 | 0.18 | 0.29 | | |
| Stepan | | | 0.41 | 4.70 | | |
| Comm./Govt. | | | 2.16 | 10.6 | | |
| MSB | | | | | 9.7 | 17.4 |
| 2-butanone | | | | | | |
| MISS | | | 0.006 | 0.007 | | |
| n-butylbenzylphthalate | | | | | | |
| MISS | 0.19 | 0.46 | 0.21 | 0.25 | | |
| Stepan | 2.93 | 6.74 | | | | |
| Comm./Govt. | 0.59 | 5.6 | 0.53 | 1.54 | | |
| Carbon disulfide | | | | | | |
| MISS | | | 0.003 | 0.004 | | |
| MSB | | | | | 7.0 | 26.4 |
| Chlordane | | | | | | |
| MISS | 0.04 | 0.07 | 0.04 | 0.07 | | |

Table 6-5 (continued)

| Ecological COCs / Operable Unit | Soils and Sediments | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| | mg/kg | | | | µg/L | |
| Chrysene | | | | | | |
| MISS | 0.32 | 0.86 | 0.25 | 0.42 | | |
| Stepan | | | | 0.61 | 32.2 | |
| Comm./Govt. | 0.35 | 2.38 | 0.30 | 0.76 | | |
| Dibenzo(a,h)antrhacene | | | | | | |
| MISS | 0.17 | 0.47 | 0.21 | 0.28 | | |
| Dibenzofuran | | | | | | |
| MISS | | | 0.88 | 0.88 | | |
| Di-n-butylphthalate | | | | | | |
| MISS | 0.12 | 100 | 0.21 | 0.49 | | |
| Stepan | | | 0.53 | 24.1 | | |
| Comm./Govt. | 3.25 | 42.0 | 2.31 | 10.9 | | |
| 1,1-dichloroethene | | | | | | |
| MSB | | | | | 7.3 | 12.5 |
| 1,2-dichloroethene | | | | | | |
| MSB | | | | | 84.5 | 230 |
| Westerly Brook | | | | | 38 | 38 |
| Fluoranthene | | | | | | |
| MISS | 0.53 | 2.06 | 0.29 | 0.67 | | |
| Stepan | | | 0.8 | 121 | | |
| Comm./Govt. | 0.65 | 6.42 | 0.56 | 1.75 | | |
| Fluorene | | | | | | |
| MISS | | | 0.21 | 0.27 | | |
| Stepan | 1.08 | 4.40 | 0.54 | 4.17 | | |
| Ideno(1,2,3-cd)pyrene | | | | | | |
| MISS | 0.29 | 0.53 | 0.24 | 0.33 | | |
| Stepan | 2.73 | 6.06 | 0.61 | 6.43 | | |
| Methylene Chloride | | | | | | |
| MSB | | | | | 17.1 | 57.1 |
| Naphthalene | | | | | | |
| MISS | | | 0.21 | 0.26 | | |
| Nitrobenzene | | | | | | |
| MISS | | | 0.46 | 0.46 | | |

## Table 6-5 (continued)

| Ecological COCs / Operable Unit | Soils and Sediments | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| | mg/kg | | | | µg/L | |
| n-nitrosodiphenylamine | | | | | | |
| MISS | | | 0.22 | 0.28 | | |
| Pentachlorophenol | | | | | | |
| MISS | | | 0.25 | 0.25 | | |
| Phenanthrene | | | | | | |
| MISS | 0.29 | 1.12 | 0.26 | 0.46 | | |
| Stepan | | | 21 | 21 | | |
| Phenol | | | | | | |
| MISS | | | 0.21 | 0.26 | | |
| MSB | | | | | 9.1 | 16.9 |
| Pyrene | | | | | | |
| MISS | 0.45 | 1.61 | 0.25 | 0.60 | | |
| Stepan | | | 0.59 | 69.5 | | |
| Comm./Govt. | 0.51 | 6.12 | 0.43 | 1.58 | | |
| 1,1,2,2-tetrachloroethane | | | | | | |
| Westerly Brook | | | | | 42 | 42 |
| Tetrachloroethylene | | | | | | |
| Stepan | 0.003 | 0.008 | | | | |
| MSB | | | | | 363 | 964 |
| Toluene | | | | | | |
| MISS | 0.004 | 0.005 | 0.004 | 0.006 | | |
| Stepan | | | 0.004 | 0.013 | | |
| MSB | | | | | 3.1 | 4.8 |
| Trichloroethylene | | | | | | |
| Stepan | | | 0.003 | 0.007 | | |
| MSB | | | | 22 | 46.5 | |
| Westerly Brook | | | | | 13 | 13 |
| Vinyl chloride | | | | | | |
| MSB | | | | | 66.8 | 148 |
| Xylenes (total) | | | | | | |
| MISS | 0.003 | 0.004 | 0.003 | 0.003 | | |
| Comm./Govt. | | | 0.004 | 0.010 | | |

A pathway analysis can link contamination in the biota directly and indirectly to contaminant sources (e.g., soil, sediment, surface water), via mechanisms of release to the environment and the movement of contaminants through the ecosystem (Figure 6-13). Exposures occur via direct and indirect pathways from contaminant sources to ecological receptors. Direct exposures of an organism to a contaminant do not involve intermediary organisms; indirect exposures do. Exposures may be internal or external and passive or active with respect to the receptor. Internal exposure occurs when the contaminant directly enters into the body, usually by the ingestion of contaminated material, whereas external exposure occurs by dermal contact. External exposures are, by definition, direct. Passive exposures are unavoidable exposures; direct external exposure is usually unavoidable by those organisms living in the contaminated medium. For this ERA, direct exposure is assumed when an organism lives in a contaminated medium. Internal exposures, here termed "active," can result from direct ingestion of contaminated abiotic material or indirectly from ingesting contaminated organisms.

Indirect pathways of exposure are best identified with a food web. Food webs generally comprise the following trophic groups:

- primary producers - green plants such as grasses, shrubs, trees, and hydrophytes;
- primary consumers (herbivores) - animals that feed on plants; for example, groundhogs, Canada geese and cottontail rabbits in the terrestrial food web, and ducks, some fish and some benthic invertebrates in the aquatic food web;
- secondary consumers (omnivores/carnivores) - animals that feed on both plants and animals or feed strictly on other animals; for example, robins and raccoons in the terrestrial food web and bass and carnivorous fish in the offsite aquatic food web; and
- decomposers - including certain fungi and bacteria.

Primary producers can mobilize contaminants from soils and sediments. This can occur by foliar absorption of contaminants deposited on leaf and stem surfaces, or by uptake via plant roots. Uptake of contaminants by plants could lead to subsequent exposure to herbivores and omnivores from ingestion of the contaminated vegetation. Contaminants that bioaccumulate in primary producers or their animal consumers, or bioconcentrate in organisms directly exposed to

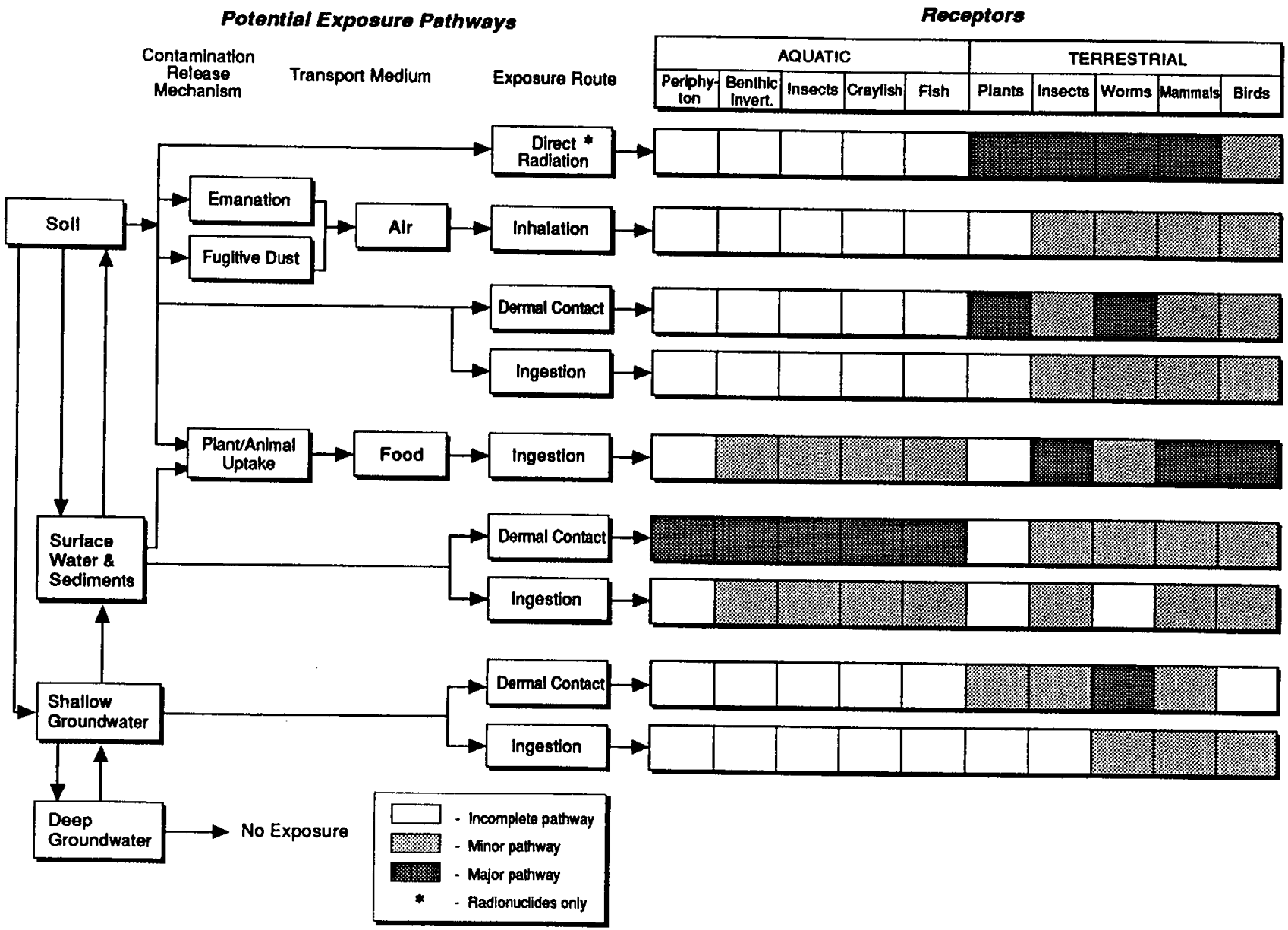



**Figure 6-13. Exposure Pathways for Maywood Ecological Receptors**

contaminated media, often further accumulate in secondary consumers (i.e., carnivores and omnivores). The last link in the food chain can be represented by transient secondary consumers—top predators such as the osprey (*Pandion haliaetus*) or bald eagle (*Haliaeetus leucocephalus*). Each is listed as threatened or endangered and could occur in the Maywood area. Figure 6-14 is a schematic representation of aquatic and terrestrial food webs that typify the Maywood site.

Organisms at the Maywood properties are potentially exposed to contaminants by one or more pathways (Figure 6-13). Internal exposure via ingestion of contaminated matter is considered here to be the primary mode of exposure to chemical contaminants for nonburrowing terrestrial animals, such as raccoons or robins. These will have additional but secondary exposures from direct contact with contaminated soil and surface water, inhalation of fumes or dust and, where applicable, direct radiation by radionuclides. Subterranean organisms, e.g., groundhogs and rabbits, will receive primary exposure by direct contact with (and inhalation of) contaminated soils. They will receive secondary exposure from ingestion of contaminated soil and surface water. Only a few organisms of a limited number of types are expected to reside within contaminated soil at the MISS, Stepan, commercial/government and residential vicinity properties. Direct external exposures are expected to be the primary mode of exposure for aquatic organisms such as minnows in Westerly and Lodi Brooks. Trophic exposure is not expected to be important because of the aquatic organisms' mode of existence and because, with few exceptions, chemicals with high water solubility are not likely to have a high bioconcentration factor (Howard 1990). Aquatic organisms are expected to be exposed secondarily via ingestion of contaminated sediments and biota.

Species of aquatic and terrestrial organisms were selected from the list of those identified at the site (Section 6.1.4) to serve as proxies for the many species constituting the ecological communities at Maywood. The term "proxy" is used instead of "indicator" because no explicit measurements were made of these species for this risk assessment, and therefore they cannot indicate anything. Rather, proxy species serve as substitutes for larger numbers of species that are potentially exposed to COCs by similar modes and pathways, i.e., ecological receptor classes. Additional criteria for selecting species to represent onsite communities are: (1) abundant or common species (in their respective animal communities); (2) species closely related to toxicological test organisms; (3) economically important species (game animals, species consumed by humans); (4) endangered, threatened, or listed species; and (5) key food-web species that might be sensitive to the Maywood COCs. To identify key trophic species requires

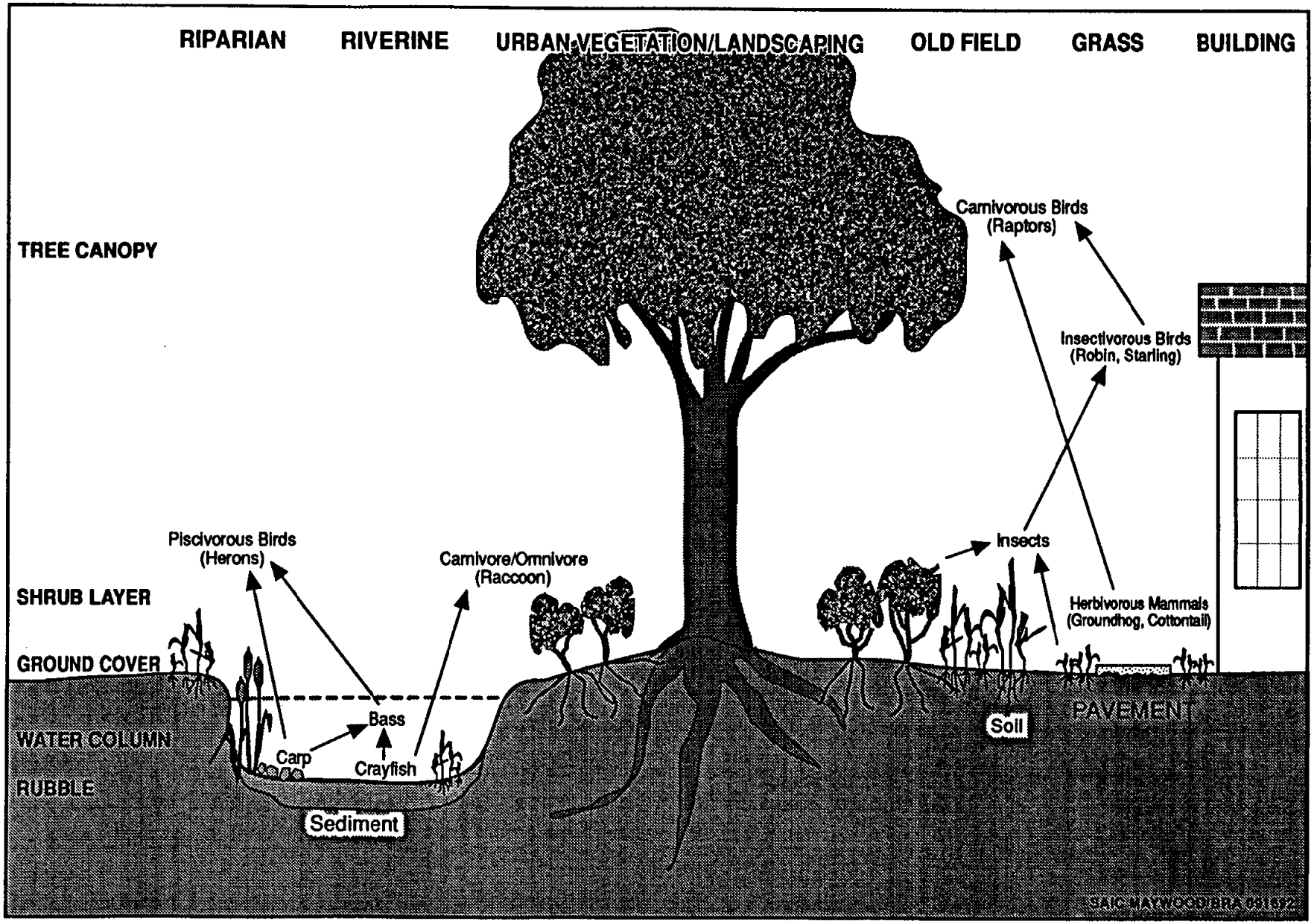



**Figure 6-14. Simplified Food Web for Maywood Habitats**

at least a quantified site-specific food web for the Maywood site, which is not feasible for this ERA.

Each ecological receptor class is exposed by direct or indirect pathways to one or more of the three Maywood contaminant sources (Table 6-6). Receptors are of two types: onsite and offsite. Onsite receptor species are those that utilize the Maywood site properties. Offsite receptors are those living outside the site boundaries, but potentially exposed to contaminants via offsite movement of abiotic or biotic media; these may include common and threatened and endangered species. Organisms that do not reside onsite, but for whatever reason visit the site, are included with onsite receptors. Onsite proxy species are found at one or more of the Maywood properties. Proxy organisms chosen to represent the aquatic and terrestrial communities in the Maywood area are:

| Aquatic | Terrestrial |
|---|---|
| midge larvae (onsite) | groundhog (onsite) |
| minnows (onsite) | raccoon (onsite) |
| bass (offsite) | robin (onsite) |
| carp (offsite) | heron (offsite) |
| duck (offsite) | muskrat (offsite) |

These organisms serve as proxies for the biotic communities in the effects assessment and risk characterization phases of the risk assessment.

The concentration of a contaminant to which ecological receptors are potentially exposed (i.e., exposure concentration), as opposed to that measured in the environment (i.e., environmental concentration), depends on the pathway and mode of exposure. The relative importance of the various exposure pathways to the ecological receptor classes is summarized in Table 6-7. These exposure factors are used to derive exposure concentrations from environmental concentrations. Organisms exposed externally to contaminated media by direct contact are exposed to the full environmental concentration for the time they reside in the media. The exposure concentration for organisms that ingest contaminated media must be corrected for the fraction of their diet that is contaminated. Organisms exposed indirectly via the food web experience an environmental concentration determined by the fraction of their diet that is contaminated and the concentration of contaminant in their food, which will be a function of the bioconcentration factor for the contaminant and organism. Organisms living in contaminated

## Table 6-6. Maywood Ecological Receptors and Exposure Scenarios

| Source Media | Primary Exposure Mode | Ecological Receptors | |
|---|---|---|---|
| | | Onsite | Offsite |
| Sediment/ Surface Water | Direct contact | Midge larvae, minnows | NI |
| | Ingestion | NI | Carp |
| Soil and Groundwater | Direct contact | Groundhog, rabbit, rat | NA |
| | Ingestion | Earthworm | NA |
| Biota | Ingestion | Robin, raccoon | Bass, muskrat, heron |

NA = Not applicable
NI = Not identified

## Table 6-7. Maywood Hypothetical Exposure Factors

| Ecological Receptors | Source Media/Exposure Mode | | | | | | |
|---|---|---|---|---|---|---|---|
| | Location | Surface Water and Sediment Direct Contact | Surface Water and Sediment Ingestion | Soil and Groundwater Direct Contact | Soil and Groundwater Ingestion | Biota Ingestion | Exposure Factor |
| Aquatic organisms, non-sediment dwellers | Onsite | 1 | 0 | 0 | 0 | 0 | 1 |
| | Offsite | 0 | 0 | 0 | 0 | 0.1 | 0.1 |
| Aquatic organisms, sediment dwellers | Onsite | 1 | 0.1 | 0 | 0 | 0 | 1.1 |
| | Offsite | 0 | 0 | 0 | 0 | 0 | 0 |
| Terrestrial organisms, non-soil dwellers | Onsite | 0 | 0 | 0 | 0 | 1 | 1 x BCF |
| | Offsite | 0 | 0 | 0 | 0 | 0.1 | 0.1 x BCF |
| Terrestrial organisms, soil dwellers | Onsite | 0 | 0 | 1 | 0.1 | 0 | 1.1 |
| | Offsite | 0 | 0 | 0 | 0 | 0 | 0 |

NA = Not applicable
NI = Not identified
BCF = Bioconcentration Factor (see Table 6-3)

media are exposed both internally and by external contact with contaminated media. Until information on the joint action of internal and external exposures is available, it will be assumed that they are additive. This is a first approximation of the relative risk to the different classes of ecological receptors from COCs at the Maywood properties (Section 6.4). Due to the considerable uncertainty surrounding the calculation of exposure concentrations, they were not used in the screening process to determine ecological COCs.

## 6.3 EFFECTS ASSESSMENT

An effects assessment quantitatively links concentrations of contaminants to adverse effects in ecological receptors (EPA 1991b). Because no site-specific toxicological studies have been conducted on Maywood proxy species, this effects assessment is based on published data (Table 6-3), which were obtained from compiled databases [e.g., IRIS (EPA 1992b), HSDB (1992), AQUIRE (1992), RTECS (1992)]. Information on test concentrations, modes of exposure, and effects on test species that were similar to those at the Maywood site ( e.g., rat, rabbit) was used to establish toxicity-threshold concentrations (Table 6-4). Here we briefly describe the effects of radiological and chemical contaminants on organisms.

Available data document some of the possible acute or chronic toxic effects on the nonhuman biotic receptors [e.g., minnows, raccoons, and others (or their proxies)] in the Maywood environment. Both terrestrial and aquatic biotic receptors are considered. Information describing chemical uptake or accumulation of radionuclides by plants and animals is limited and generally based on short-term, high-exposure laboratory experiments. Those studies may not apply to the long-term, low-level exposures at Maywood.

Chronic toxicity of contaminants is the primary concern in the Maywood effects assessment. Many contaminants observed to date at Maywood are persistent in the environment because they are insoluble in water and remain as solids in soils or bioconcentrate in organisms. Although metals can occur in high concentrations in soils, most organisms do not ingest large amounts of soil and, thus, are unlikely to be exposed by this pathway to concentrations of metals above acute oral toxicity thresholds. No investigations into chronic effects on local biota as a result of exposure to wastes have been conducted at the Maywood site, nor have analyses been performed to determine the radionuclide or chemical contaminant concentrations in the tissues of the biota. Also, there have been no rigorous population inventory or characterization studies. Therefore,

relative risks of adverse effects are estimated by the degree to which ratios of environmental concentrations to toxicity concentrations exceed unity.

### 6.3.1 Radiation Toxicity

Some biological effects from radiation, such as chromosomal aberrations and organ failure, occur similarly among different species of biota. However, except for warm-blooded species, most biota are more resistant than humans to radiotoxicity effects. The National Council on Radiation Protection and Measurements (NCRP) conducted a review of available information on the effects of ionizing radiation on aquatic biota (NCRP 1984) and concluded that no deleterious effects could be detected for radiation dose rates below 1 rad/day. Fertility and fecundity of organisms and embryonic development were found to be the most sensitive radiation response endpoints for aquatic biota, with somatic effects and mortality occurring only at much higher dose levels.

The interaction of plants with radionuclides can occur by foliar absorption of radionuclides deposited on leaf and stem surfaces or by uptake by plant roots. Information describing uptake and accumulation of radionuclides by plants is based mostly on short-term, relatively high-exposure laboratory experiments (Knight 1983) that may not be applicable to long-term, low-level exposure conditions such as those at the Maywood site. Of the radionuclides present in site wastes, Ra-226 appears to have the highest potential for uptake and accumulation by plants because it serves as an analog for calcium, an essential plant nutrient (Knight 1983).

Uptake of radionuclides by plants could lead to subsequent animal exposure via ingestion of contaminated vegetation. An important issue may be the potential for plants and animals to serve as vectors for the transport of radioactive contaminants from the Maywood site to humans or other biota. For example, excavation of contaminated soils by biota can bring the contaminants to the surface, and animal burrows can lead to increased water infiltration. Additional modes include transport of contaminated soils brought to the surface by animals, and movement of radionuclides by predators feeding on contaminated prey (Arthur et al. 1986).

### 6.3.2 Chemical Toxicity

Chemicals in the ecosystem may be lethal to biota, or they may decrease a population's ability to survive and reproduce by decreasing reproductive rates, reducing the viability of offspring, causing alterations in behavior patterns, or increasing susceptibility to disease or

predators. These disparate endpoints are characterized by different dose responses and result from different exposure pathways. Therefore, for risk characterization, it is necessary to specify what exposure pathways and endpoints are being assessed.

Toxicity of chemicals in water depends on the mode of exposure as well as the availability of the chemical to the target organism. The primary mode of exposure to aquatic organisms to dissolved contaminants, direct contact, is also the mode with greatest likely toxicity. Ingestion of contaminated water, sediments or biota will be modes of lower, but additional, toxicity to aquatic receptors. Aquatic toxicity also can depend on temperature, hardness of the water, and presence of other chemicals.

Toxicity of soil contaminants varies depending on the receptor species and on the attending physical and chemical factors, such as pH, the presence of complexing agents, or other chemicals at the site. Some soil microorganisms live in the film of water surrounding soil particles and would be exposed by direct contact to full environmental concentrations. Others live in the air spaces, where inhalation of volatile or semivolatile organic contaminants could lead to greater toxicity than by direct contact or ingestion. Toxicity of soil contaminants to burrowing organisms could be expected to have significant effect due to the multiple modes of exposure.

Plants grown in soils containing metals can accumulate higher-than-background levels of some metals. Because the ratio of plant uptake to substrate concentrations of metals may not be linear, it is difficult to determine the soil concentrations of metals that are toxic to plants. Bioaccumulation is generally most significant in the roots of plants; however, several metals can be translocated to aboveground parts of the plants. Some metals (e.g., mercury) accumulate in animal tissues and can have subtle deleterious effects over long exposure times. Many of the organics (e.g., BNAEs and pesticides) are extremely lipophilic and can biomagnify in organisms.

## 6.4 RISK CHARACTERIZATION

Risk characterization compares exposures to effects (EPA 1991b). An evaluation of the relative risk of the ecological COCs at Maywood forms the basis of this risk characterization (EPA 630/R-92/001f 1992e). No well established methods exist for calculating the risks to ecological receptors, however the use of quotient methods are supported by available guidance (EPA 1989c, 1991c). This ratio or ecological quotient approach compares the environmental concentration to the toxicity threshold concentration. Any quotient greater or equal to unity

indicates that there is the potential for adverse ecological effects, and the more the ratio exceeds unity the greater the risk. Ecological quotients (EQs) were used to characterize the relative risk of the ecological COCs at Maywood properties. In addition, the relative risks of Maywood COCs to ecological receptors exposed via different modes and pathways is assessed using exposure quotients (XQs), the ratio of exposure concentrations (i.e., the environmental concentration corrected for exposure) to the toxicity threshold concentration.

### 6.4.1 Current Risks

Calculating EQs and XQs requires a toxicity threshold for each contaminant for the appropriate mode of exposure. The toxicity thresholds used in Section 6.1.4 to screen contaminants as COCs in Maywood surface and groundwaters, soils, and sediments (Table 6-4) are also used to calculate these quotients. As described in Section 6.1.4.1, aquatic thresholds are based on WQCAQs or aquatic toxicity data (Table 6-3), sediment thresholds are based on NOAA ER-Ls (Long and Morgan 1990) or oral toxicity data (Table 6-3), and soil thresholds are based on oral toxicity data (Table 6-3). The aquatic, sediment, and oral toxicity thresholds for the 40 Maywood ecological COCs are:

| | aquatic (µg/l) | sediment (mg/kg) | soil (mg/kg) |
|---|---|---|---|
| *Radionuclides* *(This assumes associated decay products in secular equilibrium; see Table 2-3) | | | |
| • Radium | NA | NA | NA |
| • Thorium | NA | NA | NA |
| • Uranium | NA | NA | NA |
| *Metals* | | | |
| • Aluminum | NA | 1000 | 1000 |
| • Arsenic | 190 | 33 | 10 |
| • Barium | 1000 | 1 | 1 |
| • Cerium | NA | 10,000 | 10,000 |
| • Chromium (III) | 120 | 80 | 1000 |
| • Chromium (VI) | 11 | 80 | 2.4 |
| • Copper | 6.5 | 70 | 1 |
| • Gadolinum | NA | NA | NA |

| | | | |
|---|---|---|---|
| • Iron | NA | 50 | 50 |
| • Lanthanum | NA | 10,000 | 10,000 |
| • Lithium | NA | NA | NA |
| • Lead | 3.2 | 35 | 1 |
| • Manganese | NA | 500 | 500 |
| • Vanadium | NA | 10 | 10 |
| • Zinc | 100 | 120 | 10 |
| *Organics* | | | |
| • acenaphthylene | NA | NA | NA |
| • benzo(b)fluoranthene | NA | NA | NA |
| • benzo(k)fluoranthene | NA | NA | NA |
| • benzo(g,h,i)perylene | NA | NA | NA |
| • bis(2-cloroethyl)ether | 100,000 | 50 | 50 |
| • 2-butanone | NA | NA | NA |
| • n-butylbenzylphthalate | 1 | NA | NA |
| • carbon disulfide | NA | NA | NA |
| • Chlordane | 0.0043 | 0.0005 | NA |
| • dibenzofuran | NA | NA | NA |
| • 1,1-dichloroethene | NA | NA | NA |
| • 1,2-dichloroethene | NA | NA | NA |
| • 1,2-diphenylhydrazine | NA | NA | NA |
| • indeno(1,2,3-c,d))pyrene | NA | NA | NA |
| • nitrobenzene | 500 | NA | NA |
| • n-nitrosophenylamine | NA | NA | NA |
| • phenanthrene | 30 | 0.225 | 10 |
| • 1,1,2,2-tetrachloroethane | NA | 10 | 10 |
| • tetrachloroethylene | 2000 | NA | NA |
| • toluene | 17,500 | 100 | 100 |
| • trichloroethylene | 2000 | NA | NA |
| • vinyl chloride | NA | NA | NA |
| • xylenes (total) | 200 | 250 | 250 |

Table 6-8 gives the EQs for the Maywood COCs in the various source media. These were calculated for both mean and 95 percent upper confidence limit ($UL_{95}$) concentrations (Table 6-5) by dividing the concentration by the toxicity-threshold values listed above. In a few cases, an EQ could not be calculated for a COC because insufficient data were available to establish a toxicity threshold. For the characterization of relative risk, the ($UL_{95}$) concentrations are taken as the reasonable maximum exposure (RME). When calculated as the ratio of the uncorrected RME to the toxicity threshold concentration, EQs represent the reasonable maximum risk to biota, given that the environmental concentration of the COC is not increased by physical or biological processes in the transport and exposure pathways.

The highest calculated EQs for Maywood properties' soils (surface, all horizons combined) were for chromium, barium, lead, and copper (Table 6-9). Except for the high hexavalent chromium EQ, which is based on its unexplainably high RME concentration in MISS surface soil, lead had the highest EQs for both mean and RME concentrations in soils at all four Maywood properties. Arsenic (EQ = 46), chromium (29), copper (21), lead (13) and, to a lesser extent, zinc (5) have EQs greater than unity in MISS/Stepan/Ballod groundwater. Phenanthrene was the only organic COC for which an EQ could be calculated (Table 6-10) – 2.1 in Stepan soils (all horizons). EQs for toluene, 2-butanone, and xylene in soils at MISS and the commercial/government vicinity properties, and MISS/Stepan/Ballod groundwater were well below unity; these organics qualified as COCs by virtue of their mobility and persistence characteristics. The only COC in Westerly and Lodi Brooks' surface waters was lithium, for which an EQ could not be calculated. There were no COCs for Westerly Brook and Lodi Brook sediments, and therefore no EQs.

Environmental concentrations for the Maywood ERA (Table 6-5) were multiplied by exposure factors (Table 6-7) to calculate hypothetical exposure concentrations for each COC at each operational unit. Exposure concentrations then were used to calculate XQs, the exposure concentration/toxicity threshold concentration. To provide more environmental realism, XQs were used to further characterize the relative risk to various classes of receptors for each COC at each of the Maywood operational units (Table 6-11).

To derive hypothetical exposure factors (Table 6-7), assumptions regarding chemical behavior, exposure duration, and diet must be made because there have been no site-specific ecological studies. For the purposes of this assessment of relative risk to ecological receptor classes, we assume:

## Table 6-8. Maywood Ecological Quotients (EQs)

| Ecological COC / Operable Unit | Soils and Sediment | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| | mg/kg | | | | µg/L | |
| **METALS AND RARE EARTHS** | | | | | | |
| Aluminum | | | | | NA | NA |
| MISS/Stepan/Ballod (MSB) | | | | | | |
| Arsenic | | | | | 20.4 | 45.9 |
| MSB | | | | | | |
| Barium | | | | | | |
| Comm./Govt. | 98.1 | 1006 | 101 | 201 | | |
| Residential | 113 | 250 | | | | |
| MSB | | | | | | |
| Cerium | | | | | NA | NA |
| MSB | | | | | | |
| Chromium | | | | | | |
| MISS | 22.5 (VI) | 15053(VI) | 9.8(VI) | 143(VI) | | |
| Stepan | 9.1(VI) | 17.4(VI) | | | | |
| Comm./Govt. | 7.9(VI) | 22.3(VI) | 6.7(VI) | 343(VI) | | |
| MSB | | | | | 17.2(VI<br>1.6(III) | 28.7(VI)<br>2.6(III) |
| Copper | | | | | | |
| MISS | 45 | 126 | 21.7 | 58.3 | | |
| Comm./Govt. | 46.2 | 165 | 29.3 | 44.5 | | |
| MSB | | | | | 15.1 | 21.4 |
| Gadolinium | | | | | | |
| MSB | | | | | NA | NA |
| Iron | | | | | | |
| MSB | | | | | NA | NA |
| Lanthanum | | | | | | |
| MSB | | | | | NA | NA |
| Lead | | | | | | |
| MISS | 102 | 345 | | | | |
| Stepan | 93.4 | 141 | | | | |
| Comm./Govt. | 79.5 | 7000 | | | | |

## Table 6-8 (continued)

| Ecological COCs | Soils and Sediments | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| Operable Unit | mg/kg | | | | µg/L | |
| Residential | 345 | 1048 | | | | |
| MSB | | | | | 8.8 | 13.2 |
| Lithium | | | | | | |
| MSB | | | | | NA | NA |
| Lodi Brook | | | | | NA | NA |
| Westerly Brook | | | | | NA | NA |
| Manganese | | | | | | |
| MSB | | | | | NA | NA |
| Vanadium | | | | | NA | NA |
| MSB | | | | | | |
| Zinc | | | | | | |
| Residential | 23.3 | 68.3 | | | | |
| MSB | | | | | 2.8 | 5.2 |
| | | | | | | |
| **ORGANICS** | | | | | | |
| Acenaphthylene | | | | | | |
| MISS | | | NA | NA | | |
| Benzo(b)fluoranthene | | | | | | |
| MISS | NA | NA | NA | NA | | |
| Stepan | NA | NA | NA | NA | | |
| Benzo(k)fluroanthene | | | | | | |
| MISS | NA | NA | NA | NA | | |
| Stepan | | | NA | NA | | |
| Benzo(g,h,i)perylene | | | | | | |
| MISS | NA | NA | NA | NA | | |
| Stepan | NA | NA | NA | NA | | |
| Bis(2-chloroethyl)ether | | | | | | |
| MSB | | | | | NA | NA |
| 2-butanone | | | | | | |
| MISS | | | 0.0001 | 0.0001 | | |
| n-butylbenzylphthalate | | | | | | |
| MISS | NA | NA | NA | NA | | |
| Stepan | NA | NA | | | | |
| Comm./Govt. | NA | NA | NA | NA | | |
| Carbon disulfide | | | | | | |

## Table 6-8 (continued)

| Ecological COCs / Operable Unit | Soils and Sediments | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| | mg/kg | | | | µg/L | |
| MISS | | | NA | NA | | |
| MSB | | | | | NA | NA |
| Chlordane | | | | | | |
| MISS | NA | NA | NA | NA | | |
| Dibenzofuran | | | | | | |
| MISS | | | NA | NA | | |
| 1,1-dichloroethene | | | | | | |
| MSB | | | | | NA | NA |
| 1,2-dichloroethene | | | | | | |
| MSB | | | | | NA | NA |
| Westerly Brook | | | | | NA | NA |
| Indeno(1,2,3-cd)pyrene | | | | | | |
| MISS | NA | NA | NA | NA | | |
| Stepan | NA | NA | NA | NA | | |
| Nitrobenzene | | | | | | |
| MISS | | | | | | |
| n-nitrosodiphenylamine | | | | | | |
| MISS | | | NA | NA | | |
| Pentachlorophenol | | | | | | |
| MISS | | | NA | NA | | |
| Phenanthrene | | | | | | |
| Stepan | | | 2.1 | 2.1 | | |
| 1,1,2,2-tetrachloroethane | | | | | | |
| Westerly Brook | | | | | NA | NA |
| Tetrachloroethylene | | | | | | |
| Stepan | NA | NA | | | | |
| Toluene | | | | | | |
| MISS | 0.00004 | 0.00005 | 0.00004 | 0.00006 | | |
| Stepan | | | 0.00004 | 0.00013 | | |
| MSB | | | | | 0.00002 | 0.00003 |
| Trichloroethylene | | | | | | |
| Stepan | | | NA | NA | | |

## Table 6-o (continued)

| Ecological COCs / Operable Unit | Soils and Sediments | | | | Surface and Groundwater | |
|---|---|---|---|---|---|---|
| | Surface Soils and Sediments | | Soil (all horizons) | | | |
| | Mean | Upper 95 | Mean | Upper 95 | Mean | Upper 95 |
| | mg/kg | | | | µg/L | |
| Vinyl chloride | | | | | | |
| MSB | | | | | NA | NA |
| Xylenes (total) | | | | | | |
| MISS | 0.00001 | 0.00002 | 0.00001 | 0.00001 | | |
| Comm./Govt. | | | 0.00002 | 0.00004 | | |

NA = No threshold available
MSB = Miss/Stepan/Ballod

## Table 6-9. Summary of Ecological Quotients (EQs) for COCs at Maywood Sites: Metals and Rare Earth Elements

| | Soil | | | | Groundwater | Surface Water | |
|---|---|---|---|---|---|---|---|
| | MISS | Stepan | Comm./Govt. | Residential | MISS/Stepan/ Ballod | Westerly Brook | Lodi Brook |
| $EQ \geq 10^4$ | Chromium (VI) | | | | | | |
| $10^3 \leq EQ < 10^4$ | | | Barium, Lead | Lead | | | |
| $10^2 \leq EQ < 10^3$ | Chromium (III) Copper, Lead | Lead | Chromium (VI) Copper | | | | |
| $10^1 \leq EQ < 10^2$ | | | | | Arsenic Chromium (VI) Copper, Lead | | |
| $10^0 \leq EQ < 10^1$ | | | | | Zinc | | |
| Unknown Risk | | | | | Aluminum Cerium Gadolinium Iron Lanthanum Lithium Manganese Vanadium | Lithium | Lithium |

## Table 6-10. Summary of Ecological Quotients (EQs) for COCs at Maywood Sites: Organics

| | Soil | | | | Groundwater | Surface Water | |
|---|---|---|---|---|---|---|---|
| | MISS | Stepan | Comm./Govt. | Residential | MSB | Westerly Brook | Lodi Brook |
| $10^0 \leq EQ < 10^1$ | | Phenanthrene | | | | | |
| Unknown Risk | Acenaphthylene<br>Benzo(b)fluor-anthene<br>Benzo(k)fluor-anthene<br>Benzo(g,h,i)-perylene<br>Butylbenzyl-phthalate<br>Carbondisulfide<br>Chlordane<br>Dibenzofuran<br>Indeno(1,2,3-cd)pyrene<br>Nitrobenzene<br>Nitrosodiphenyl-amine<br>Pentachlorophenol | Benzo(b)fluor-anthene<br>Benzo(k)fluor-anthene<br>Benzo(g,h,i)-perylene<br>Butylbenzyl-phthalate<br>Indeno(1,2,3-cd)pyrene<br>Tetrachloro-ethylene<br>Trichloro-ethylene | Butylbenzyl-phthalate | | Bis(2-chloro-ethyl)ether<br>Carbondisulfide<br>1,1-dichloroethene<br>1,2-dichloroethene<br>Vinyl chloride | 1,2-dichloroethene<br>1,1,2,2-tetrachloro-ethane | |
| EQ<1 | 2-butanone<br>Toulene<br>Xylenes (total) | Toluene | Xylenes (total) | | Toluene | | |

## Table 6-11. Largest Exposure Quotients (XQs) for Ecological Receptors at Maywood Operational Units

| | Ecological Receptor Class | | | |
|---|---|---|---|---|
| | Aquatic | | Terrestrial | |
| **Remedial Unit** | Non-sediment Dwellers | Sediment Dwellers | Non-soil Dwellers | Soil Dwellers |
| MISS | -- | -- | Chromium(VI) $1.5x10^{7}$; Lead $3.5x10^{5}$ | Chromium(VI) $1.7x10^{4}$; Lead $3.80x10^{2}$ |
| Stepan | -- | -- | Lead $1.41x10^{5}$ | Lead $1.6x10^{2}$ |
| Comm./Govt. | -- | -- | Lead $7.7x10^{6}$ | Lead $7.7x10^{3}$ |
| Residential | -- | -- | Lead $1.05x10^{6}$ | Lead $1.2x10^{3}$ |
| MSB | -- | -- | Chromium(VI) $2.9x10^{4}$ | Arsenic $5.1x10^{1}$ |
| Westerly Brook | NA | NA | NA | NA |
| Lodi Brook | NA | NA | NA | NA |

-- = not applicable
NA = no threshold available

1) Onsite receptors exposed by direct contact to contaminants are exposed 100 percent of the time to contaminants at their measured environmental concentration (Table 6-5)

2) Offsite receptors are not exposed by direct contact with contaminated media.

3) Ten percent of what sediment or soil dwelling animals ingest is contaminated sediments or soils.

4) Onsite receptors obtain 100 percent of their diet from contaminated prey.

5) Offsite receptors obtain 10 percent of their diet from contaminated prey.

6) The contaminant concentration in terrestrial prey organisms is equal to the environmental concentration times the lowest available bioconcentration factor for the contaminant in a suitable prey (Table 6-3).

7) Although bioconcentration is assumed, biomagnification is assumed not to occur.

Clearly these assumptions do not hold in all cases, but they should suffice to calculate XQs and to distinguish different classes of onsite and offsite receptors by the relative magnitude of the risks from exposure to contaminants at the Maywood site. In general, the potential for biomagnification of certain contaminants, e.g., methylmercury, could cause the relative risk to receptors exposed via trophic pathways to be underestimated; mercury is not, however, a COC at the Maywood site.

For aquatic and subterranean organisms, the primary exposure pathways are 1) direct contact with and 2) consumption of contaminated media. For nonburrowing terrestrial organisms, the primary exposure pathway is assumed to be consumption of contaminated biota. For exposure by direct contact alone, environmental concentrations are a conservative estimate of exposure concentrations. This is the case for aquatic animals that do not dwell in the sediments (e.g., most fish). Exposure concentrations for aquatic organisms that live in Westerly and Lodi Brook sediments (e.g., midge larvae), and subterranean animals in MISS soils (e.g., groundhogs) are calculated as 110 percent of the environmental concentration at their locations; 100 percent by direct exposure and an additional 10 percent by ingestion of contaminated media. To calculate the exposure concentration for receptor species exposed to COCs via the trophic pathway (e.g., raccoons at residential vicinity properties), the environmental concentration is multiplied by the

lowest available published BCF for a possible prey organism. Direct exposure to contaminated soils and water is not included as a secondary source of risk to nonburrowing terrestrial organisms. In the summary that follows, the characterization of risk to the different ecological receptors is based on these XQs.

Overall, the heavy metals, especially lead, hexavalent chromium, and copper, pose the greatest risk to ecological receptors exposed to soils at the MISS, Stepan, commercial/government, and residential properties at the Maywood site. The COCs with the largest XQs for the ecological receptor classes at each of the Maywood operational units are given in Table 6-11. Lead, chromium, copper, barium, and zinc present the largest risks (XQ >100) to onsite terrestrial organisms from ingestion of contaminated biota or direct contact with contaminated soils. Onsite non-soil dwelling terrestrial organisms may be exposed to an additional and similar level of risk from phenanthrene, if the BCF of 325 reported for a cladoceran is similar to that for terrestrial invertebrates. Aquatic receptors are exposed only to an unknown level of risk from lithium in surface water. Arsenic has the highest XQ of all contaminants for soil-dwelling organisms exposed to groundwater at the MISS/Stepan/Ballod area. Chromium, if present in the hexavalent form, poses the greatest risk to non-soil dwelling terrestrial organisms indirectly exposed to groundwater via trophic pathways because chromium's BCF (1,000) is greater than arsenic's BCF (44). Terrestrial organisms at MISS and Stepan properties are exposed to an unknown degree of risk from organic COCs other than phenanthrene.

For MISS soils, chromium, copper, and lead pose the greatest ecological risk (EQ > 100). Twelve BNAE organics and the pesticide, Chlordane, pose an unknown degree of risk because of the unavailability of oral toxicity data. The BCFs used to calculate XQs for chromium (1,000), lead (1000) and copper (200) mean that the XQs for trophic exposure to these COCs in MISS soils are 2 to 3 orders of magnitude higher than the EQs. This strongly suggests that chromium, lead, and copper pose a significant risk to terrestrial organisms via the food web at MISS, but it is uncertain how many individuals or types of organisms, other than groundhogs, use or inhabit this property.

For Stepan soils, lead (EQ = 141) and phenanthrene (EQ = 2.1) pose the greatest ecological risks. Seven BNAE organics pose an unknown degree of risk. The major contaminants in commercial/government vicinity property soils are barium and lead (EQ > 1000), and to a lesser extent chromium and copper (100 <EQs < 1000). The low BCF for barium (4) and the high

BCFs for the others mean that the XQs for chromium(VI), copper, and lead are greater than that for barium. Butylbenzylphthalate is the only BNAE organic at this operational unit.

Only lead in residential vicinity property soils exceeds its soil toxicity threshold (EQ = 1048).

The COCs at the MISS/Stepan/Ballod area that pose the greatest risk to ecological receptors exposed to groundwater are arsenic, chromium (VI), copper, and lead, and, to an unknown extent, bis(2-chloroethyl)ether, carbon disulfide, 1,1-dichloroethene, 1,2-dichloroethene, and vinyl chloride. Although it is a COC because of its mobility and persistence characteristics, toluene is unlikely to bioconcentrate sufficiently (BCF=11 in fish) to increase its environmental concentration by the 8 orders of magnitude required to exceed its toxicity threshold (17,500 mg/L).

Lithium, 1,2-dichloroethene, and 1,1,2,2-tetrachloroethane are the COCs in Westerly Brook surface water, but the relative magnitude of the risks cannot be calculated because there are no toxicity thresholds for these contaminants.

The effects of metals, in general, and copper and lead, in particular, on organisms are well characterized (Section 6.3). With these contaminants concentrations so high above their toxic thresholds, deleterious effects and risks on both ecosystems (e.g., community structure, primary production) and organisms (e.g. animal behaviors, reproduction) are highly probable. Nevertheless, MISS and commercial/government vicinity properties, except for the Sears wetland, are so highly modified and have such little natural habitat remaining that the actual risk to ecosystem structure or function at these sites is small, although the risk to organisms residing at or visiting the sites may be large. The ecological risks to biota at residential vicinity properties and the Sears wetland are likely significant.

### 6.4.2 Future Risks

The risks to the biota at the Maywood site can be considered long-term risks. Toxicity threshold concentrations were based on subacute exposures. Based on their half-lives, $K_{OC}$, and water solubilities, the ecological COCs at the site can be expected to persist for extended periods of time. In summary, the many ecological COCs with EQs and XQs exceeding 10 indicate that they will likely remain above toxic concentrations for many years if the site is not remediated.

These risks to the ecological receptors at the Maywood site are the risks of individual contaminants. The risks from exposure to multiple contaminants depend on the interactions among them; effects could be additive, synergistic, or antagonistic. This ERA provides a foundation for an extended characterization of the risks to exposure to multiple contaminants, but such an effort cannot be conducted without additional data or evaluation of alternative assumptions.

For ecological COCs, remedial actions undertaken to protect human populations would not necessarily also protect the limited ecological resources of the Maywood site. A separate remedial strategy could become necessary to deal with the COCs as sources of ecological risk.

### 6.4.3 Uncertainties in the Ecological Risk Assessment

Uncertainties in each of the four interrelated steps of the ecological risk assessment process are addressed in the following discussion. More generally, there is uncertainty about whether characterizing the risk to organisms underestimates or overestimates the risk to populations at the Maywood site and the ecosystems that comprise them. The issue remains unresolved, so at present, there is no alternative to organismal-based ecological risk assessment using conservative estimates of toxicity and exposure.

#### 6.4.3.1 Uncertainties in Problem Formulation and Selection of Ecological COCs

The structure of the biotic community comprising the ecological receptors at the Maywood site (i.e., the distribution and abundance of organisms) was not quantified for the ERA. The lack of quantitative data introduces uncertainties concerning whether, and to what extent, the risk characterization based on proxy organisms underestimates or overestimates the risk to the remainder of the ecological community. Onsite reconnaissance establishes the nature and quality of habitat and confirms the presence of vegetation types and of active, visible animal species. These observations justify assumptions about the presence of unobserved organisms that are essential to normal ecosystem functioning, such as soil dwelling worms and arthropods, herbivorous insects, and aquatic benthic invertebrates. It is possible that one or more unobserved species of organism at Maywood are more sensitive than those species for which toxicity data were available for use in setting toxicity thresholds. It does not necessarily follow that these organisms are at significantly greater risk of adverse ecological effects than that estimated in this ERA, because exposure concentrations could be overestimated.

Environmental concentrations of contaminants at the Maywood site, which are used to calculate EQs and XQs and which are, thus, critical to the characterization of ecological risk, are based on a limited number of nonrandomly located samples (Section 2). Given that assumptions on the distribution of the data are correct, there is a quantifiable degree of uncertainty about the actual spatial distribution of contaminants, that is, whether a site chosen at random would have a contaminant concentration above or below a given value. For example, the concentration in 95 of every 100 samples will, on average, not be greater than the 95th percentile ($UL_{95}$) concentration. Also, because the estimated $UL_{95}$ concentrations were used to calculate EQs and XQs, the estimates of risk from ecological COCs were conservative. Using $UL_{95}$ concentrations decreases the likelihood of underestimating the risk posed by each ecological COC, and it increases the likelihood of overestimating the risk. If the data do not fit the assumed distribution well, the number of ecological COCs and their exposure concentrations could be overestimated or underestimated depending on how the actual data distribution differs from the assumed data distribution.

The ecological COC screening process likely overestimated the number of organic substances that pose potential risks to ecological resources at Maywood. While most of the inorganic contaminants and one organic contaminant were ecological COCs because their mean environmental concentrations exceeded their toxicity thresholds, an even greater number of contaminants were ecological COCs despite low environmental concentrations (e.g., the mean concentration of tetrachloroethylene in Stepan surface soil was 0.003 mg/kg). These organic compounds were ecological COCs because there was no factual basis for choosing a toxicity threshold. Yet, in all cases except one, where a threshold existed for an organic potential ecological COC, the contaminant concentration did not exceed the threshold. A few contaminants' estimated mean concentrations were below their toxicity thresholds but were included as ecological COCs because of their mobility and persistence characteristics. Thus, the rules for selecting ecological COCs likely overestimates the number of ecological COCs.

#### 6.4.3.2 Uncertainties in Ecological Exposure Assessment

Rigorous tracing of the movement of contaminants from Maywood source media to ecological receptors, including quantification of a site-specific food web, was not performed for this ERA. This introduces uncertainties about the actual modes and pathways of exposure for the biotic community and the actual exposure concentrations of contaminants. Exposure concentrations can differ from measured environmental concentrations as a result of physical and

chemical processes during transport from source to receptor and as a result of biomagnification through the food web. These processes could not be evaluated explicitly and quantitatively in this ERA. It is reasonable to assume that exposure to some organisms, especially top predators, would be underestimated due to neglect of biomagnification of contaminant concentrations in their prey. The exposure experienced by others would be overestimated by neglecting processes that dilute contaminants, or otherwise make them unavailable to organisms, especially those organisms exposed by direct contact or inhalation and ingestion of contaminated media.

Except for soil-dwelling terrestrial organisms, there is little uncertainty that the exposure modes and pathways used to characterize the exposure to ecological receptors at the Maywood site are most important for the large, active organisms in terrestrial and aquatic habitats. Burrowing animals may be exposed to soil and groundwater primarily by way of inhalation following volatilization of contaminants, but gaseous concentrations in soil interstices, cavities, and burrows were not available. Therefore, the exposure to burrowing organisms at the Maywood site from direct contact with and ingestion of contaminated soil and groundwater may be underestimated if gas concentrations are larger than soil and groundwater measurements, or if toxicity thresholds are lower for inhalation than they are for ingestion. Overestimating exposure by using conservative exposure concentrations and toxicity thresholds balances the underestimating of exposure due to neglecting exposure modes and pathways of lesser importance.

Finally, some contaminants in surface water and sediments may be toxic to Maywood organisms at concentrations below analytical detection limits, and thus, the exposure to aquatic biota may be underestimated.

#### 6.4.3.3 Uncertainties in Ecological Effects Assessment

There is little doubt that, for most Maywood organisms, the identified ecological COCs have deleterious effects at concentrations above the threshold concentrations used to screen contaminants as ecological COCs and to characterize the risks at the Maywood site. Toxicity thresholds were either based on concentrations reported not to have an effect on the study organism, including federal water quality criteria (WQCAQ), or were estimated conservatively. These thresholds would underestimate the risks only to organisms at Maywood that are considerably more sensitive than the study organisms, and overestimate the risk to organisms equally or less sensitive than the study organisms. There remains the possibility that some

thresholds were set at levels at or below which some harm would occur to the study organism or similar organisms at the Maywood site.

Additional uncertainty exists as to the pertinence of organismal toxicity for characterizing the risk to populations and ecosystems. It is possible that populations may compensate for the loss of large numbers of juveniles or adults with increased survival or fecundity, and ecosystems may possess functionally redundant species that are less sensitive to contaminants. The great uncertainty as to whether ecosystems at the Maywood site, e.g., Westerly and Lodi Brooks) possess these buffering mechanisms justifies a conservative approach to risk assessment based on organismal toxicity.

6.4.3.4 Uncertainties in Ecological Risk Characterization

In addition to the uncertainties described above, which ultimately produce the uncertainty in the assessment of current risks for the Maywood site, there are three additional areas of uncertainty in the risk characterization: offsite receptors, cumulative risks and future risks.

The ERA characterizes the risk to offsite ecological receptors from onsite contaminants without benefit of contaminant tracer studies and offsite biotic and habitat surveys. Offsite receptors can be exposed to contaminants via animal and physical transport processes, but evaluating the magnitude of this exposure would require additional studies. It is unlikely that offsite receptors would have lower toxicity thresholds for contaminants than the thresholds used for onsite biotic receptors. Also, there is little reason to expect that contaminants migrating offsite would be concentrated beyond measured concentrations at the Maywood site unless a contaminant bioconcentrates in organisms that move extensively on and off the site. In general, the estimate of risk to offsite receptors is likely to be overestimated rather than underestimated. The XQs are a means to more realistically estimate offsite risks, but the hypothetical Maywood exposure factors for offsite receptors (10 percent of onsite exposure) may, nevertheless, underestimate the risks. Actual offsite risks are likely to lie between those for onsite receptors based on EQs and those for offsite receptors based on XQs.

The ERA estimates the risk to ecological receptors from individual contaminants. Generally, the methods used were sufficiently conservative that individual risks are overestimated. Nevertheless, synergistic effects are possible, perhaps likely, when toxicants interact in biological systems. Deleterious effects in ecosystems (and organisms) may cascade throughout the system and have indirect effects on the ability of a population to persist in the area even

though individual organisms are not sensitive to the given contaminants in isolation. Therefore, the ecological risk characterization for the Maywood site may underestimate actual risks to biotic receptors from chemical mixtures.

A third area of uncertainty in the ecological risk characterization is the future risk to the environment from contamination at the Maywood site. The ERA characterizes the current risk based on chronic exposure to low concentrations of toxicants with the potential to persist in the environment for extended periods of time. Nevertheless, possible mechanisms exist that could significantly increase (e.g., erosion, leaching to surface or groundwater) or decrease (e.g., enhanced microbial degradation) the risk to future nonhuman inhabitants of the Maywood site.

#### 6.4.3.5 Summary

The major uncertainties in this ERA center around the estimates of the contaminant concentrations to which ecological receptors at the Maywood site are actually exposed (exposure concentrations) and the concentrations that present an acceptable level of risk of adverse effects to the Maywood organisms, their populations and the ecosystems that comprise them (toxicity thresholds). These uncertainties arise from many sources, especially the lack of site-specific data on contaminant transport and transformation processes, organismal toxicity, animal behavior and diet, population parameters, interspecific interactions, and the lack of a fundamental understanding of how ecosystems respond to environmental perturbations.

Given the uncertainties inherent in the risk assessment process, the results of this ERA are not precisely correct but are, nevertheless, sufficiently reliable to guide remedial actions that are intended to protect the ecological resources at the Maywood site.

## 6.5 SUMMARY

### 6.5.1 Habitats and Wildlife

The Maywood site is located in an urban and industrialized area. The Maywood site has some ecological resources including aquatic, terrestrial, and wetland habitats. Onsite surveys disclosed the following commonly seen organisms in terrestrial habitats: groundhog, raccoon, robin, and mourning dove. For aquatic habitats, the commonly encountered organisms were: midge larvae, minnow, geese, and ducks. A food web shows how these and other organisms interact

trophically. No threatened or endangered species identified by the U.S. Fish and Wildlife Service or the state of New Jersey is known to inhabit the site.

Habitats and biota occurring at the Maywood site are believed not to be (1) unique or unusual; (2) necessary for continued propagation of key species; or (3) highly valued for economic, recreational, or aesthetic reasons. The biotic diversity at Maywood is consistent with a modified urban environment with scattered industries, residential areas, commercial properties, and scattered wetlands, old-fields and lotic habitats. Intensive field analysis for documenting possible impacts to biota from site contaminants beyond the findings reported in this section may not be warranted.

### 6.5.2 Chemicals of Ecological Concern and Risk Characterization

Sixty-two chemicals were recognized as potential ecological COCs. Most of these chemicals were found above background levels in the soils of MISS, Stepan, commercial/government, residential vicinity properties, groundwater in the MISS/Stepan/Ballod property and Westerly and Lodi Brooks. Calcium, potassium, and sodium were dropped from the risk characterization because they are essential biological minerals. There are no readily available terrestrial wildlife toxicity data for radium, thorium, and uranium (or their isotopes) at the Maywood sites. The risk assessment for metals and other elements and volatile and semivolatile organic chemicals relies on aquatic and oral toxicity data for laboratory animals, data which was gathered from compendia of published studies, e.g., Long and Morgan (1990), AQUIRE (1992). When the observed environmental concentrations and physical-chemical parameters of COCs were compared to toxicity, mobility and persistence thresholds, 40 of these emerged as the contaminants of ecological concern. The ecological quotients or EQs for those contaminants exceeding their toxicity threshold ranged from 2.1 to 98 (mean) and 2.1 to 15,053 (RME), where any ratio of 1 or greater is a concern. The ecological COCs consist of radium, thorium, and uranium (and their isotopes), 14 elements (metals and rare earths), 22 volatile and BNAE organic chemicals, and 1 organic pesticide. A discussion of uncertainties in the ERA is provided in Section 5.3.3.

Lead, chromium, and copper generally had the highest EQs in Maywood operational units. Barium and lead exceeded 1,000 in soils at commercial/government properties. The EQs of chromium, copper and lead exceeded 100 in MISS and commercial/government property soils. Lead's EQ exceeded 100 in Stepan and residential vicinity property soils. Arsenic, chromium,

copper and lead in groundwater at the MISS/Stepan/Ballod property had EQs between 10 and 100. Zinc and phenanthrene had EQs between 1 and 10 in MISS/Stepan/Ballod groundwater and Stepan soils, respectively. EQs for the other organic COCs in MISS, Stepan, commercial/government vicinity-property soils, MISS/Stepan/Ballod groundwater and Westerly Brook surface water could not be calculated because toxicity thresholds could not be established.

When hypothetical exposure is considered, the heavy metals and phenanthrene present the greatest ecological risk to both onsite and offsite aquatic receptors: exposure quotients or XQs $>10^2$ (Table 6-11). Terrestrial organisms exposed onsite via trophic pathways (Table 6-6) are subject to the greatest risk from 1) arsenic and chromium in MISS/Stepan/Ballod groundwater, 2) lead in soils at all sites, and 3) chromium in MISS soil (all XQs $> 10^2$). They are exposed to an unknown degree of risk from the organics. All COCs pose a serious but lower relative risk to offsite terrestrial predators because all XQs for onsite non-soil dwelling organisms exceed 100 and offsite receptors are hypothesized to experience no less than a tenth of this exposure.

The numerous COCs with large EQs and XQs strongly indicate that, in the absence of remediation, both onsite and offsite terrestrial organisms and populations at Maywood properties will continue to be at risk of adverse effects of the type described in Section 6.3.

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DOE/OR/21950-003
FINAL

**FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM (FUSRAP)**
**CONTRACT NO. DE-AC05-91OR21950**

# BASELINE RISK ASSESSMENT FOR THE MAYWOOD SITE

## VOLUME II

**MAYWOOD, NEW JERSEY**


Prepared by:
Former Sites Restoration Division
U.S. DEPARTMENT OF ENERGY

**APRIL 1993**

Technical support by:
Science Applications International Corporation
ESC-FUSRAP

92-500ML/042393

# APPENDIX A

# STATUS OF MAYWOOD PROPERTIES

## Table A-1. Status of the Maywood Site Properties

| RESIDENTIAL OPERABLE UNIT | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| 1 | Branca Court and Redstone Lane Residences | 2 Branca Court, Lodi | C | BNI (1989j) |
| | | 4 Branca Court, Lodi | C | BNI (1989k) |
| | | 6 Branca Court, Lodi | C | BNI (1989l) |
| | | 7 Branca Court, Lodi | C | BNI (1988a) |
| | Branca Court and Redstone Lane Residences | 11 Branca Court, Lodi | C | BNI (1988b) |
| | | 11 Redstone Lane, Lodi | C | BNI (1988h) |
| | | 17 Redstone Lane, Lodi | C | BNI (1989i) |
| | | 19 Redstone Lane, Lodi | C | BNI (1989za) |
| | Hancock St., Avenue F and Trudy Drive Residences | 3 Hancock St., Lodi | C<br>R | BNI (1985b)<br>BNI (1986d) |
| | | 4 Hancock St., Lodi | C | BNI (1989a) |

## Table A-1. Status of the Maywood Site Properties (continued)

| RESIDENTIAL OPERABLE UNIT (continued) | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| 1 (con) | Hancock St., Avenue F and Trudy Drive Residences (con) | 5 Hancock St., Lodi | C | BNI (1989b) |
| | | 6 Hancock St., Lodi | C | BNI (1989c) |
| | | 7 Hancock St., Lodi | C | BNI (1989d) |
| | | 8 Hancock St., Lodi | C | BNI (1989e) |
| | | 9 Hancock St., Lodi | C | BNI (1989x) |
| | | 10 Hancock St., Lodi | C | BNI (1989f) |
| | | 121 Avenue F, Lodi | C<br>R | BNI (1985c)<br>BNI (1986d) |
| | | 123 Avenue F, Lodi | C<br>R | BNI (1985d)<br>BNI (1986d) |
| | | 58 Trudy Drive, Lodi | C<br>R | ORNL (1984a)<br>BNI (1986d) |
| | | 59 Trudy Drive, Lodi | C<br>R | ORNL (1984b)<br>BNI (1986d) |

**Table A-1. Status of the Maywood Site Properties (continued)**

| RESIDENTIAL OPERABLE UNIT (continued) | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| 1 (con) | Hancock St., Avenue F and Trudy Drive Residences (con) | 60 Trudy Drive, Lodi | C | BNI (1989m) |
| | | 61 Trudy Drive, Lodi | C<br>R | ORNL (1984c)<br>BNI (1986d) |
| | | 62 Trudy Drive, Lodi | D | ORNL (1989a)<br>BNI (1986d) |
| | | 64 Trudy Drive, Lodi | C<br>R | BNI (1985a)<br>BNI (1986d) |
| | Ave. B and Ave. C Residences | 79 Ave. B, Lodi | D | ORNL (1989b) |
| | | 59 Ave. C, Lodi | C<br>R | ORNL (1984d)<br>BNI (1986d) |
| | | 90 Ave. C, Lodi[c] | D | ORNL (1989c) |
| | 106 Columbia Lane and 99 Garibaldi Ave. | 106 Columbia Lane, Lodi | C | BNI (1989o) |
| | | 99 Garibaldi Ave., Lodi | C | BNI (1989p) |
| | 136 West Central | 136 West Central Ave., Maywood | D | ORNL (1989g) |

**Table A-1. Status of the Maywood Site Properties (continued)**

| RESIDENTIAL OPERABLE UNIT (continued) | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| 1 (con) | Ave. E Residences | 108 Ave. E, Lodi | D | ORNL (1989d) |
| | | 112 Ave. E, Lodi | D | ORNL (1989e) |
| | | 113 Ave. E, Lodi | D | ORNL (1989f) |
| 2 | I-80 South Right-of-Way | East Bound Right-of-Way | C | BNI (1989zb) |
| | Long Valley Rd. Residences | 14 Long Valley Rd, Lodi | C | BNI (1989y) |
| | | 16 Long Valley Rd, Lodi | C | BNI (1988c) |
| | | 18 Long Valley Rd, Lodi | C | BNI (1988d) |
| | | 20 Long Valley Rd, Lodi | C | BNI (1988e) |
| | | 22 Long Valley Rd, Lodi | C | BNI (1988f) |
| | | 24 Long Valley Rd, Lodi | C | BNI (1989z) |
| | | 26 Long Valley Rd, Lodi | C | BNI (1988g) |

## Table A-1. Status of the Maywood Site Properties (continued)

| RESIDENTIAL OPERABLE UNIT (continued) | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| R (Previously Remediated) | Grove Ave., and Parkway Residences | 10 Grove Ave., Rochelle Park | C<br>R<br>V | BNI (1984a)<br>BNI (1986c)<br>ORNL (1986h) |
| | | 22 Grove Ave., Rochelle Park | C<br>R<br>V | BNI (1984b)<br>BNI (1986c)<br>ORNL (1986i) |
| | | 26 Grove Ave., Rochelle Park | C<br>R<br>V | BNI (1984c)<br>BNI (1986c)<br>ORNL (1986j) |
| | | 30 Grove Ave., Rochelle Park | C<br>R<br>V | BNI (1984d)<br>BNI (1986c)<br>ORNL (1986k) |
| | | 34 Grove Ave., Rochelle Park | C<br>R<br>V | BNI (1984e)<br>BNI (1986c)<br>ORNL (1986l) |
| | | 38 Grove Ave., Rochelle Park | C<br>R<br>V | BNI (1984f)<br>BNI (1986c)<br>ORNL (1986m) |
| | | 42 Grove Ave., Rochelle Park | C<br>R<br>V | BNI (1984g)<br>BNI (1986c)<br>ORNL (1986n) |
| | | 86 Parkway, Rochelle Park | C<br>R<br>V | BNI (1984h)<br>BNI (1986c)<br>ORNL (1986o) |

**Table A-1. Status of the Maywood Site Properties (continued)**

| RESIDENTIAL OPERABLE UNIT (continued) | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| R (con) | Grove Ave., and Parkway Residences (con) | 90 Parkway, Rochelle Park | C<br>R<br>V | BNI (1984i)<br>BNI (1986c)<br>ORNL (1986p) |
| | Davison Ave. & Latham St. Residences | 454 Davison Ave., Maywood | C<br>R<br>V | ORNL (1986a)<br>BNI (1986b)<br>ORNL (1986a) |
| | | 459 Davison Ave., Maywood | C<br>R<br>V | ORNL (1981b)<br>BNI (1986b)<br>ORNL (1986b) |
| | | 460 Davison Ave., Maywood | C<br>R<br>V | ORNL (1981a)<br>BNI (1986b)<br>ORNL (1986c) |
| | | 464 Davison Ave., Maywood | C<br>R<br>V | ORNL (1981c)<br>BNI (1986b)<br>ORNL (1986d) |
| | | 468 Davison Ave., Maywood | C<br>R<br>V | ORNL (1981d)<br>BNI (1986b)<br>ORNL (1986e) |
| | | 459 Latham St., Maywood | C<br>R<br>V | ORNL (1981e)<br>BNI (1986b)<br>ORNL (1986f) |
| | | 461 Latham St., Maywood | C<br>R<br>V | ORNL (1981f)<br>BNI (1986b)<br>ORNL (1986r) |

**Table A-1. Status of the Maywood Site Properties (continued)**

| Property Unit Designation | Name | Property | Status[a] | Reference |
|---|---|---|---|---|
| **RESIDENTIAL OPERABLE UNIT (continued)** | | | | |
| R (con) | Davison Ave. & Latham St. Residences | 467 Latham St., Maywood | C<br>R<br>V | ORNL (1981g)<br>BNI (1986b)<br>ORNL (1986g) |
| **STEPAN OPERABLE UNIT** | | | | |
| 3 | Stepan Property | Stepan Property, Maywood | C | Morton (1981) |
| **MUNICIPAL PARKS OPERABLE UNIT** | | | | |
| 4 | Lodi Municipal Park | Lodi Municipal Park, Lodi | C | BNI (1988i) |
| | Firemen's Memorial Park, J.F. Kennedy Park Lodi Fire Station | Firemen's Memorial Park, Lodi | C | BNI (1989r) |
| | | J.F. Kennedy Municipal Park, Lodi | C | BNI (1989u) |
| | | Fire Station #2, Lodi | C | BNI (1989q) |

**Table A-1. Status of the Maywood Site Properties (continued)**

| COMMERCIAL/GOVERNMENT | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| 5 | Ave. E Residences, Airco Medical, Appleton Electronics | AIRCO Medical (100 Hancock St.) | C | BNI (1989h) |
| | | Appleton Electronics (80 Hancock St.) | C | BNI (1989g) |
| | National Community Bank I-80 North (West Bound Right-of-Way) | Flint Ink (80 Industrial Rd) | C | BNI (1989n) |
| | | NJ Vehicle Inspection Station, Lodi | C | BNI (1987e) |
| | Sidney St. Auto Storage | 72 Sidney St. Auto Storage | C | BNI (1989s) |
| | Bergen Cable | Bergen Cable Property, Lodi | C | BNI (1987f) |
| | National Community Bank I-80 North (West Bound Right-of-Way) | 160/174 Essex St. Lodi (National Community Bank) | C | BNI (1989t) |
| | | I-80 West Bound Right-of-Way | C | BNI (1989zb) |

**Table A-1. Status of the Maywood Site Properties (continued)**

| COMMERCIAL/GOVERNMENT (continued) | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| 5 (con) | Nat. Community Bank, Muscarelle Associates, Sears Truck Repair | 113 Essex St. Maywood (National Community Bank) | C | ORNL (1989i) |
| | | Sears Truck Repair, Maywood (Joseph Muscarelle & Asso.) | D | ORNL (1989j) |
| **MISS** | | | | |
| 6 | MISS, NJ Rt. 17 New York Susquehanna, and Western Railroad | MISS, Maywood | C | BNI (1987g) NUS (1983) |
| | | New York Susquehanna and Western Railroad Property | C | Kannard (1986c) |
| | | NJ Route 17, Maywood and Rochelle Park | C | Kannard (1986b) |
| | MISS Pile | MISS Pile | C | BNI (1991) |
| | Ballod Property | Ballod Property, Rochelle Park | C<br>R<br>b | Cole et al. (1981)<br>Crotwell (1985)<br>BNI (1986a) |

**Table A-1. Status of the Maywood Site Properties (continued)**

| COMMERCIAL/GOVERNMENT | | | | |
|---|---|---|---|---|
| Property Unit Designation | Name | Property | Status[a] | Reference |
| 7 | Federal Express, Gulf Station, Hunter-Douglas, Sunoco Station, Sears Small Truck Repair (con) | Hunter-Douglas Property, Maywood | C | BNI (1987b) |
| | | Sunoco Station Property, Maywood | C | BNI (1987d) |
| | | 200 Rt. 17, Maywood (Sears Small Truck Repair) | D | ORNL (1989h) |
| | Federal Express, Gulf Station, Hunter-Douglas, Sunoco Station, Sears Small Truck Repair | Federal Express Property, Maywood | C | BNI (1987c) |
| | | Gulf Station Property, Maywood | C | BNI (1989v) |
| | Sears and DeSaussure Properties | Sears Property, Maywood | C | BNI (1987a) |
| | | DeSaussure Property, Maywood | C | BNI (1989w) |
| 8 | Scanel Properties | Scanel Property, Maywood | C | Kannard (1986a) |

**Table A-1. Status of the Maywood Site Properties (continued)**

[a] C = Radiological characterization completed.
R = Remedial action performed.
V = Post-remedial action verification performed by independent verification contractor.
D = Designation survey completed.

[b] Only part of the site remediated.

[c] Partial remediation completed in 1991 as a time-critical removal action. Documentation of the cleanup being prepared.

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Oak Ridge National Laboratory 1989g. Results of the Radiological Survey at 136 W. Central Avenue (MJ030), Maywood, New Jersey, ORNL/RASA-88/22, Oak Ridge, TN, February.

Oak Ridge National Laboratory 1989h. Results of the Radiological Survey at 200 Rt. 17 (MJ035), Maywood, New Jersey, ORNL/RASA-88/23, Oak Ridge, TN, February.

Oak Ridge National Laboratory 1989i. Results of the Radiological Survey at National Community Bank, 113 Essex Street (MJ021), Maywood, New Jersey, ORNL/RASA-88/51, Oak Ridge, TN, September.

Oak Ridge National Laboratory 198j. Results of the Radiological Survey at Rt. 17 and Essex Street (MJ036), Maywood, New Jersey, ORNL/RASA-88/24, Oak Ridge, TN, February.

# APPENDIX B

# ARARs TABLES

## Table B-1. Potential ARARs for Air at Maywood, NJ

| Contaminant | Max Level at Maywood | DOE Guidelines for Residual Radioactivity at FUSRAP Sites (1987) | Clean Air Act 40CFR61 Subpart Q | NJAC 7:28-6 | | EPA 40CFR192 | DOE Order 5820.2A | DOE Order 5400.5 Chapters III, IV |
|---|---|---|---|---|---|---|---|---|
| | | | | Occupational | Non-Occupational | | | |
| Radon | 2 pCi/L | 3 pCi/L | | | | 0.02 WL* rec<br>0.03 WL* max | | 0.02 WL* rec<br>0.03 WL* max |
| Radon-222 (Radon) | 9.9 pCi/L | | | 3E-8 | 1E-9 | | | 3E-9 |
| Radon-220 (Thoron) | | | | 3E-7 | 1E-8 | | | 3E-9 |
| Average Radon-222 flux from waste | 0.02 pCi/sq-m/s | 20 pCi/sq-m/s | 20 pCi/sq-m/s | | | 20 pCi/sq-m/s | 20 pCi/sq-m/s | 20 pCi/sq-m/s |
| Radon-222 increase at fenceline | | 0.5 pCi/L above background | | | | 0.5 pCi/L above b.g. | | 0.5 pCi/L above b.g. |
| Rn-222 in atmosphere above facility surface or openings | | 100 pCi/L above b.g. | | | | | | 100 pCi/L above b.g. |
| Annual avg. Rn-222 in atmosphere over facility site | | 30 pCi/L above b.g. | | | | | | 30 pCi/L above b.g. |
| Annual avg. concentration of Rn-222 at or above any location outside facility site | | 3 pCi/L above b.g. | | | | | | 3 pCi/L above b.g. |
| Annual avg. concentration of Rn-220 at or above any location outside facility site | | 10 pCi/L above b.g. | | | | | | |

* WL - a working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3E5 MeV of potential alpha energy.

## Table B-2. Potential ARARs for External Gamma Radiation at Maywood, NJ

| Contaminant | Maximum Level at Maywood | DOE Guidelines for Residual Radioactivity at FUSRAP Sites (1987) | EPA 40CFR192 | DOE Order 5400.5 Chapter IV |
|---|---|---|---|---|
| Annual average external gamma at fenceline | 6.62μR/h (excludes 7.76μR/h) background | | | |
| Average level of gamma radiation inside building or habitable structure on site for unrestricted use | | 20 μR/h above background | 20 μR/h above background | 20 μR/h above background |

## Table B-3. Potential ARARs for Surface Contamination at Maywood, NJ

| Contaminant | DOE Guidelines for Residual Radioactivity at FUSRAP Sites (1987) | DOE Order 5400.5 Chapter IV | NRC (1982)* |
|---|---|---|---|
| Ra-226, Ra-228, Th-228 on surfaces (100 cm2) | 100 dpm/100 cm2 | | 100 dpm/100 cm2 |
| Maximum Ra-226, Ra-228, Th-228 on surfaces (100 cm2) | 300 dpm/100 cm2 | | 300 dpm/100 cm2 |
| Removable Ra-226, Ra-228, Th-228 on surfaces (100 cm2) | 20 dpm/100 cm2 | | 20 dpm/100 cm2 |
| Average Th-Natural, Th-232 on surfaces (100 cm2) | 1000 dpm/100 cm2 | 1000 dpm/100 cm2 | 1000 dpm/100 cm2 |
| Maximum Th-Natural, Th-232 on surfaces (100 cm2) | 3000 dpm/100 cm2 | 3000 dpm/100 cm2 | 3000 dpm/100 cm2 |
| Removable Th-Natural, Th-232 on surfaces(100 cm2) | 200 dpm/100 cm2 | 200 dpm/100 cm2 | 200 dpm/100 cm2 |

* Functional equivalent of NRC Regulatory Guide 1.86 but applied to non-reactor facilities

## Table B-4. Potential ARARs for Groundwater and Surface Water at Maywood, NJ

| Contaminant Class and Name | Maywood Maximum Level in GW/SW | SDWA National Primary Drinking Water Std. (EPA MCL) 40CFR141 | National Drinking Water Goal (EPA MCLG) | National Secondary Drinking Water Std. (EPA SMCL) | EPA National Ambient Water Quality Criteria (public health) | EPA National *Ambient Water* Quality Criteria (taste & odor) | DOE Order 5400.5 Chapter III Derived *Concentration* Guidelines for Ingested Water | DOE Guidelines for Residual *Radioactivity* at FUSRAP..., Sites (1987) | Groundwater Protection Standards for Release from Solid Waste Mgmt Units, including Uranium and Thorium Byproduct Materials *40 CFR 264.92* & 40 CFR 192.32 |
|---|---|---|---|---|---|---|---|---|---|
| **Radiologic Contaminants (µci/mL)** | | | | | | | | | |
| Cesium-137 | | | | | | | 3000 E-9 | | |
| Gross alpha | | 15 E-9 | 0 | | | | 15 E-9 | | 15 E-9 |
| Potassium-40 | | | | | | | 7000 E-9 | | |
| Radium-226 | 3.8 E-9 | 20 E-9 (1) | | | | | 100 E-9 | 100 E-9 | |
| Radium-228 | | 20 E-9 (1) | | | | | | | |
| Radium-226+Radium-228 | | 5 E-9 | 0 | | | | 5E-9 | | 5 E-9 |
| Thorium-230 | | | | | | | 300 E-9 | 300 E-9 | |
| Thorium-232 | 3.4 E-9 | | | | | | 50 E-9 | | |
| Total Uranium | | 20 ppb (1) | 0 | | | | 500 E -9 | | |
| Uranium-234 | | | | | | | 500 E-9 | | |
| Uranium-235 | | | | | | | 600 E-9 | | |
| Uranium-238 | | | | | | | 600 E-9 | | |
| **Organic Compounds (µg/L)** | | | | | | | | | |
| Acetone | 18 | | | | | | | | |
| Benzene | 1240 | 5 | 0 | | 0.66 | | | | |
| Bis(2-chloroethyl)ether | 40.0 | | | | | | | | |
| Bis(2-ethylhexyl)phthalate | 1200.0 | 4 (1) | 0 (1) | | | | | | |
| Chloroform | 39.0 | 100 (THM) | | | 0.19 | | | | |
| 1,1-Dichloroethene | 8 | 7 | | | | | | | |
| trans-1,2-Dichloroethene | 2964 | 100 | 100 | | | | | | |
| Di-n-oclyl phthalate | 41 | | | | | | | | |

## Table B-4. Potential ARARs for Groundwater and Surface Water at Maywood, NJ (continued)

| Contaminant Class and Name | Maywood Maximum Level in GW/SW | SDWA National Primary Drinking Water Std. (EPA MCL) 40CFR141 | National Drinking Water Goal (EPA MCLG) | National Secondary Drinking Water Std. (EPA SMCL) | EPA National Ambient Water Quality Criteria (public health) | EPA National Ambient Water Quality Criteria (taste & odor) | DOE Order 5400.5 Chapter III Derived Concentration Guidelines for Ingested Water | DOE Guidelines for Residual Radioactivity at FUSRAP..., Sites (1987) | Groundwater Protection Standards for Release from Solid Waste Mgmt Units, including Uranium and Thorium Byproduct Materials 40 CFR 264.92 & 40 CFR 192.32 |
|---|---|---|---|---|---|---|---|---|---|
| Methylene Chloride | 1087 | 5 (1) | 0 | | 0.19 | | | | |
| Phenol | 16 | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | 51 | | | | | | | | |
| Tetrachloroethene | 260 | 5 | 0 | | 0.8 | | | | |
| Toluene | 55 | 1000 | 1000 | 40 (1) | 14300 (2) | | | | |
| Trichloroethene | 66 | 5 | 0 | | 2.7 | | | | |
| Vinyl Chloride | 220.0 | 2 | 0 | | 2 | | | | |
| **Inorganic Elements/Anions (mg/L)** | | | | | | | | | |
| Arsenic, Total | 5.9 | 0.05 | | | 0.0000022 | | | | 0.05 |
| Arsenic, TCLP Leachate | 1.450 | | | | | | | | |
| Barium, Total | 3.5 | 2 | 2 | | 1 (2) | | | | 1.0 |
| Barium, TCLP Leachate | 3.880 | | | | | | | | |
| Cadmium, Total | 0.03 | 0.005 | 0.005 | | 0.01 (2) | | | | 0.01 |
| Cadmium, TCLP Leachate | .0188 | | | | | | | | |
| Chloride | 19.6 | | | 250 | 250 (2) | | | | |
| Chromium, TCLP Leachate | .310 | | | | | | | | |
| Chromium, Total | 2.2 | 0.1 | 0.1 | | 0.05 | | | | 0.05 |
| Copper, Total | 0.4 | 1.3 (1) | 1.3 (1) | 1 | | 1 | | | |
| Iron, Total | 3.430 | 0.015 (1) | | 0.3 | | 0.3 | | | |
| Lead, TCLP Leachate | 1.380 | | | | | | | | |
| Lead, Total | 0.1 | 0.05/0.005(1) | 0 (1) | | 0.05 (2) | | | | 0.05 |

## Table B-4. Potential ARARs for Groundwater and Surface Water at Maywood, NJ (continued)

| Contaminant Class and Name | Maywood Maximum Level in GW/SW | SDWA National Primary Drinking Water Std. (EPA MCL) 40CFR141 | National Drinking Water Goal (EPA MCLG) | National Secondary Drinking Water Std. (EPA SMCL) | EPA National Ambient Water Quality Criteria (public health) | EPA National Ambient Water Quality Criteria (taste & odor) | DOE Order 5400.5 Chapter III Derived Concentration Guidelines for Ingested Water | DOE Guidelines for Residual Radioactivity at FUSRAP..., Sites (1987) | Groundwater Protection Standards for Release from Solid Waste Mgmt Units, including Uranium and Thorium Byproduct Materials 40 CFR 264.92 & 40 CFR 192.32 |
|---|---|---|---|---|---|---|---|---|---|
| Manganese, Total | 11.0 | | | 0.05 | | 0.05 | | | |
| Mercury, TCLP Leachate | .002 | | | | | | | | |
| Nickel | 0.098 | | | | | | | | |
| Phosphate, as P | 0.2 | | | | | | | | |
| Selenium | | 0.01 | 0.01 | | | | | | |
| Silver, Total | 0.133 | 0.05 | | 0.1 | 0.05 (2) | | | | 0.05 |
| Silver, TCLP Leachate | .0208 | | | | | | | | |
| Sulfate | 6680.0 | 400 | 400 | 250 | | 250 | | | |
| Tellurium, Total | 5.130 | | | | | | | | |
| Thallium, Total | .210 | | | | | | | | |
| Total Organic Carbon | 31.8 | | | | | | | | |
| Total Solids | 275.0 | | | | | | | | |
| Zinc, Total | 44.0 | | | 5 | 0.05 (2) | 5 | | | |

(1) These values are proposed

## Table B-4. Potential ARARs for Groundwater and Surface Water at Maywood, NJ (continued)

| Contaminant Class and Name | Maywood Maximum Level in GW/SW | FAO Agricultural Water Quality Goal | New Jersey Safe Drinking Water Act Standards 7NJAC 10-1 et. seq (NJ MCL) | Releases from Hazardous Waste Treatment, Storage Disposal Facilities (RCRA) US EPA 40 CFR 261.24 EP TOX | NJAC 7:26-8.12 EP TOX | New Jersey Surface Water Quality Standards (1989) | New Jersey Groundwater Quality Standards | NJAC 7:28-6.5 Max permissible concentrations of radioactive materials in air & water |
|---|---|---|---|---|---|---|---|---|
| **Radiologic Contaminants (µCi/mL)** | | | | | | | | |
| Cesium-137 | | | | | | | | 20000 E-9 |
| Gross alpha | | | 15 E-9 | | | | 15 E-9 | |
| Potassium-40 | | | | | | | | |
| Radium-226 | 3.8 E-9 | | | | | | | 30 E-9 |
| Radium-226+Radium-228 | | | | | | | 5 E-9 | |
| Thorium-230 | | | | | | | | 2000 E-9 |
| Thorium-232 | 3.4 E-9 | | | | | | | 2000 E-9 |
| Total Uranium | | | | | | | | 600 E-9 |
| Uranium-234 | | | | | | | | 4000 E-9 |
| Uranium-235 | | | | | | | | 4000 E-9 |
| Uranium-238 | | | | | | | | 600 E-9 |
| **Organic Compounds (µg/L)** | | | | | | | | |
| Acetone | 210.0 | | | | | | | |
| Benzene | 110.0 | | 1 | 500 | | | | |
| Bis(2-chloroethyl)ether | 40.0 | | | | | | | |
| Bis(2-Ethylhexyl)Phthalate | 26.0 | | | | | | | |
| Chloroform | 50.0 | | | 6,000 | | | | |
| | 8 | | | | | | | |
| trans-1,2-Dichloroethene | 360.0 | | 10 | 130 | | | | |
| Di-n-oclyl phthalate | | | | | | | | |

## Table B-4. Potential ARARs for Groundwater and Surface Water at Maywood, NJ (continued)

| Contaminant Class and Name | Maywood Maximum Level in GW/SW | FAO Agricultural Water Quality Goal | New Jersey Safe Drinking Water Act Standards 7NJAC 10-1 et. seq (NJ MCL) | Releases from Hazardous Waste Treatment, Storage Disposal Facilities (RCRA) US EPA 40 CFR 261.24 EP TOX | NJAC 7:26-8.12 EP TOX | New Jersey Surface Water Quality Standards (1989) | New Jersey Groundwater Quality Standards | NJAC 7:28-6.5 Max permissible concentrations of radioactive materials in air & water |
|---|---|---|---|---|---|---|---|---|
| Methylene Chloride | | | 2 | | | | | |
| Phenol | 16.0 | | | | | | | |
| 1,1,2,2-Tetrachloroethane | | | | | | | | |
| Tetrachloroethene | 670.0 | | 1 | 700 | | | | |
| Toluene | 26.0 | | | | | | | |
| Trichloroethene | 350.0 | | 1 | 500 | | | | |
| Vinyl Chloride | 180.0 | | 2 | 200 | | | | |
| **Inorganic Elements/Anions (mg/L)** | | | | | | | | |
| Arsenic, Total | 5.9 | 0.1 | 0.05 | 5.0 | | 0.05 | 0.05 | |
| Arsenic, TCLP Leachate | 1.450 | | | | 5.0 | | | |
| Barium, Total | 0.5 | | 1.0 | 100.0 | | 1.0 | 1.0 | |
| Barium, TCLP Leachate | 3.880 | | | | 100.0 | | | |
| Cadmium, Total | 0.03 | 0.01 | 0.01 | 1.0 | | 0.01 | 0.01 | |
| Cadmium, TCLP Leachate | .0188 | | | | 1.0 | | | |
| Chloride | 19.6 | 106 | 250 | | | | 250 | |
| Chromium, TCLP Leachate | .310 | | | | 5.0 | | | |
| Chromium, Total | .132 | | 0.05 | 5.0 | | 0.05 | 0.05 | |
| Copper, Total | .646 | 0.2 | 1.0 | | | | 1.0 | |
| Iron, Total | 3.430 | 5 | 0.3 | | | | 0.3 | |
| Lead, TCLP Leachate | 1.380 | | | 5.0 | | | | |
| Lead, Total | .0192 | 5 | 0.05 | | 5.0 | 0.05 | 0.05 | |

## Table B-4. Potential ARARs for Groundwater and Surface Water at Maywood, NJ (continued)

| Contaminant Class and Name | Maywood Maximum Level in GW/SW | FAO Agricultural Water Quality Goal | New Jersey Safe Drinking Water Act Standards 7NJAC 10-1 et. seq (NJ MCL) | Releases from Hazardous Waste Treatment, Storage Disposal Facilities (RCRA) US EPA 40 CFR 261.24 EP TOX | NJAC 7:26-8.12 EP TOX | New Jersey Surface Water Quality Standards (1989) | New Jersey Groundwater Quality Standards | NJAC 7:28-6.5 Max permissible concentrations of radioactive materials in air & water |
|---|---|---|---|---|---|---|---|---|
| Manganese, Total | .199 | 0.2 | 0.05 | | | | 0.05 | |
| Mercury, TCLP Leachate | .002 | | | | | | | |
| Nickel | | | | | | | 0.7 | |
| Phosphate, as P | 0.2 | | | | | | | |
| Selenium | | | 0.01 | 1.0 | 1.0 | 0.01 | 0.01 | |
| Silver, Total | | | | | 5.0 | 0.05 | 0.05 | |
| Silver, TCLP Leachate | .0208 | | | 5.0 | | | | |
| Sulfate | 6680.0 | | 250.5 | | | 250.0 | 250.0 | |
| Tellurium, Total | 5.130 | | | | | | | |
| Thallium, Total | .210 | | | | | | | |
| Total Organic Carbon | 31.8 | | | | | | | |
| Total Solids | 275.0 | | | | | | 500 | |
| Zinc, Total | 1.250 | 2 | 0.5 | | | | 5 | |

(1) These values are proposed

## Table B-5. Potential ARARs for Soil and Sediment at Maywood, NJ

| Contaminant Class and Name | Maximum Level in Soil/Sediment | Underground Storage Tank Regulations Proposed Jan. 1990 | DOE Order 5400.5 Chapter IV Residual Radioactive Material | DOE Guidelines for Residual Radioactivity at FUSRAP Sites (1987) | EPA 40CFR192 | NJ DEPE Proposed Cleanup Standards (24 NJR Feb 92) | NJAC 7.26 - 8.20 | EPA TSCA | OSWER Directive 9355.4-02 | EPA Haz Waste 3-29-90 TCLP | RCRA 40CFR268 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Radiologic Contaminants (pCi/g)** | | | | | | | | | | | |
| Potassium-40 | 48.1 | | | | | | | | | | |
| Radium-226 | 447.0 | | 5/15* | 5/15* | 5/15* | | | | | | |
| Radium-228 | | | | | 5/15* | | | | | | |
| Thorium-232 | 2490/6200 | | 5/15* | 5/15* | 5/15* | | | | | | |
| Uranium-238 | 250/628 | | | | | | | | | | |
| **Organic Compounds (mg/kg)** | | | | | | | | | | | |
| Acetone | 0.2400 | | | | | 1,000/50/1,000** | | | | | |
| Anthracene | 5.7000 | | | | | 10,000/50/10,000 | | | | | |
| Arochlor-1254 (PCB) | 0.1100 | | | | | | 50 | 50 | | | 50 |
| Arochlor-1260 (PCB) | 0.9800 | | | | | | 50 | 50 | | | 50 |
| Benzene | 0.1000 | 0.1 | | | | 3/1/13 | | | | .5 | |
| Benzo(A)anthracene | 9.0000 | | | | | .66/500/2.5 | | | | | |
| Benzo(A)pyrene | 9.4000 | | | | | .66/100/.66 | | | | | |
| Benzo(B)fluoranthene | 7.6000 | | | | | | | | | | |
| Benzo(K)fluoranthene | 7.2000 | | | | | .66/500/2.5 | | | | | |
| Bis(2-ethylhexyl)phthalate | 4.2000 | | | | | 49/100/210 | | | | | |
| 2-Butanone (Methyl Ethyl Ketone) | 0.1000 | 4.0 | | | | 1,000/50/1,000 | | | | 200 | |
| Carbon Disulfide | 0.0150 | | | | | | | | | | |
| Carbon Tetrachloride | 0.0200 | | | | | 2/1/4 | | | | 0.500 | |
| Chrysene | 9.2000 | | | | | .66/500/2.5 | | | | | |
| Corrosivity by pH | 0.0070 | | | | | | | | | | |
| Di-N-Butylphthalate | 4.3000 | | | | | 5,700/100/10,000 | | | | | |
| Dibenz(A,H)anthracene | 1.3000 | | | | | .66/500/.66 | | | | | |
| Fluoranthene | 25 | | | | | 2,300/500/10,000 | | | | | |
| Fluorene | 2.4000 | | | | | 2,300/100/10,000 | | | | | |
| Indeno(1,2,3-CD)pyrene | 3.2000 | | | | | .66/500/2.5 | | | | | |
| N-Nitrosodiphenylamine | 2.1000 | | | | | 140/100/590 | | | | | |

## Table B-5. Potential ARARs for Soil and Sediment at Maywood, NJ (continued)

| Contaminant Class and Name | Maximum Level in Soil/Sediment | Underground Storage Tank Regulations Proposed Jan. 1990 | DOE Order 5400.5 Chapter IV Residual Radioactive Material | DOE Guidelines for Residual Radioactivity at FUSRAP Sites (1987) | EPA 40CFR192 | NJ DEPE Proposed Cleanup Standards (24 NJR Feb 92) | NJAC 7.26 - 8.20 | EPA TSCA | OSWER Directive 9355.4-02 | EPA Haz Waste 3-29-90 TCLP | RCRA 40CFR268 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pyrene | 15.0000 | | | | | 1,700/500/10,000 | | | | | |
| Tetrachloroethylene | 0.0200 | | | | | 9/1/37 | | | | 0.700 | |
| Toluene | 2.6000 | 2.0 | | | | 1,000/500/1,000 | | | | | |
| Trichloroethylene | 0.0300 | | | | | | | | | 0.500 | |
| | | | | | Inorganic Elements (mg/kg) | | | | | | |
| Antimony, Total | 30.3 | | | | | 14/ - /340 | | | | | |
| Arsenic, Total | 1060.0 | | | | | 20/ - /20 | | | | 5 | |
| Barium, Total | 311.0 | | | | | 600/ - /26,000 | | | | 100 | |
| Beryllium, Total | 5.3 | | | | | 2/ - /2 | | | | | |
| Boron, Total | 114.0 | | | | | | | | | | |
| Cadmium, Total | 2.3 | | | | | 1/ - /100 | | | | 1 | |
| Chromium, Total | 1500.0 | | | | | 100.0 | | | | 5 | |
| Cobalt, Total | 269.0 | | | | | | | | | | |
| Copper, Total | 224.0 | | | | | | | | | | |
| Lead, Total | 1080.0 | | | | | 100/ - /600 | | | 500-1000 | 5 | |
| Manganese, Total | 861.0 | | | | | | | | | | |
| Mercury, total | 0.23 | | | | | 14/ - /260 | | | | 0.2 | |
| Neodemium, Total | 2400.0 | | | | | | | | | | |
| Nickel, Total | 135.0 | | | | | 250/ - /2,400 | | | | | |
| N-Nitrosodiphenylamine | 2.1 | | | | | .66/1/590 | | | | | |
| Phosphate, as P | 58100.0 | | | | | | | | | | |
| Potassium, Total | 1690.0 | | | | | | | | | | |
| Praseodymium | 372.0 | | | | | | | | | | |
| Samarium | 454.0 | | | | | | | | | | |
| Selenium, Total | 37.1 | | | | | 1/ - /1,000 | | | | 1 | |
| Sodium, Total | 28300.0 | | | | | | | | | | |

## Table B-5. Potential ARARs for Soil and Sediment at Maywood, NJ (continued)

| Contaminant Class and Name | Maximum Level in Soil/Sediment | Underground Storage Tank Regulations Proposed Jan. 1990 | DOE Order 5400.5 Chapter IV Residual Radioactive Material | DOE *Guidelines* for Residual Radioactivity at FUSRAP Sites (1987) | EPA 40CFR192 | NJ DEPE Proposed Cleanup Standards (24 NJR Feb 92) | NJAC 7.26 - 8.20 | EPA TSCA | OSWER Directive 9355.4-02 | EPA Haz Waste 3-29-90 TCLP | RCRA 40CFR268 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sulfate | 19200.0 | | | | | | | | | | |
| Tellurium, Total | 1100.0 | | | | | | | | | | |
| Terbium, Total | 67.7 | | | | | | | | | | |
| Thallium | 204.0 | | | | | | | | | | |
| Vanadium, Total | 3.3 | | | | | 2/ - /2 | | | | | |
| Zinc, Total | 68.0 | | | | | 380/ - /7,000<br>1,500/ - /1,500 | | | | | |

* 5 pCi/g above background averaged over first 15 cm of soil below the surface; 15 pCi/g above background when averaged over 15-cm thick soil layers more than 15 cm below the surface. All soil averaged over 100 square meter area.

** Residential surface soil/Subsurface soil/Non-residential surface soil

# APPENDIX C

# INCREMENTAL EXPOSURE DOSE CALCULATION TABLES

# Appendix C

## Incremental Exposure Dose Calculation Tables

Appendix C contains tables of incremental exposure dose calculations including soil ingestion, water ingestion, inhalation, direct radiation, and radon for the Maywood, NJ property units, exposure scenarios, and receptors. The results presented on these tables are discussed in Section 3 and Summarized in Table 3-7. Listed below are the tables included in the Appendix.

| | |
|---|---|
| Table C-1 | Estimated Exposure Dosage - Current Employee |
| Table C-2 | Estimated Exposure Dosage - Current Resident (Child) |
| Table C-3 | Estimated Exposure Dosage - Current Resident (Adult) |
| Table C-4 | Estimated Exposure Dosage - Current Resident (Adult and Child) |
| Table C-5 | Estimated Exposure Dosage - Current Transient |
| Table C-6 | Estimated Exposure Dosage - Future Employee |
| Table C-7 | Estimated Exposure Dosage - Future Resident (Child) |
| Table C-8 | Estimated Exposure Dosage - Future Resident (Adult) |
| Table C-9 | Estimated Exposure Dosage - Future Resident (Adult and Child) |
| Table C-10 | Estimated Exposure Dosage - Future Transient |

# Table C-1. Estimated Exposure Dosage - Current Employee

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | TOTAL w/o Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | | | | | | | | | | | | | | |
| | UNIT 2 | | | | | | | | | | | | | | |
| STEPAN | UNIT 3 | 0.0244 | 0.0588 | NP | NP | 0.2613 | 1.029 | 4 | 4 | 4.2857 | 5.0878 | 17 | 38 | 21.286 | 43.088 |
| | UNIT 3H | 0.1145 | 0.2381 | NP | NP | 1.13 | 3.665 | 10 | 12 | 11.245 | 15.903 | 41.28 | 61.86 | 52.525 | 77.763 |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 0.0164 | 0.0324 | NP | NP | 0.1859 | 0.5842 | 9 | 14 | 9.2023 | 14.617 | 0 | 0 | 9.2023 | 14.617 |
| | UNIT 6 (MISS) | 0.0766 | 0.172 | NP | NP | 0.8747 | 3.158 | 76 | 87 | 76.951 | 90.33 | 37 | 52 | 113.95 | 142.33 |
| | UNIT 6H | | | | | | | 138 | 149 | 138 | 149 | 32.95 | 57.7 | 170.95 | 206.7 |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | |
| | UNIT 7 | 0.1538 | 0.332 | NP | NP | 1.854 | 6.363 | 7 | 10 | 9.0078 | 16.695 | 0 | 13 | 9.0078 | 29.695 |
| | UNIT 7H | 0.3151 | 0.6959 | NP | NP | 3.666 | 12.99 | 108 | 230 | 111.98 | 243.69 | 28.82 | 37.17 | 140.8 | 280.86 |
| | UNIT 8 | | | | | | | | | | | | | | |

Bold cells indicate doses from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

ND = No Data

## Table C-2. Estimated Exposure Dosage - Current Resident (Child)

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 0.0202 | 0.4738 | 0 | 0 | 0.2 | 0.6507 | 27 | 57 | 1.407 | 2.6659 | 28.627 | 60.79 | 22 | 186 | 50.627 | 246.79 |
| | UNIT 2 | 0.5582 | 1.385 | 0 | 0 | 0.5765 | 2.001 | 1 | 3 | 3.535 | 6.777 | 5.6717 | 13.163 | 0 | 0 | 5.6717 | 13.163 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | | | |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate doses from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

# Table C-3. Estimated Exposure Dosage - Current Resident (Adult)

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 0.121 | 0.2369 | 0 | 0 | 0.1823 | 0.5769 | 27 | 57 | 2.2501 | 2.3809 | 29.553 | 60.195 | 22 | 186 | 51.553 | 246.19 |
| | UNIT 2 | 0.3349 | 0.6926 | 0 | 0 | 0.5273 | 1.744 | 1 | 3 | 5.655 | 6.031 | 7.5172 | 11.468 | 0 | 0 | 7.5172 | 11.468 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | | | |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate doses from actual measured values

X = *Mean*

RME = Reasonable Maximum Exposure

NP = No Pathway

## Table C-4. Estimated Exposure Dosage - Current Resident (Adult and Child)

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 0.0538 | 0.2843 | 0 | 0 | 0.1941 | 0.5917 | 27 | 57 | 1.6878 | 2.4379 | 28.936 | 60.314 | 18.69 | 21.41 | 50.936 | 246.31 |
| | UNIT 2 | 0.4838 | 0.8311 | 0 | 0 | 0.5615 | 1.7954 | 1 | 3 | 4.241 | 6.1802 | 6.2863 | 11.807 | 39.73 | 44.75 | 6.2863 | 11.807 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | | | |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate doses from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

# Table C-5. Estimated Exposure Dosage - Current Transient

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | TOTAL w/o Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | | | | | | | | | | | | | | |
| | UNIT 2 | | | | | | | | | | | | | | |
| STEPAN | UNIT 3 | 3.2E-05 | 0.00089 | NP | NP | 0.0065 | 0.0267 | 0 | 1 | 0.007 | 1.028 | 0.03 | 4 | 0.037 | 5.028 |
| | UNIT 3H | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | 1.2E-05 | 0.00034 | NP | NP | 0.0025 | 0.0104 | 0.3 | 5 | 0.303 | 5.011 | 0 | 0 | 0.303 | 5.011 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | 9.9E-05 | 0.0026 | NP | NP | 0.0215 | 0.0816 | 2 | 23 | 2.022 | 23.08 | 1 | 1 | 3.022 | 24.08 |
| | UNIT 6H | 0 | 0 | NP | NP | 0 | 0 | 15 | 180 | 15 | 180 | 1 | 9 | 16 | 189 |
| | UNIT 6B (BALLOD) | 0 | 0 | NP | NP | 0 | 0 | 2.332 | 6.178 | 2.332 | 6.178 | 0.02 | 3.4 | 2.352 | 9.578 |
| | UNIT 7 | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | |
| | UNIT 8 | 0.00015 | 0.00108 | NP | NP | 0.0331 | 0.1422 | 3.131 | 3.0962 | 3.164 | 3.239 | 0.08 | 14.6 | 3.244 | 17.84 |

Bold cells indicate doses from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

# Table C-6. Estimated Exposure Dosage - Future Employee

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | TOTAL w/o Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | | | | | | | | | | | | | | |
| | UNIT 2 | | | | | | | | | | | | | | |
| STEPAN | UNIT 3 | 0.0244 | 0.0588 | 0 | 0 | 0.2613 | 1.029 | 4 | 4 | 4.2857 | 5.0878 | 17 | 38 | 21.286 | 43.088 |
| | UNIT 3H | 0.2015 | 0.5052 | 1.0049 | 2.0007 | 2.137 | 8.587 | 10 | 12 | 13.343 | 23.093 | 41.28 | 61.86 | 54.623 | 84.953 |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | 0.122 | 0.2492 | 1.5005 | 2.6926 | 1.364 | 4.49 | 76 | 87 | 78.986 | 94.432 | 37 | 52 | 115.99 | 146.43 |
| | UNIT 6H | 2.155 | 5.616 | 12.66 | 27.12 | 22.36 | 90.97 | 138 | 149 | 175.18 | 272.71 | 34.9 | 58.26 | 210.08 | 330.97 |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | |
| | UNIT 8 | 0.2042 | 0.799 | 1.0419 | 2.5151 | 2.462 | 15.6 | 177.9 | 433.9 | 181.61 | 452.81 | 11.49 | 21.92 | 193.1 | 474.73 |

*Bold cells indicate doses from actual measured values*

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

ND = No Data

# Table C-7. Estimated Exposure Dosage - Future Resident (Child)

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 0.2017 | 0.4738 | 0 | 0 | 0.2 | 0.6507 | 27 | 57 | 1.4066 | 2.6659 | 28.808 | 60.79 | 22 | 186 | 50.808 | 246.79 |
| | UNIT 2 | 0.5582 | 1.385 | 0 | 0 | 0.5785 | 2.001 | 1 | 3 | 3.5353 | 6.777 | 5.672 | 13.163 | 0 | 0 | 5.672 | 13.163 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | 0.118 | 0.3344 | 0.0064 | 0.1317 | 0.111 | 0.4389 | 31 | 51 | 0.8533 | 1.8918 | 32.089 | 53.797 | 0 | 0 | 32.089 | 53.797 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 0.1648 | 0.3909 | 0 | 0 | 0.1452 | 0.4731 | 28 | 40 | 1.0513 | 2.0347 | 29.361 | 42.899 | 0 | 0 | 29.361 | 42.899 |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | 4.76 | 25.35 | 1.826 | 7.243 | 4.024 | 29.57 | 934.7 | 2482 | 104.08 | 284.63 | 1049.4 | 2828.8 | 14.4 | 30.79 | 1063.8 | 2859.6 |
| | UNIT 7 | 1.523 | 4.929 | 2.381 | 4.5409 | 1.246 | 5.797 | 12 | 13 | 23.15 | 55.419 | 40.3 | 83.686 | 0 | 43 | 40.3 | 126.69 |
| | UNIT 7H | 3.167 | 8.383 | 0 | 0 | 2.863 | 10.51 | 351 | 748 | 20.57 | 55.786 | 377.6 | 822.68 | 181.2 | 226.97 | 558.8 | 1049.6 |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate doses from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

## Table C-8. Estimated Exposure Dosage - Future Resident (Adult)

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 0.121 | 0.2369 | 0 | 0 | 0.1823 | 0.5769 | 27 | 57 | 2.2501 | 2.3809 | 29.553 | 60.195 | 22 | 186 | 51.553 | 246.19 |
| | UNIT 2 | 0.3349 | 0.6926 | 0 | 0 | 0.5273 | 1.744 | 1 | 3 | 5.655 | 6.031 | 7.5172 | 11.468 | 0 | 0 | 7.5172 | 11.468 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | 0.0706 | 0.1692 | 0.1637 | 0.3292 | 0.1012 | 0.3891 | 31 | 51 | 1.355 | 1.6219 | 32.69 | 53.509 | 0 | 0 | 32.69 | 53.509 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 0.0989 | 0.1955 | 0 | 0 | 0.1323 | 0.4194 | 28 | 40 | 1.6823 | 1.8207 | 29.913 | 42.436 | 0 | 0 | 29.913 | 42.436 |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | 2.855 | 12.68 | 4.46 | 18.81 | 3.657 | 26.22 | 935.8 | 2482 | 104.89 | 244.07 | 1051.7 | 2783.8 | 0 | 0 | 1051.7 | 2783.8 |
| | UNIT 7 | 0.8504 | 2.465 | 3.5005 | 11.35 | 1.027 | 5.14 | 12 | 13 | 38.167 | 47.647 | 55.545 | 79.602 | 0 | 43 | 55.545 | 122.6 |
| | UNIT 7H | 1.9 | 4.192 | 0 | 0 | 2.61 | 9.322 | 351 | 748 | 23.38 | 49.216 | 378.89 | 810.73 | 0 | 0 | 378.89 | 810.73 |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate doses from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

# Table C-9. Estimated Exposure Dosage - Future Resident (Adult and Child)

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 0.1748 | 0.2843 | 0 | 0 | 0.1941 | 0.5917 | 27 | 57 | 1.6875 | 2.4379 | 29.056 | 60.314 | 18.69 | 21.41 | 51.056 | 246.31 |
| | UNIT 2 | 0.4838 | 0.8311 | 0 | 0 | 0.5615 | 1.7954 | 1 | 3 | 4.2412 | 6.1802 | 6.2865 | 11.807 | 39.73 | 44.75 | 6.2865 | 11.807 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | 0.1022 | 0.2022 | 0.0588 | 0.2897 | 0.1077 | 0.3991 | 31 | 51 | 1.0204 | 1.6759 | 32.289 | 53.567 | 6.4 | 8.67 | 32.289 | 53.567 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 0.1428 | 0.2346 | 0 | 0 | 0.1409 | 0.4301 | 28 | 40 | 1.2614 | 1.8635 | 29.545 | 42.528 | 11.56 | 13.5 | 29.545 | 42.528 |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | 4.1256 | 15.214 | 2.7031 | 16.497 | 3.9018 | 26.89 | 935.07 | 2482 | 104.35 | 252.19 | 1050.1 | 2792.8 | 14.4 | 30.79 | 1059.8 | 2798.9 |
| | UNIT 7 | 1.299 | 2.9578 | 2.7538 | 9.988 | 1.1731 | 5.2714 | 12 | 13 | 28.151 | 49.202 | 45.377 | 80.419 | 157.61 | 258.76 | 45.377 | 123.42 |
| | UNIT 7H | 2.7451 | 5.0302 | 0 | 0 | 2.7788 | 9.5596 | 351 | 748 | 21.506 | 50.53 | 378.03 | 813.12 | 181.2 | 226.97 | 498.89 | 858.51 |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate doses from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

# Table C-10. Estimated Exposure Dosage - Future Transient

mrem/yr

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | TOTAL w/o Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | | | | | | | | | | | | | | |
| | UNIT 2 | | | | | | | | | | | | | | |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | 0.0002 | 0.0037 | 0 | 0 | 0.0336 | 0.1126 | 2 | 23 | 2.034 | 23.116 | 0.008 | 0.0097 | 2.042 | 23.125 |
| | UNIT 6H | 0.0028 | 0.0207 | NP | NP | 0.5506 | 2.35 | 15 | 180 | 15.55 | 182.37 | 1 | 9 | 16.55 | 191.37 |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | |
| | UNIT 8 | | | | | | | | | | | | | | |

Bold cells indicate doses from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

ND = No Data

# APPENDIX D

# GENERAL ANALYTICAL ASSUMPTIONS

# Appendix D

## General Analytical Assumptions

Appendix D contains tales of values assumed in the computation of doses and risks for the various scenarios. Listed below are the tables included in this appendix.


| | |
|---|---|
| Table D-1 | Values Assumed for Scenario Parameters |
| Table D-2 | Values Assumed for RESRAD Analysis |
| Table D-3 | Site-Specific Geotechnical Assumptions |
| Table D-4 | RME Parameter Assumptions |
| Table D-5 | Dose Conversion Factors |
| Table D-6 | Cancer Risk Slope Factor Summary |
| Table D-7 | Actual Measured Data for the Maywood Site |
| Table D-8 | Radiological Dose From Actual Measured Values |

## Table D-1. Values Assumed for Scenario Parameters

| Parameter | Unit | | Resident Adult | Resident Child | Employee | Recreational | Transient |
|---|---|---|---|---|---|---|---|
| Exposure time indoors (ET) | h/d | AVE: | 16.4[a] | 16.4 | 7 | 0 | 0 |
| | | RME: | 16.4 | 16.4 | 7 | 0 | 0 |
| Time spent outdoors | h/d | AVE: | 0.44[a] | .44 | 1.75 | 1.4[b] | 0.14[b] |
| | | RME: | 0.44 | .44 | 1.75 | 1.4 | 1.4[c] |
| Exposure frequency (EF)[d] | d/yr | AVE: | 350 | 350 | 250 | 350 | 350 |
| | | RME: | 350 | 350 | 250 | 350 | 350 |
| Exposure duration (ED)[d,g] | yr | AVE: | 3 | 6 | 7 | 9 | 9 |
| | | RME: | 24 | 6 | 25 | 30 | 30 |
| Body weight (BW)[d] | kg | | 70 | 15 | 70 | 70 | 70 |
| | | | | | N/A | 15 | 15 |
| Inhalation rate (IR) | $m^3/h$ | AVE: | 0.62[d,h] | 0.68 | 1.875 | 1.0 | 1.0 |
| | | RME: | 0.83[d,i] | 0.94 | 2.5 | 1.4[a] | 1.4[a] |
| Dust concentration in air[j] | $\mu g/m^3$ | AVE: | 100 | | 100 | 100 | 100 |
| | | RME: | 200 | | 200 | 200 | 200 |
| Amount of dust from contaminated soil[j] | % | | 50 | | 50 | 50 | 50 |
| Amount of dust that is respirable[j] | % | | 30 | | 30 | 30 | 30 |
| Amount of outdoor dust assumed[k] to be present indoors | % | | 40 | | 40 | N/A | N/A |

## Table D-1. Values Assumed for Scenario Parameters (continued)

| Parameter | Unit | | Resident | | Employee | Recreational | Transient |
|---|---|---|---|---|---|---|---|
| Soil ingestion rate[a,d,g] | mg/d | AVE: | 60 | 100 | 30 | 100 | 100 |
| | | RME: | 100 | 100 | 50 | 480 | 200 |
| Water ingestion rate (IRw)[a,d] | L/d | AVE: | 1.4 | 0.54 | 0.7 | N/A | N/A |
| | | RME: | 2.0 | 0.7 | 1.0 | N/A | N/A |
| Incidental ingeston of surface water while swimming[g] | l/h | | 0.05 | 0.05 | N/A | N/A | N/A |
| Consumption rate of homegrown produce[d] | g/d | AVE: | 80 | 50 | N/A | N/A | N/A |
| | | RME: | 80 | 80 | | | |
| External gamma shielding factor | | | 0.8 | 0.2 | 0.8 | N/A | N/A |

N/A not applicable

a Exposure Factors Handbook, (EPA 1989a)

b 1 h/wk

c 10 h/wk

d OSWER 9285.6-0.3 (EPA 1991b)

e Based on residential construction

f Based on commercial construction

g RAGS (EPA 1989b)

h 15 $m^3$/d

i 20 $m^3$/d

j (Gilbert 1983), (Paustenbach 1989).

k Based on value given in Alzona et al. (1979).

## Table D-2. Values Assumed for RESRAD Analysis

| Parameter | Unit | | Resident Adult | Resident Child | Employee | Transient |
|---|---|---|---|---|---|---|
| Exposure time indoors (ET) | h/d | AVE: | 15.6[e] | | 4.8[a] | 0 |
| | | RME: | 15.6[e] | | 4.8[a] | 0 |
| Time spent outdoors | h/d | AVE: | 0.48[e] | | 1.2[e] | 0.14[b] |
| | | RME: | 0.48[e] | | 1.2[e] | 1.4 |
| Exposure frequency (EF)[h] | d/yr | | 350 | | 250 | 350 |
| Exposure duration (ED)[h,i] | yr | AVE: | 3 | 6 | 7 | 9 |
| | | RME: | 24 | 6 | 25 | 30 |
| Body weight (BW) | kg | | 70 | 15 | 70 | 70 |
| Inhalation rate (IR)[h] | $m^3$/yr | AVE: | 5430[c] | | 16425 | 2760 |
| | | RME: | 7300[d] | | 21900 | 8760 |
| Dust concentration in air[f] | $\mu g/m^3$ | AVE: | 100 | | 100 | 100 |
| | | RME: | 200 | | 200 | 200 |
| Amount of dust from contaminated soil[f] | % | | 50 | | 50 | 50 |
| Amount of dust that is respirable[f] | % | | 30 | | 30 | 30 |
| Amount of outdoor dust assumed to be present indoors[g] | % | | 40 | | 40 | 40 |
| Soil ingestion rate, adult[e,i] | g/yr | AVE: | 21 | 35 | 7.5 | .21[h] |
| | | RME: | 35 | 70 | 12.5 | 4.1[h] |
| Water ingestion rate (IRw)[e,i] | L/yr | AVE: | 490 | 190 | 175 | N/A |
| | | RME: | 700 | 280 | 250 | N/A |
| External gamma shielding factor[j] | | | 0.8 | | 0.8 | N/A |

N/A not applicable

a 7 h/d for 250 d/y, divided by 8760 h/y (24 hr/day)

b 1 h/wk (52 wk/y) divided by 8760 h/y (24 hr/day)

c 15 $m^3$/d

d 20 $m^3$/d

e Exposure Factors Handbook, (EPA 1990)

f (Gilbert 1983), (Paustenbach 1989)

g Based on value given in Alzona et al. (1979)

h OSWER 9285.6-0.3 (EPA 1991b)

i RAGS (EPA 1989b)

**Table D-3. Site-Specific Geotechnical Assumptions**

| | |
|---|---|
| Contaminated Zone Total Porosity: | .45 |
| Contaminated Zone Hydrologic Conductivity: | 123 m/yr sat<br>or<br>1.23 m/yr unsat |
| Dilution Attentuation Factor | 100/500 ft |
| Evapotranspiration Coeff: | 0.46 |
| Precipitation: | 1.07 m/yr |
| Runoff Coeff: | .25 |
| Saturated Zone Total Porosity: | 0.45 |
| Saturated Zone Hydraulic Conductivity: | 123 m/yr |
| Saturated Zone Hydraulic Gradient: | 0.01 |
| Unsaturated Zone Thickness: | 1 to 4.6 m |
| Unsaturated Zone Total Porosity: | 0.45 |
| Unsaturated Zone Effective Porosity: | 0.26 |
| Unsaturated Zone Hydraulic Conductivity: | 1.23 m/yr |

**Table D-4**
**RME Parameter Assumptions**

| | |
|---|---|
| Resident: | |
| | RME: Use all average values except (use 95% UCL)<br>soil concentration<br>time fractions (indoor and outdoor)<br>dust loading<br>soil ingestion rate<br>drinking water intake |
| Employee: | |
| | RME: replaced<br>soil concentration<br>dust loading<br>soil ingestion rate<br>drinking water intake |
| Transient: | |
| | RME: replace<br>soil concentration<br>dust loading<br>soil ingestion rate |

## Table D-5. Dose Conversion Factors

| Parent Radionuclide | Inhalation mrem/pCi | Ingestion mrem/pCi | Direct (mrem/yr / pCi/cm$^3$) |
|---|---|---|---|
| Thorium-232 | 1.6 | 2.8 E-3 | 6.04 E-3 |
| Radium-228+D | 4.5 E-3 | 1.2 E-3 | 4.51 |
| Thorium-228+D | 3.1 E-1 | 7.5 E-4 | 7.36 |
| Uranium-238+D | 1.2 E-1 | 2.5 E-4 | 6.97 E-2 |
| Uranium-234 | 1.3 E-1 | 2.6 E-4 | 6.97 E-4 |
| Thorium-230 | 2.6 E-1 | 5.3 E-4 | 1.03 E-3 |
| Radium-226+D | 7.9 E-3 | 1.1 E-3 | 8.56 |
| Lead-210+D | 2.1 E-2 | 6.7 E-3 | 2.31 E-3 |
| Uranium-235+D | 1.2 E-1 | 2.5 E-4 | 4.9 E-1 |
| Protactinium-231 | 1.3 | 1.1 E-2 | 1.21 E-1 |
| Actinium-227+D | 6.7 | 1.5 E-2 | 1.52 |

## Table D-6. Cancer Risk Slope Factor Summary

| Parent Radionuclide | Inhalation 1/pCi | Ingestion mrem/pCi | Direct (mrem/yr / pCi/cm$^3$) |
|---|---|---|---|
| Thorium-232 | 2.8 E-8 | 1.2 E-11 | 2.6 E-11 |
| Radium-228+D | 6.9 E-10 | 1.0 E-10 | 2.9 E-6 |
| Thorium-228+D | 7.8 E-8 | 5.5 E-11 | 5.6 E-6 |
| Uranium-238+D | 5.2 E-8 | 2.8 E-11 | 3.6 E-8 |
| Uranium-234 | 2.6 E-8 | 1.6 E-11 | 3.0 E-11 |
| Thorium-230 | 2.9 E-8 | 1.3 E-11 | 5.4 E-11 |
| Radium-226+D | 3.0 E-9 | 1.2 E-10 | 6.0 E-6 |
| Lead-210+D | 4.0 E-9 | 6.6 E-10 | 1.6 E-10 |
| Uranium-235+D | 2.5 E-8 | 1.6 E-11 | 2.4 E-7 |
| Protactinium-231 | 3.6 E-8 | 9.2 E-11 | 2.6 E-8 |
| Actinium-227+D | 8.8 E-8 | 3.5 E-10 | 8.5 E-7 |

Source: RESRAD Computer Code V4.6 (Gilbert et al. 1987)

## TABLE D-7. ACTUAL MEASURED DATA FOR THE MAYWOOD SITE*

| LOCATION | PROPERTY UNIT | INDOOR RADON (pCi/l) | | | | OUTDOOR RADON (pCi/l) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | n | mean | UCL 95 | max | n | mean | UCL 95 | max |
| RESIDENTIAL | UNIT 1 | 25 | 0.1 | 1.2 | 12 | | | | |
| | UNIT 2 | 8 | 0 | 0 | 0 | | | | |
| STEPAN | UNIT 3 | 7 | 0.4 | 0.8 | 1 | | | | |
| | UNIT 3H | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | 2 | 0 | 0 | 0 | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 7 | 0 | 0 | 0 | | | | |
| | UNIT 6 (MISS) | | | | | 11 | 1 | 1 | 3 |
| | UNIT 6H | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 1 |
| | UNIT 6B (BALLOD) | | | | | | | | |
| | UNIT 7 | 5 | 0 | 0.3 | 1 | | | | |
| | UNIT 7H | | | | | | | | |
| | UNIT 8 | | | | | | | | |

| LOCATION | PROPERTY UNIT | INDOOR GAMMA (uR/hour) | | | | OUTDOOR GAMMA (uR/hour) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | n | mean | UCL 95 | max | n | mean | UCL 95 | max |
| RESIDENTIAL | UNIT 1 | 19 | 5 | 10 | 56 | 232 | 5 | 5 | 43 |
| | UNIT 2 | 6 | 0 | 0.3 | 1 | 62 | 6 | 7 | 41 |
| STEPAN | UNIT 3 | 81 | 2 | 2 | 11 | 157 | 1 | 2 | 31 |
| | UNIT 3H | 189 | 2 | 3 | 27 | 341 | 14 | 16 | 142 |
| MUNICIPAL PARKS | UNIT4 | | 5 | 9 | 59 | 30 | 7 | 11 | 74 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 2 | 5 | 7 | 7 | 66 | 2 | 4 | 68 |
| | UNIT 6 (MISS) | | 33 | 36 | 362 | 242 | 41 | 47 | 452 |
| | UNIT 6H | 1 | 79 | 85 | 79 | 85 | 310 | 368 | 1392 |
| | UNIT 6B (BALLOD) | | | | | | | | |
| | UNIT 7 | 2 | 2 | 2 | 2 | 15 | 8 | 16 | 68 |
| | UNIT 7H | 4 | 61 | 130 | 140 | 2 | 4 | 5 | 5 |
| | UNIT 8 | | | | | | | | |

MAX VALUES USED FOR UCL95- when n<3 or UCL95>max

[shaded] =.8*OUTDOOR WHEN NO INDOOR GAMMA AVAILABLE

*BACKGROUND SUBTRACTED

ZERO EXPOSURE VALUES ARE BELOW BACKGROUND

## TABLE D-8. RADIOLOGICAL DOSE FROM ACTUAL MEASURED VALUES*

| RADON (mrem/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|
| LOCATION | PROPERTY UNIT | Employee | | Resident | | Transient | |
| | | Mean | RME | Mean | RME | Mean | RME |
| RESIDENTIAL | UNIT 1 | | | 22 | 186 | | |
| | UNIT 2 | | | 0 | 0 | | |
| STEPAN | UNIT 3 | 17 | 38 | | | 0 | 11 |
| | UNIT 3H | ND | ND | | | | |
| MUNICIPAL PARKS | UNIT4 | | | 0 | 0 | 0 | 0 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 0 | 0 | 0 | 0 | | |
| | UNIT 6 (MISS) | 37 | 52 | | | 1 | 1 |
| | UNIT 6H | 0 | 0 | | | 1 | 9 |
| | UNIT 6B (BALLOD) | | | ND | ND | ND | ND |
| | UNIT 7 | 0 | 13 | 0 | 43 | | |
| | UNIT 7H | ND | ND | ND | ND | | |
| | UNIT 8 | ND | ND | | | ND | ND |

| DIRECT GAMMA (mrem/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|
| LOCATION | PROPERTY UNIT | Employee | | Resident | | Transient | |
| | | Mean | RME | Mean | RME | Mean | RME |
| RESIDENTIAL | UNIT 1 | | | 27 | 57 | | |
| | UNIT 2 | | | 1 | 3 | | |
| STEPAN | UNIT 3 | 4 | 4 | | | 0 | 1 |
| | UNIT 3H | 10 | 12 | | | | |
| MUNICIPAL PARKS | UNIT4 | | | 31 | 51 | 0.3 | 5 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 9 | 14 | 28 | 40 | | |
| | UNIT 6 (MISS) | 76 | 87 | | | 2 | 23 |
| | UNIT 6H | | | | | 15 | 180 |
| | UNIT 6B (BALLOD) | | | ND | ND | ND | ND |
| | UNIT 7 | 7 | 10 | 12 | 13 | | |
| | UNIT 7H | 108 | 230 | 351 | 748 | | |
| | UNIT 8 | ND | ND | | | ND | ND |

RME=REASONABLE MAXIMUM EXPOSURE
ND=NO MEASURED DATA AVAILABLE FOR SCENARIO
*BACKGROUND SUBTRACTED
ZERO EXPOSURE VALUES ARE BELOW BACKGROUND

# APPENDIX E

# CHEMICAL CONTAMINANTS EXPOSURE AND RISK ESTIMATES

Appendix E contains tables of intake and risk estimates for chemical contaminants of concern. Results are tabulated as total cancer risk or total hazard index for carcinogens and noncarcinogens respectively for the MISS and Stepan and in the case of groundwater immediate adjoining properties.

| | |
|---|---|
| Table E-1 | Risk From Soil Ingestion at MISS Using RME Values - Receptor: Current and Future Employee |
| Table E-2 | Risk From Soil Ingestion at MISS Using Mean Values - Receptor: Current and Future Employee |
| Table E-3 | Risk From Soil Ingestion at MISS Using RME Values - Receptor: - Current and Future Transient |
| Table E-4 | Risk From Soil Ingestion at MISS Using Mean Values - Receptor: - Current and Future Transient |
| Table E-5 | Risk From Inhalation of Soil Particulates at MISS Using RME Values - Receptor: Current and Future Employee |
| Table E-6 | Risk From Inhalation of Soil Particulates at MISS Using Mean Values - Receptor: Current and Future Employee |
| Table E-7 | Risk From Inhalation of Soil Particulates at MISS Using RME Values - Receptor: Current and Future Transient |
| Table E-8 | Risk From Inhalation of Soil Particulates at MISS Using Mean Values - Receptor: Current and Future Transient |
| Table E-9 | Risk From Soil Ingestion at Stepan Using RME Values - Receptor: Current and Future Employee |
| Table E-10 | Risk From Soil Ingestion at Stepan Using Mean Values - Receptor: Current and Future Employee |
| Table E-11 | Risk From Soil Ingestion at Stepan Using RME Values - Receptor: Current and Future Transient |
| Table E-12 | Risk From Soil Ingestion at Stepan Using Mean Values - Receptor: Current and Future Transient |
| Table E-13 | Risk From Inhalation of Soil Particulates at Stepan Using RME Values - Receptor: Current and Future Employee |
| Table E-14 | Risk From Inhalation of Soil Particulates at Stepan Using Mean Values - Receptor: Current and Future Employee |
| Table E-15 | Risk From Inhalation of Soil Particulates at Stepan Using RME Values - Receptor: Current and Future Transient |
| Table E-16 | Risk From Inhalation of Soil Particulates at Stepan Using Mean Values - Receptor: Current and Future Transient |
| Table E-17 | Risk From Alluvium Groundwater Ingestion at MISS Using RME Values - Receptor: Future Employee |
| Table E-17A | Risk From Alluvium Groundwater Ingestion at MISS Using RME Values - Receptor: Future Resident (Adult) |
| Table E-17B | Risk From Alluvium Groundwater Ingestion at MISS Using RME Values - Receptor: Future Resident (Child) |
| Table E-17C | Risk From Alluvium Groundwater Ingestion at MISS Using RME Values - Receptor: Future Resident (Adult) (D = 1000') |
| Table E-17D | Risk From Alluvium Groundwater Ingestion at MISS Using RME Values - Receptor: Future Resident (Child) (D = 1000') |
| Table E-18 | Risk From Alluvium Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Employee |
| Table E-18A | Risk From Alluvium Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Resident (Adult) |
| Table E-18B | Risk From Alluvium Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Resident (Child) |

| | |
|---|---|
| Table E-18C | Risk From Alluvium Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Resident (Adult) (D = 1000') |
| Table E-18D | Risk From Alluvium Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Resident (Child) (D = 1000') |
| Table E-19 | Risk From Bedrock Groundwater Ingestion at MISS Using RME Values - Receptor: Future Employee |
| Table E-19A | Risk From Bedrock Groundwater Ingestion at MISS Using RME Values - Receptor: Future Resident (Adult) |
| Table E-19B | Risk From Bedrock Groundwater Ingestion at MISS Using RME Values - Receptor: Future Resident (Child) |
| Table E-19C | Risk From Bedrock Groundwater Ingestion at MISS Using RME Values - Receptor: Future Resident (Adult) (D = 1000') |
| Table E-19D | Risk From Bedrock Groundwater Ingestion at MISS Using RME Values - Receptor: Future Resident (Child) (D = 1000') |
| Table E-20 | Risk From Bedrock Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Employee |
| Table E-20A | Risk From Bedrock Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Resident (Adult) |
| Table E-20B | Risk From Bedrock Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Resident (Child) |
| Table E-20C | Risk From Bedrock Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Resident (Adult) (D = 1000') |
| Table E-20D | Risk From Bedrock Groundwater Ingestion at MISS Using Mean Values - Receptor: Future Resident (Child) (D = 1000') |
| Table E-21 | Risk From Surface Water Ingestion Using RME Values - Receptor: Child Wading in Westerly Brook |
| Table E-22 | Risk From Surface Water Ingestion Using Mean Values - Receptor: Child Wading in Westerly Brook |
| Table E-23 | Risk From Sediment Ingestion Using RME values - Receptor: Child Wading in Lodi Brook |
| Table E-24 | Risk From Sediment Ingestion Using Mean Values - Receptor: Child Wading in Lodi Brook |

TABLE E-1
RISK FROM SOIL INGESTION AT MISS
RECEPTOR: CURRENT AND FUTURE EMPLOYEE
USING RME VALUES

CONTAMINANT OF CONCERN

| CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| BENZO(A)ANTHRACENE | 7.85E-01 | 7.30E+00 | 1.37E-07 | 1.00E-06 |
| BENZO(A)PYRENE | 7.38E-01 | 7.30E+00 | 1.29E-07 | 9.42E-07 |
| BENZO(B)FLOURANTHENE | 8.34E-01 | 7.30E+00 | 1.46E-07 | 1.06E-06 |
| BENZO(K)FLOURANTHENE | 7.66E-01 | 7.30E+00 | 1.34E-07 | 9.77E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 7.59E-01 | 1.40E-02 | 1.33E-07 | 1.86E-09 |
| CHROMIUM | 1.10E+03 | ND | 1.92E-04 | ND |
| CHRYSENE | 8.62E-01 | 7.30E+00 | 1.51E-07 | 1.10E-06 |
| DIBENZO(A,H)ANTHRACENE | 4.71E-01 | 7.30E+00 | 8.23E-08 | 6.01E-07 |
| INDENO(1,2,3-CD)PYRENE | 5.25E-01 | 7.30E+00 | 9.17E-08 | 6.69E-07 |
| LITHIUM | 2.03E+03 | ND | 3.55E-04 | ND |
| | | | TOTAL CANCER RISK = | 6.35E-06 |

| NON-CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 4.72E-01 | 3.00E-01 | 2.31E-07 | 7.70E-07 |
| BENZO(G,H,I)PERYLENE | 4.20E-01 | ND | 1.49E-08 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 7.59E-01 | 2.00E-02 | 3.72E-07 | 1.86E-05 |
| BUTYLBENZYLPHTHALATE | 1.00E-01 | 2.00E-01 | 4.89E-08 | 2.45E-07 |
| CHROMIUM | 1.10E+03 | 5.00E-03 | 5.38E-04 | 1.08E-01 |
| COPPER | 1.26E+02 | 4.00E-02 | 6.18E-05 | 1.55E-03 |
| DI-N-BUTYLPHTHALATE | 4.30E+00 | 1.00E-01 | 2.10E-06 | 2.10E-05 |
| FLUORANTHENE | 2.06E+00 | 4.00E-02 | 1.01E-06 | 2.52E-05 |
| LITHIUM | 2.03E+03 | 2.00E-02 | 9.93E-04 | 4.97E-02 |
| PYRENE | 1.61E+00 | 3.00E-02 | 7.85E-07 | 2.62E-05 |
| TOLUENE | 4.53E-03 | 2.00E-01 | 2.22E-09 | 1.11E-08 |
| URANIUM | 6.08E+01 | 3.00E-03 | 2.97E-05 | 9.92E-03 |
| | | | HAZARD INDEX = | 1.69E-01 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AF \times AD}$$

CS = UL95 chemical concentration in surface soil (mg/kg)
IR = Ingestion rate (50 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (25 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-2
RISK FROM SOIL INGESTION AT MISS
RECEPTOR: CURRENT AND FUTURE EMPLOYEE
USING MEAN VALUES

CONTAMINANT OF CONCERN

| CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| BENZO(A)ANTHRACENE | 3.76E-01 | 7.30E+00 | 1.10E-08 | 8.06E-08 |
| BENZO(A)PYRENE | 3.54E-01 | 7.30E+00 | 1.04E-08 | 7.59E-08 |
| BENZO(B)FLOURANTHENE | 4.01E-01 | 7.30E+00 | 1.18E-08 | 8.59E-08 |
| BENZO(K)FLOURANTHENE | 3.57E-01 | 7.30E+00 | 1.05E-08 | 7.65E-08 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.12E-01 | 1.40E-02 | 9.16E-09 | 1.28E-10 |
| CHROMIUM | 1.70E+02 | ND | 4.99E-06 | ND |
| CHRYSENE | 4.30E-01 | 7.30E+00 | 1.26E-08 | 9.21E-08 |
| DIBENZO(A,H)ANTHRACENE | 2.31E-01 | 7.30E+00 | 6.78E-09 | 4.95E-08 |
| INDENO(1,2,3-CD)PYRENE | 3.36E-01 | 7.30E+00 | 9.86E-09 | 7.20E-08 |
| LITHIUM | 3.55E+02 | ND | 1.04E-05 | ND |
| | | | | 5.33E-07 |

| NON-CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 2.57E-01 | 3.00E-01 | 7.54E-08 | 2.51E-07 |
| BENZO(G,H,I)PERYLENE | 3.18E-01 | ND | 5.92E-09 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.12E-01 | 2.00E-02 | 9.16E-08 | 4.58E-06 |
| BUTYLBENZYLPHTHALATE | 1.50E-01 | 2.00E-01 | 4.40E-08 | 2.20E-07 |
| CHROMIUM | 1.70E+02 | 5.00E-03 | 4.99E-05 | 9.98E-03 |
| COPPER | 6.16E+01 | 4.00E-02 | 1.81E-05 | 4.52E-04 |
| DI-N-BUTYLPHTHALATE | 1.80E-01 | 1.00E-01 | 5.28E-08 | 5.28E-07 |
| FLUORANTHENE | 8.30E-01 | 4.00E-02 | 2.44E-07 | 6.09E-06 |
| LITHIUM | 3.55E+02 | 2.00E-02 | 1.04E-04 | 5.21E-03 |
| PYRENE | 6.71E-01 | 3.00E-02 | 1.97E-07 | 6.57E-06 |
| TOLUENE | 3.82E-03 | 2.00E-01 | 1.12E-09 | 5.61E-09 |
| URANIUM | 5.26E+01 | 3.00E-03 | 1.54E-05 | 5.15E-03 |
| | | | HAZARD INDEX = | 2.08E-02 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AF \times AD}$$

CS = Mean chemical concentration in surface soil (mg/kg)
IR = Ingestion rate (30 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (7 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-3
RISK FROM SOIL INGESTION AT MISS
RECEPTOR: CURRENT AND FUTURE TRANSIENT
USING RME VALUES

CONTAMINANT OF CONCERN

| CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| BENZO(A)ANTHRACENE | 7.85E-01 | 7.30E+00 | 5.37E-08 | 3.92E-07 |
| BENZO(A)PYRENE | 7.38E-01 | 7.30E+00 | 5.05E-08 | 3.69E-07 |
| BENZO(B)FLOURANTHENE | 8.34E-01 | 7.30E+00 | 5.71E-08 | 4.17E-07 |
| BENZO(K)FLOURANTHENE | 7.66E-01 | 7.30E+00 | 5.24E-08 | 3.83E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 7.59E-01 | 1.40E-02 | 5.20E-08 | 7.28E-10 |
| CHROMIUM | 1.10E+03 | ND | 7.53E-05 | ND |
| CHRYSENE | 8.62E-01 | 7.30E+00 | 5.90E-08 | 4.30E-07 |
| DIBENZO(A,H)ANTHRACENE | 4.71E-01 | 7.30E+00 | 3.22E-08 | 2.35E-07 |
| INDENO(1,2,3-CD)PYRENE | 5.25E-01 | 7.30E+00 | 3.59E-08 | 2.62E-07 |
| LITHIUM | 2.03E+03 | ND | 1.39E-04 | ND |
| | | | TOTAL CANCER RISK = | 2.49E-06 |

| NON-CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 4.72E-01 | 3.00E-01 | 7.54E-08 | 2.51E-07 |
| BENZO(G,H,I)PERYLENE | 4.20E-01 | ND | 1.61E-07 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 7.59E-01 | 2.00E-02 | 1.21E-07 | 6.06E-06 |
| BUTYLBENZYLPHTHALATE | 1.00E-01 | 2.00E-01 | 1.60E-08 | 7.98E-08 |
| CHROMIUM | 1.10E+03 | 5.00E-03 | 1.76E-04 | 3.51E-02 |
| COPPER | 1.26E+02 | 4.00E-02 | 2.02E-05 | 5.04E-04 |
| DI-N-BUTYLPHTHALATE | 4.30E+00 | 1.00E-01 | 6.87E-07 | 6.87E-06 |
| FLUORANTHENE | 2.06E+00 | 4.00E-02 | 3.30E-07 | 8.24E-06 |
| LITHIUM | 2.03E+03 | 2.00E-02 | 3.24E-04 | 1.62E-02 |
| PYRENE | 1.61E+00 | 3.00E-02 | 2.56E-07 | 8.54E-06 |
| TOLUENE | 4.53E-03 | 2.00E-01 | 7.23E-10 | 3.62E-09 |
| URANIUM | 6.08E+01 | 3.00E-03 | 9.71E-06 | 3.24E-03 |
| | | | HAZARD INDEX = | 5.51E-02 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AF \times AD}$$

CS = UL95 chemical concentration in surface soil (mg/kg)
IR = Ingestion rate (200 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (20.4 d/yr)
ED = Exposure duration (30 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-4
RISK FROM SOIL INGESTION AT MISS
RECEPTOR: CURRENT AND FUTURE TRANSIENT
USING MEAN VALUES

CONTAMINANT OF CONCERN

| CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| BENZO(A)ANTHRACENE | 3.76E-01 | 7.30E+00 | 3.86E-09 | 2.82E-08 |
| BENZO(A)PYRENE | 3.54E-01 | 7.30E+00 | 3.63E-09 | 2.65E-08 |
| BENZO(B)FLOURANTHENE | 4.01E-01 | 7.30E+00 | 4.12E-09 | 3.01E-08 |
| BENZO(K)FLOURANTHENE | 3.57E-01 | 7.30E+00 | 3.66E-09 | 2.68E-08 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.12E-01 | 1.40E-02 | 3.20E-09 | 4.48E-11 |
| CHROMIUM | 1.70E+02 | ND | 1.75E-06 | ND |
| CHRYSENE | 4.30E-01 | 7.30E+00 | 4.41E-09 | 3.22E-08 |
| DIBENZO(A,H)ANTHRACENE | 2.31E-01 | 7.30E+00 | 2.37E-09 | 1.73E-08 |
| INDENO(1,2,3-CD)PYRENE | 3.36E-01 | 7.30E+00 | 3.45E-09 | 2.52E-08 |
| LITHIUM | 3.55E+02 | ND | 3.64E-06 | ND |
| | | | TOTAL CANCER RISK = | 1.86E-07 |

| NON-CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 2.57E-01 | 3.00E-01 | 2.05E-08 | 6.84E-08 |
| BENZO(G,H,I)PERYLENE | 3.18E-01 | ND | 2.21E-08 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.12E-01 | 2.00E-02 | 2.49E-08 | 1.25E-06 |
| BUTYLBENZYLPHTHALATE | 1.50E-01 | 2.00E-01 | 1.20E-08 | 5.99E-08 |
| CHROMIUM | 1.70E+02 | 5.00E-03 | 1.36E-05 | 2.71E-03 |
| COPPER | 6.16E+01 | 4.00E-02 | 4.92E-06 | 1.23E-04 |
| DI-N-BUTYLPHTHALATE | 1.80E-01 | 1.00E-01 | 1.44E-08 | 1.44E-07 |
| FLUORANTHENE | 8.30E-01 | 4.00E-02 | 6.63E-08 | 1.66E-06 |
| LITHIUM | 3.55E+02 | 2.00E-02 | 2.83E-05 | 1.42E-03 |
| PYRENE | 6.71E-01 | 3.00E-02 | 5.36E-08 | 1.79E-06 |
| TOLUENE | 3.82E-03 | 2.00E-01 | 3.05E-10 | 1.53E-09 |
| URANIUM | 5.26E+01 | 3.00E-03 | 4.20E-06 | 1.40E-03 |
| | | | HAZARD INDEX = | 5.66E-03 |

$$\text{Intake(mg/kg-d)} = \frac{\text{CS x IR x CF x FI x EF x ED}}{\text{BW x AF x AD}}$$

CS = Mean chemical concentration in surface soil (mg/kg)
IR = Ingestion rate (100 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (20.4 d/yr)
ED = Exposure duration (9 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-5
RISK FROM INHALATION OF SOIL PARTICULATES AT MISS
RECEPTOR: CURRENT AND FUTURE EMPLOYEE
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| BENZO(A)ANTHRACENE | 2.35E-08 | ND | 2.70E-10 | ND |
| BENZO(A)PYRENE | 2.22E-08 | ND | 2.54E-10 | ND |
| BENZO(B)FLOURANTHENE | 2.50E-08 | ND | 2.87E-10 | ND |
| BENZO(K)FLOURANTHENE | 2.30E-08 | ND | 2.63E-10 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.28E-08 | ND | 2.61E-10 | ND |
| CHROMIUM | 3.30E-05 | 4.10E+01 | 3.78E-07 | 1.55E-05 |
| CHRYSENE | 2.58E-08 | ND | 2.96E-10 | ND |
| DIBENZO(A,H)ANTHRACENE | 3.00E-09 | ND | 3.44E-11 | ND |
| INDENO(1,2,3-CD)PYRENE | 1.57E-08 | ND | 1.80E-10 | ND |
| LITHIUM | 3.04E-05 | ND | 3.49E-07 | ND |
| | | | TOTAL CANCER RISK = | 1.55E-05 |

| NON-CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 1.42E-08 | ND | 4.55E-10 | ND |
| BENZO(G,H,I)PERYLENE | 1.26E-08 | ND | 4.05E-10 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.28E-08 | ND | 7.31E-10 | ND |
| BUTYLBENZYLPHTHALATE | 3.00E-09 | ND | 9.63E-11 | ND |
| CHROMIUM | 3.30E-05 | ND | 1.06E-06 | ND |
| COPPER | 3.79E-06 | ND | 1.22E-07 | ND |
| DI-N-BUTYLPHTHALATE | 1.29E-07 | ND | 4.14E-09 | ND |
| FLUORANTHENE | 6.19E-08 | ND | 1.99E-09 | ND |
| LITHIUM | 3.04E-05 | ND | 9.76E-07 | ND |
| PYRENE | 4.82E-08 | ND | 1.55E-09 | ND |
| TOLUENE | 1.35E-10 | ND | 4.33E-12 | ND |
| URANIUM | 1.82E-06 | ND | 5.84E-08 | ND |
| | | | HAZARD INDEX = | ND |

$$\text{Intake(mg/kg-d)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AF \times AD}$$

CA = UL95 chemical concentration in soil (mg/m3)
IR = Inhalation rate (1.875 m3/hr)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (25 yr)
ET = Exposure time (1.75 hr/d)
BW = Body weight (70 kg)
AF = Averaging frequency (365d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens )

TABLE E-6
RISK FROM INHALATION OF SOIL PARTICULATES AT MISS
RECEPTOR: CURRENT AND FUTURE EMPLOYEE
USING MEAN VALUES

CONTAMINANT OF CONCERN

| CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| BENZO(A)ANTHRACENE | 5.64E-09 | ND | 1.81E-11 | ND |
| BENZO(A)PYRENE | 5.31E-09 | ND | 1.70E-11 | ND |
| BENZO(B)FLOURANTHENE | 6.02E-09 | ND | 1.93E-11 | ND |
| BENZO(K)FLOURANTHENE | 5.36E-09 | ND | 1.72E-11 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.68E-09 | ND | 1.50E-11 | ND |
| CHROMIUM | 2.55E-06 | 4.10E+01 | 8.19E-09 | 3.36E-07 |
| CHRYSENE | 6.45E-09 | ND | 2.07E-11 | ND |
| DIBENZO(A,H)ANTHRACENE | 3.47E-09 | ND | 1.11E-11 | ND |
| INDENO(1,2,3-CD)PYRENE | 5.04E-09 | ND | 1.62E-11 | ND |
| LITHIUM | 5.32E-06 | ND | 1.71E-08 | ND |
| | | | TOTAL CANCER RISK = | 3.36E-07 |

| NON-CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 3.86E-09 | ND | 1.24E-10 | ND |
| BENZO(G,H,I)PERYLENE | 4.77E-09 | ND | 1.53E-10 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.68E-09 | ND | 1.50E-10 | ND |
| BUTYLBENZYLPHTHALATE | 2.25E-09 | ND | 7.22E-11 | ND |
| CHROMIUM | 2.55E-06 | ND | 8.19E-08 | ND |
| COPPER | 9.24E-07 | ND | 2.97E-08 | ND |
| DI-N-BUTYLPHTHALATE | 2.70E-09 | ND | 8.67E-11 | ND |
| FLUORANTHENE | 1.25E-08 | ND | 4.00E-10 | ND |
| LITHIUM | 5.32E-06 | ND | 1.71E-07 | ND |
| PYRENE | 1.01E-08 | ND | 3.23E-10 | ND |
| TOLUENE | 5.73E-11 | ND | 1.84E-12 | ND |
| URANIUM | 7.89E-07 | ND | 2.53E-08 | ND |
| | | | HAZARD INDEX = | ND |

$$\text{Intake(mg/kg-d)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AF \times AD}$$

CA = Mean chemical concentration in air (mg/m3)
IR = Inhalation rate (1.875 m3/h)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (7 yr)
ET = Exposure time (1.75 hr/d)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-7
RISK FROM INHALATION OF SOIL PARTICULATES AT MISS
RECEPTOR: CURRENT AND FUTURE TRANSIENT
USING RME VALUES

CONTAMINANT OF CONCERN

| CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| BENZO(A)ANTHRACENE | 2.35E-08 | ND | 1.93E-10 | ND |
| BENZO(A)PYRENE | 2.22E-08 | ND | 1.82E-10 | ND |
| BENZO(B)FLOURANTHENE | 2.50E-08 | ND | 2.06E-10 | ND |
| BENZO(K)FLOURANTHENE | 2.30E-08 | ND | 1.89E-10 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.28E-08 | ND | 1.87E-10 | ND |
| CHROMIUM | 3.30E-05 | 4.10E+01 | 2.71E-07 | 1.11E-05 |
| CHRYSENE | 2.58E-08 | ND | 2.12E-10 | ND |
| DIBENZO(A,H)ANTHRACENE | 3.00E-09 | ND | 2.47E-11 | ND |
| INDENO(1,2,3-CD)PYRENE | 1.57E-08 | ND | 1.29E-10 | ND |
| LITHIUM | 3.04E-05 | ND | 2.50E-07 | ND |
| | | | TOTAL CANCER RISK = | 1.11E-05 |

| NON-CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 1.42E-08 | ND | 2.72E-10 | ND |
| BENZO(G,H,I)PERYLENE | 1.26E-08 | ND | 2.42E-10 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.28E-08 | ND | 4.37E-10 | ND |
| BUTYLBENZYLPHTHALATE | 3.00E-09 | ND | 5.75E-11 | ND |
| CHROMIUM | 3.30E-05 | ND | 6.33E-07 | ND |
| COPPER | 3.79E-06 | ND | 7.27E-08 | ND |
| DI-N-BUTYLPHTHALATE | 1.29E-07 | ND | 2.47E-09 | ND |
| FLUORANTHENE | 6.19E-08 | ND | 1.19E-09 | ND |
| LITHIUM | 3.04E-05 | ND | 5.83E-07 | ND |
| PYRENE | 4.82E-08 | ND | 9.24E-10 | ND |
| TOLUENE | 1.35E-10 | ND | 2.59E-12 | ND |
| URANIUM | 1.82E-06 | ND | 3.49E-08 | ND |
| | | | HAZARD INDEX = | ND |

$$\text{Intake(mg/kg-d)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AF \times AD}$$

CA = UL95 chemical concentration in air (mg/m3)
IR = Inhalation rate (1.0 m3/h)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (30 yr)
ET = Exposure time (1.4 hr/d)
BW = Body weight (70 kg)
AF = Averaging frequency (365d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens )

TABLE E-8
RISK FROM INHALATION OF SOIL PARTICULATES AT MISS
RECEPTOR: CURRENT AND FUTURE TRANSIENT
USING MEAN VALUES

CONTAMINANT OF CONCERN

| CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| BENZO(A)ANTHRACENE | 5.64E-09 | ND | 1.39E-12 | ND |
| BENZO(A)PYRENE | 5.31E-09 | ND | 1.31E-12 | ND |
| BENZO(B)FLOURANTHENE | 6.02E-09 | ND | 1.48E-12 | ND |
| BENZO(K)FLOURANTHENE | 5.36E-09 | ND | 1.32E-12 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.68E-09 | ND | 1.15E-12 | ND |
| CHROMIUM | 2.55E-06 | 4.10E+01 | 6.29E-10 | 2.58E-08 |
| CHRYSENE | 6.45E-09 | ND | 1.59E-12 | ND |
| DIBENZO(A,H)ANTHRACENE | 3.47E-09 | ND | 8.54E-13 | ND |
| INDENO(1,2,3-CD)PYRENE | 5.04E-09 | ND | 1.24E-12 | ND |
| LITHIUM | 5.32E-06 | ND | 1.31E-09 | ND |
| | | | TOTAL CANCER RISK = | 2.58E-08 |

| NON-CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 3.86E-09 | ND | 7.39E-12 | ND |
| BENZO(G,H,I)PERYLENE | 4.77E-09 | ND | 9.15E-12 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.68E-09 | ND | 8.98E-12 | ND |
| BUTYLBENZYLPHTHALATE | 2.25E-09 | ND | 4.32E-12 | ND |
| CHROMIUM | 2.55E-06 | ND | 4.89E-09 | ND |
| COPPER | 9.24E-07 | ND | 1.77E-09 | ND |
| DI-N-BUTYLPHTHALATE | 2.70E-09 | ND | 5.18E-12 | ND |
| FLUORANTHENE | 1.25E-08 | ND | 2.39E-11 | ND |
| LITHIUM | 5.32E-06 | ND | 1.02E-08 | ND |
| PYRENE | 1.01E-08 | ND | 1.94E-11 | ND |
| TOLUENE | 5.73E-11 | ND | 1.10E-13 | ND |
| URANIUM | 7.89E-07 | ND | 1.51E-09 | ND |
| | | | HAZARD INDEX = | ND |

$$\text{Intake(mg/kg-d)} = \frac{\text{CA x IR x ET x EF x ED}}{\text{BW x AF x AD}}$$

CA = Mean Chemical Concentration in air (mg/m3)
IR = Inhalation rate (1.0 m3/h)
EF = Exposure Frequency (350 d/yr)
ED = Exposure Duration (9 yr)
ET = Exposure time (0.14 hrs/d)
BW = Body Weight (70 kg)
AF = Averaging frequency (365d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens )

TABLE E-9
*RISK FROM SOIL INGESTION AT STEPAN*
RECEPTOR : CURRENT AND FUTURE EMPLOYEE
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg/-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 2.53E+01 | 1.75E+00 | 4.42E-06 | 7.74E-06 |
| BENZO(A)ANTHRACENE | 3.23E+00 | 7.30E+00 | 5.65E-07 | 4.12E-06 |
| BENZO(A)PYRENE | 3.83E+00 | 7.30E+00 | 6.69E-07 | 4.88E-06 |
| BENZO(B)FLOURANTHENE | 3.38E+00 | 7.30E+00 | 5.90E-07 | 4.31E-06 |
| INDENO(1,2,3-CD)PYRENE | 2.73E+00 | 7.30E+00 | 4.76E-07 | 3.48E-06 |
| | | | TOTAL CANCER RISK = | 2.45E-05 |

| NONCARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg/-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 2.90E+00 | 3.00E-01 | 1.42E-06 | 4.73E-06 |
| ARSENIC | 2.53E+01 | 3.00E-04 | 1.24E-05 | 4.13E-02 |
| BENZO(G,H,I)PERYLENE | 2.68E+00 | ND | 1.31E-06 | ND |
| DI-N-BUTYLPHTHALATE | 2.93E+00 | 1.00E-01 | 1.43E-06 | 1.43E-05 |
| FLUORENE | 2.08E+00 | 4.00E-02 | 1.02E-06 | 2.54E-05 |
| URANIUM | 1.11E+01 | 3.00E-03 | 5.41E-06 | 1.80E-03 |
| | | | HAZARD INDEX = | 4.31E-02 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AF \times AD}$$

CS = UL95 *chemical concentration in surface soil* (mg/kg)
IR = Ingestion rate (50 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (25 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens )

TABLE E-10
RISK FROM SOIL INGESTION AT STEPAN
RECEPTOR: CURRENT AND FUTURE EMPLOYEE
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 1.24E+01 | 1.75E+00 | 3.64E-07 | 6.37E-07 |
| BENZO(A)ANTHRACENE | 3.23E+00 | 7.30E+00 | 9.48E-08 | 6.92E-07 |
| BENZO(A)PYRENE | 3.83E+00 | 7.30E+00 | 1.12E-07 | 8.21E-07 |
| BENZO(B)FLOURANTHENE | 3.38E+00 | 7.30E+00 | 9.92E-08 | 7.24E-07 |
| INDENO(1,2,3-CD)PYRENE | 2.40E+00 | 7.30E+00 | 7.05E-08 | 5.14E-07 |
| | | | TOTAL CANCER RISK = | 3.39E-06 |

| NONCARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 2.10E+00 | 3.00E-01 | 6.16E-07 | 2.05E-06 |
| ARSENIC | 1.24E+01 | 3.00E-04 | 3.64E-06 | 1.21E-02 |
| BENZO(G,H,I)PERYLENE | 2.68E+00 | ND | 7.87E-07 | ND |
| DI-N-BUTYLPHTHALATE | 2.93E+00 | 1.00E-01 | 8.60E-07 | 8.60E-06 |
| FLUORENE | 1.30E+00 | 4.00E-02 | 3.82E-07 | 9.54E-06 |
| URANIUM | 1.05E+01 | 3.00E-03 | 3.07E-06 | 1.02E-03 |
| | | | HAZARD INDEX = | 1.32E-02 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AF \times AD}$$

CS = Mean chemical concentration in surface soil (mg/kg)
IR = Ingestion rate (30 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (7 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens )

TABLE E-11
RISK FROM SOIL INGESTION AT STEPAN
RECEPTOR: CURRENT AND FUTURE TRANSIENT
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg/-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 2.53E+01 | 1.75E+00 | 1.73E-06 | 3.03E-06 |
| BENZO(A)ANTHRACENE | 3.23E+00 | 7.30E+00 | 2.21E-07 | 1.62E-06 |
| BENZO(A)PYRENE | 7.32E+00 | 7.30E+00 | 5.01E-07 | 3.66E-06 |
| BENZO(B)FLOURANTHENE | 6.24E+00 | 7.30E+00 | 4.27E-07 | 3.12E-06 |
| INDENO(1,2,3-CD)PYRENE | 2.73E+00 | 7.30E+00 | 1.87E-07 | 1.36E-06 |
| | | | TOTAL CANCER RISK = | 1.28E-05 |

| NONCARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg/-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 2.90E+00 | 3.00E-01 | 4.63E-07 | 1.54E-06 |
| ARSENIC | 2.53E+01 | 3.00E-04 | 4.04E-06 | 1.35E-02 |
| BENZO(G,H,I)PERYLENE | 4.80E+00 | ND | 7.66E-07 | ND |
| DI-N-BUTYLPHTHALATE | 5.18E+00 | 1.00E-01 | 8.27E-07 | 8.27E-06 |
| FLUORENE | 2.08E+00 | 4.00E-02 | 3.32E-07 | 8.29E-06 |
| URANIUM | 1.11E+01 | 3.00E-03 | 1.77E-06 | 5.89E-04 |
| | | | HAZARD INDEX = | 1.41E-02 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AF \times AD}$$

CS = UL95 chemical concentration in surface soil (mg/kg)
IR = *Ingestion rate (200 mg/d)*
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (20.4 d/yr)
ED = Exposure duration (30 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-12
RISK FROM SOIL INGESTION AT STEPAN
RECEPTOR: CURRENT AND FUTURE TRANSIENT
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 1.24E+01 | 1.75E+00 | 1.27E-07 | 2.23E-07 |
| BENZO(A)ANTHRACENE | 3.23E+00 | 7.30E+00 | 3.32E-08 | 2.42E-07 |
| BENZO(A)PYRENE | 7.32E+00 | 7.30E+00 | 7.51E-08 | 5.49E-07 |
| BENZO(B)FLOURANTHENE | 6.24E+00 | 7.30E+00 | 6.41E-08 | 4.68E-07 |
| INDENO(1,2,3-CD)PYRENE | 2.40E+00 | 7.30E+00 | 2.46E-08 | 1.80E-07 |
| | | | TOTAL CANCER RISK = | 1.66E-06 |

| NONCARCINOGENS | SOIL CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 2.10E+00 | 3.00E-01 | 1.68E-07 | 5.59E-07 |
| ARSENIC | 1.25E+01 | 3.00E-04 | 9.94E-07 | 3.31E-03 |
| BENZO(G,H,I)PERYLENE | 2.68E+00 | ND | 2.14E-07 | ND |
| DI-N-BUTYLPHTHALATE | 5.18E+00 | 1.00E-01 | 4.14E-07 | 4.14E-06 |
| FLUORENE | 1.30E+00 | 4.00E-02 | 1.04E-07 | 2.59E-06 |
| URANIUM | 1.05E+01 | 3.00E-03 | 8.36E-07 | 2.79E-04 |
| | | | HAZARD INDEX = | 3.60E-03 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times FI \times EF \times ED}{BW \times AF \times AD}$$

CS = Mean chemical concentration in surface soil (mg/kg)
IR = Ingestion rate (100 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (20.4 d/yr)
ED = Exposure duration (9 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens )

TABLE E-13
*RISK FROM INHALATION OF SOIL PARTICULATES AT STEPAN*
RECEPTOR: CURRENT AND FUTURE EMPLOYEE
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION SF (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 7.59E-07 | 50 | 8.70E-09 | 4.35E-07 |
| BENZO(A)ANTHRACENE | 9.69E-08 | ND | 1.11E-09 | ND |
| BENZO(A)PYRENE | 1.15E-07 | ND | 1.32E-09 | ND |
| BENZO(B)FLOURANTHENE | 1.01E-07 | ND | 1.16E-09 | ND |
| INDENO(1,2,3-CD)PYRENE | 8.18E-08 | ND | 9.38E-10 | ND |
| | | | TOTAL CANCER RISK = | 4.35E-07 |

| NONCARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 8.70E-08 | ND | 2.79E-09 | ND |
| ARSENIC | 7.59E-07 | ND | 2.44E-08 | ND |
| BENZO(G,H,I)PERYLENE | 8.03E-08 | ND | 2.58E-09 | ND |
| DI-N-BUTYLPHTHALATE | 8.80E-08 | ND | 2.83E-09 | ND |
| FLUORENE | 6.23E-08 | ND | 2.00E-09 | ND |
| URANIUM | 3.32E-07 | ND | 1.07E-08 | ND |
| | | | HAZARD INDEX = | ND |

$$\text{Intake(mg/kg-d)} = \frac{(CA \times IR \times ET \times EF \times ED)}{(BW \times AF \times AD)}$$

CA = UL95 chemical concentration in air (mg/m3)
IR = Inhalation rate (1.875 m3/hr)
EF = Exposure frequency (250 d/yr)
ET = Exposure time (1.75 hr/d)
ED = Exposure duration (25 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED years for noncarcinogens and 70 years for carcinogens )

TABLE E-14
RISK FROM INHALATION OF SOIL PARTICULATES AT STEPAN
RECEPTOR: CURRENT AND FUTURE EMPLOYEE
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 1.87E-07 | 50 | 6.00E-10 | 2.998E-08 |
| BENZO(A)ANTHRACENE | 4.85E-08 | ND | 1.56E-10 | ND |
| BENZO(A)PYRENE | 1.10E-07 | ND | 3.53E-10 | ND |
| BENZO(B)FLOURANTHENE | 9.36E-08 | ND | 3.01E-10 | ND |
| INDENO(1,2,3-CD)PYRENE | 3.60E-08 | ND | 1.16E-10 | ND |
| | | | TOTAL CANCER RISK = | 3.00E-08 |

| NONCARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 3.15E-08 | ND | 1.01E-09 | ND |
| ARSENIC | 1.87E-07 | ND | 6.00E-09 | ND |
| BENZO(G,H,I)PERYLENE | 6.90E-08 | ND | 2.22E-09 | ND |
| DI-N-BUTYLPHTHALATE | 7.77E-08 | ND | 2.49E-09 | ND |
| FLUORENE | 1.95E-08 | ND | 6.26E-10 | ND |
| URANIUM | 1.57E-07 | ND | 5.04E-09 | ND |
| | | | HAZARD INDEX = | ND |

$$\text{Intake (mg/kg-d)} = \frac{(CA \times IR \times ET \times EF \times ED)}{(BW \times AF \times AD)}$$

CA = Mean chemical concentration in air (mg/m3)
IR = Inhalation rate (1.875 m3/hr)
ET = Exposure time (1.75 hr/d)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (7 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 for carcinogens)

TABLE E-15
RISK FROM INHALATION OF SOIL PARTICULATES AT STEPAN
RECEPTOR: CURRENT AND FUTURE TRANSIENT
*USING RME VALUES*

CONTAMINANTS OF CONCERN

| CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 7.59E-07 | 50 | 6.24E-09 | 3.119E-07 |
| BENZO(A)ANTHRACENE | 9.69E-08 | ND | 7.96E-10 | ND |
| BENZO(A)PYRENE | 1.15E-07 | ND | 9.45E-10 | ND |
| BENZO(B)FLOURANTHENE | 1.01E-07 | ND | 8.30E-10 | ND |
| INDENO(1,2,3-CD)PYRENE | 8.18E-08 | ND | 6.72E-10 | ND |
| | | | TOTAL CANCER RISK = | 3.12E-07 |

| NONCARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 8.70E-08 | ND | 1.67E-09 | ND |
| ARSENIC | 7.59E-07 | ND | 1.46E-08 | ND |
| BENZO(G,H,I)PERYLENE | 8.03E-08 | ND | 1.54E-09 | ND |
| DI-N-BUTYLPHTHALATE | 8.80E-08 | ND | 1.69E-09 | ND |
| FLUORENE | 6.23E-08 | ND | 1.19E-09 | ND |
| URANIUM | 3.32E-07 | ND | 6.37E-09 | ND |
| | | | HAZARD INDEX = | ND |

$$\text{Intake(mg/kg-d)} = \frac{(CA \times IR \times ET \times EF \times ED)}{(BW \times AF \times AD)}$$

CA = UL95 chemical concentration in air (mg/m3)
IR = Inhalation rate (1.0 m3/hr)
ET = Exposure time (1.4 hr/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (30 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED years for *noncarcinogens and 70 years for carcinogens*)

TABLE E-16
RISK FROM INHALATION OF SOIL PARTICULATES AT STEPAN
RECEPTOR : CURRENT AND FUTURE TRANSIENT
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 1.87E-07 | 50 | 4.60E-11 | 2.30E-09 |
| BENZO(A)ANTHRACENE | 4.85E-08 | ND | 1.19E-11 | ND |
| BENZO(A)PYRENE | 1.10E-07 | ND | 2.71E-11 | ND |
| BENZO(B)FLOURANTHENE | 9.36E-08 | ND | 2.31E-11 | ND |
| INDENO(1,2,3-CD)PYRENE | 3.60E-08 | ND | 8.88E-12 | ND |
| | | | TOTAL CANCER RISK = | 2.30E-09 |

| NONCARCINOGENS | AIR CONCENTRATION (mg/m3) | INHALATION RfD (mg/kg/d) | INTAKE (mg/kg/-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ANTHRACENE | 3.15E-08 | ND | 6.04E-11 | ND |
| ARSENIC | 1.87E-07 | ND | 3.58E-10 | ND |
| BENZO(G,H,I)PERYLENE | 6.90E-08 | ND | 1.32E-10 | ND |
| DI-N-BUTYLPHTHALATE | 7.77E-08 | ND | 1.49E-10 | ND |
| FLUORENE | 1.95E-08 | ND | 3.74E-11 | ND |
| URANIUM | 1.57E-07 | ND | 3.01E-10 | ND |
| | | | HAZARD INDEX = | ND |

$$\text{Intake(mg/kg/d)} = \frac{(CA \times IR \times ET \times EF \times ED)}{(BW \times AF \times AD)}$$

CA = Mean chemical concentration in air (mg/m3)
IR = Inhalation rate (1.0 m3/hr)
ET = Exposure time (0.14 hr/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (9 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED years for noncarcinogens and 70 years for carcinogens)

TABLE E-17
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE EMPLOYEE
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1-DICHLOROETHENE | 7.33E-03 | 6.00E-01 | 2.56E-05 | 1.54E-05 |
| ARSENIC | 4.64E-01 | 1.75E+00 | 1.62E-03 | 2.84E-03 |
| BERYLLIUM | 2.00E-03 | 4.30E+00 | 6.99E-06 | 3.01E-05 |
| BIS(2-CHLOROETHYL)ETHER | 6.67E-03 | 1.10E+00 | 2.33E-05 | 2.56E-05 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-02 | 1.40E-02 | 7.34E-05 | 1.03E-06 |
| CHROMIUM(VI) | 1.34E+00 | ND | 4.68E-03 | ND |
| METHYLENE CHLORIDE | 9.50E-02 | 7.50E-03 | 3.32E-04 | 2.49E-06 |
| NICKEL | 2.30E-01 | ND | 8.04E-04 | ND |
| LITHIUM | 5.21E+00 | ND | 1.82E-02 | ND |
| PHENOL | 3.00E-01 | ND | 1.05E-03 | ND |
| TETRACHLOROETHYLENE | 3.63E-01 | 5.20E-02 | 1.27E-03 | 6.60E-05 |
| TRICHLOROETHYLENE | 5.50E-02 | 1.10E-02 | 1.92E-04 | 2.11E-06 |
| VINYL CHLORIDE | 1.90E-01 | 1.90E+00 | 6.64E-04 | 1.26E-03 |
| | | | TOTAL CANCER RISK = | 4.24E-03 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 1.80E-02 | 9.00E-02 | 1.76E-04 | 1.96E-03 |
| 1,1-DICHLOROETHENE | 7.33E-03 | 9.00E-03 | 7.17E-05 | 7.97E-03 |
| 1,2- DICHLOROETHENE | 3.60E-01 | 2.00E-02 | 3.52E-03 | 1.76E-01 |
| ALUMINIUM | 5.51E+01 | 1.00E+00 | 5.39E-01 | 5.39E-01 |
| ARSENIC | 4.64E-01 | 3.00E-04 | 4.54E-03 | 1.51E+01 |
| BARIUM | 3.04E-01 | 7.00E-02 | 2.98E-03 | 4.25E-02 |
| BERYLLIUM | 2.29E-03 | 5.00E-03 | 2.24E-05 | 4.48E-03 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-02 | 2.00E-02 | 2.05E-04 | 1.03E-02 |
| BORON | 7.68E-01 | 9.00E-02 | 7.51E-03 | 8.35E-02 |
| CARBON DISULFIDE | 7.00E-03 | 1.00E-01 | 6.85E-05 | 6.85E-04 |
| CHROMIUM(VI) | 1.34E+00 | 5.00E-03 | 1.31E-02 | 2.62E+00 |
| COPPER | 4.20E-01 | 4.00E-02 | 4.11E-03 | 1.03E-01 |
| LITHIUM | 5.21E+00 | 2.00E-02 | 5.10E-02 | 2.55E+00 |
| MANGANESE | 5.15E+00 | 5.00E-03 | 5.04E-02 | 1.01E+01 |
| METHYLENE CHLORIDE | 9.50E-02 | 6.00E-02 | 9.30E-04 | 1.55E-02 |
| NICKEL | 2.34E-01 | 2.00E-02 | 2.29E-03 | 1.14E-01 |
| PHENOL | 3.00E-01 | 6.00E-01 | 2.94E-03 | 4.89E-03 |
| SELENIUM | 6.34E-03 | 5.00E-03 | 6.20E-05 | 1.24E-02 |
| TETRACHLOROETHYLENE | 3.63E-01 | 1.00E-02 | 3.55E-03 | 3.55E-01 |
| TOLUENE | 5.78E-03 | 2.00E-01 | 5.66E-05 | 2.83E-04 |
| TRICHLOROETHYLENE | 5.50E-02 | 6.00E-03 | 5.38E-04 | 8.97E-02 |
| VANADIUM | 4.20E-02 | 7.00E-03 | 4.11E-04 | 5.87E-02 |
| VINYL CHLORIDE | 1.90E-01 | ND | 1.86E-03 | ND |
| | | | HAZARD INDEX = | 3.20E+01 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (1.0 l/d)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (25 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-17A
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (ADULT)
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1-DICHLOROETHENE | 7.33E-05 | 6.00E-01 | 8.61E-07 | 5.16E-07 |
| ARSENIC | 4.64E-03 | 1.75E+00 | 5.45E-05 | 9.53E-05 |
| BERYLLIUM | 2.00E-05 | 4.30E+00 | 2.35E-07 | 1.01E-06 |
| BIS(2-CHLOROETHYL)ETHER | 6.67E-05 | 1.10E+00 | 7.83E-07 | 8.61E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-04 | 1.40E-02 | 2.47E-06 | 3.45E-08 |
| CHROMIUM | 1.34E-02 | ND | 1.57E-04 | ND |
| METHYLENE CHLORIDE | 9.50E-04 | 7.50E-03 | 1.12E-05 | 8.37E-08 |
| NICKEL | 2.30E-03 | ND | 2.70E-05 | ND |
| LITHIUM | 5.21E-02 | ND | 6.12E-04 | ND |
| PHENOL | 3.00E-03 | ND | 3.52E-05 | ND |
| TETRACHLOROETHYLENE | 3.63E-03 | 5.20E-02 | 4.26E-05 | 2.22E-06 |
| TRICHLOROETHYLENE | 5.50E-04 | 1.10E-02 | 6.46E-06 | 7.10E-08 |
| VINYL CHLORIDE | 1.90E-03 | 1.90E+00 | 2.23E-05 | 4.24E-05 |
| | | | TOTAL CANCER RISK = | 1.43E-04 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 1.80E-04 | 9.00E-02 | 4.93E-06 | 5.48E-05 |
| 1,1-DICHLOROETHENE | 7.33E-05 | 9.00E-03 | 2.01E-06 | 2.23E-04 |
| 1,2- DICHLOROETHENE | 3.60E-03 | 2.00E-02 | 9.86E-05 | 4.93E-03 |
| ALUMINIUM | 5.51E-01 | 1.00E+00 | 1.51E-02 | 1.51E-02 |
| ARSENIC | 4.64E-03 | 3.00E-04 | 1.27E-04 | 4.24E-01 |
| BARIUM | 3.04E-03 | 7.00E-02 | 8.33E-05 | 1.19E-03 |
| BERYLLIUM | 2.29E-05 | 5.00E-03 | 6.27E-07 | 1.25E-04 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-04 | 2.00E-02 | 5.75E-06 | 2.88E-04 |
| BORON | 7.68E-03 | 9.00E-02 | 2.10E-04 | 2.34E-03 |
| CARBON DISULFIDE | 7.00E-05 | 1.00E-01 | 1.92E-06 | 1.92E-05 |
| CHROMIUM | 1.34E-02 | 5.00E-03 | 3.67E-04 | 7.34E-02 |
| COPPER | 4.20E-03 | 4.00E-02 | 1.15E-04 | 2.88E-03 |
| LITHIUM | 5.21E-02 | 2.00E-02 | 1.43E-03 | 7.14E-02 |
| MANGANESE | 5.15E-02 | 5.00E-03 | 1.41E-03 | 2.82E-01 |
| METHYLENE CHLORIDE | 9.50E-04 | 6.00E-02 | 2.60E-05 | 4.34E-04 |
| NICKEL | 2.34E-03 | 2.00E-02 | 6.41E-05 | 3.21E-03 |
| PHENOL | 3.00E-03 | 6.00E-01 | 8.22E-05 | 1.37E-04 |
| SELENIUM | 6.34E-05 | 5.00E-03 | 1.74E-06 | 3.47E-04 |
| TETRACHLOROETHYLENE | 3.63E-03 | 1.00E-02 | 9.95E-05 | 9.95E-03 |
| TOLUENE | 5.78E-05 | 2.00E-01 | 1.58E-06 | 7.92E-06 |
| TRICHLOROETHYLENE | 5.50E-04 | 6.00E-03 | 1.51E-05 | 2.51E-03 |
| VANADIUM | 4.20E-04 | 7.00E-03 | 1.15E-05 | 1.64E-03 |
| VINYL CHLORIDE | 1.90E-03 | ND | 5.21E-05 | ND |
| | | | HAZARD INDEX = | 8.96E-01 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (2.0 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (30 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-17B
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (CHILD)
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1-DICHLOROETHENE | 7.33E-05 | 6.00E-01 | 2.81E-07 | 1.69E-07 |
| ARSENIC | 4.64E-03 | 1.75E+00 | 1.78E-05 | 3.11E-05 |
| BERYLLIUM | 2.00E-05 | 4.30E+00 | 7.67E-08 | 3.30E-07 |
| BIS(2-CHLOROETHYL)ETHER | 6.67E-05 | 1.10E+00 | 2.56E-07 | 2.81E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-04 | 1.40E-02 | 8.05E-07 | 1.13E-08 |
| CHROMIUM | 1.34E-02 | ND | 5.14E-05 | ND |
| METHYLENE CHLORIDE | 9.50E-04 | 7.50E-03 | 3.64E-06 | 2.73E-08 |
| NICKEL | 2.30E-03 | ND | 8.82E-06 | ND |
| LITHIUM | 5.21E-02 | ND | 2.00E-04 | ND |
| PHENOL | 3.00E-03 | ND | 1.15E-05 | ND |
| TETRACHLOROETHYLENE | 3.63E-03 | 5.20E-02 | 1.39E-05 | 7.24E-07 |
| TRICHLOROETHYLENE | 5.50E-04 | 1.10E-02 | 2.11E-06 | 2.32E-08 |
| VINYL CHLORIDE | 1.90E-03 | 1.90E+00 | 7.29E-06 | 1.38E-05 |
| | | | TOTAL CANCER RISK = | 4.66E-05 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 1.80E-04 | 9.00E-02 | 8.05E-06 | 8.95E-05 |
| 1,1-DICHLOROETHENE | 7.33E-05 | 9.00E-03 | 3.28E-06 | 3.64E-04 |
| 1,2- DICHLOROETHENE | 3.60E-03 | 2.00E-02 | 1.61E-04 | 8.05E-03 |
| ALUMINIUM | 5.51E-01 | 1.00E+00 | 2.47E-02 | 2.47E-02 |
| ARSENIC | 4.64E-03 | 3.00E-04 | 2.08E-04 | 6.92E-01 |
| BARIUM | 3.04E-03 | 7.00E-02 | 1.36E-04 | 1.94E-03 |
| BERYLLIUM | 2.29E-05 | 5.00E-03 | 1.02E-06 | 2.05E-04 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-04 | 2.00E-02 | 9.40E-06 | 4.70E-04 |
| BORON | 7.68E-03 | 9.00E-02 | 3.44E-04 | 3.82E-03 |
| CARBON DISULFIDE | 7.00E-05 | 1.00E-01 | 3.13E-06 | 3.13E-05 |
| CHROMIUM | 1.34E-02 | 5.00E-03 | 6.00E-04 | 1.20E-01 |
| COPPER | 4.20E-03 | 4.00E-02 | 1.88E-04 | 4.70E-03 |
| LITHIUM | 5.21E-02 | 2.00E-02 | 2.33E-03 | 1.17E-01 |
| MANGANESE | 5.15E-02 | 5.00E-03 | 2.30E-03 | 4.61E-01 |
| METHYLENE CHLORIDE | 9.50E-04 | 6.00E-02 | 4.25E-05 | 7.09E-04 |
| NICKEL | 2.34E-03 | 2.00E-02 | 1.05E-04 | 5.24E-03 |
| PHENOL | 3.00E-03 | 6.00E-01 | 1.34E-04 | 2.24E-04 |
| SELENIUM | 6.34E-05 | 5.00E-03 | 2.84E-06 | 5.67E-04 |
| TETRACHLOROETHYLENE | 3.63E-03 | 1.00E-02 | 1.62E-04 | 1.62E-02 |
| TOLUENE | 5.78E-05 | 2.00E-01 | 2.59E-06 | 1.29E-05 |
| TRICHLOROETHYLENE | 5.50E-04 | 6.00E-03 | 2.46E-05 | 4.10E-03 |
| VANADIUM | 4.20E-04 | 7.00E-03 | 1.88E-05 | 2.68E-03 |
| VINYL CHLORIDE | 1.90E-03 | ND | 8.50E-05 | ND |
| | | | HAZARD INDEX = | 1.46E+00 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = ULS5 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.7 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (6 yr)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-17C (D=1000')
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (ADULT)
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1-DICHLOROETHENE | 7.33E-07 | 6.00E-01 | 8.61E-09 | 5.16E-09 |
| ARSENIC | 4.64E-05 | 1.75E+00 | 5.45E-07 | 9.53E-07 |
| BERYLLIUM | 2.00E-07 | 4.30E+00 | 2.35E-09 | 1.01E-08 |
| BIS(2-CHLOROETHYL)ETHER | 6.67E-07 | 1.10E+00 | 7.83E-09 | 8.61E-09 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-06 | 1.40E-02 | 2.47E-08 | 3.45E-10 |
| CHROMIUM(VI) | 1.34E-04 | ND | 1.57E-06 | ND |
| METHYLENE CHLORIDE | 9.50E-06 | 7.50E-03 | 1.12E-07 | 8.37E-10 |
| NICKEL | 2.30E-05 | ND | 2.70E-07 | ND |
| LITHIUM | 5.21E-04 | ND | 6.12E-06 | ND |
| PHENOL | 3.00E-05 | ND | 3.52E-07 | ND |
| TETRACHLOROETHYLENE | 3.63E-05 | 5.20E-02 | 4.26E-07 | 2.22E-08 |
| TRICHLOROETHYLENE | 5.50E-06 | 1.10E-02 | 6.46E-08 | 7.10E-10 |
| VINYL CHLORIDE | 1.90E-05 | 1.90E+00 | 2.23E-07 | 4.24E-07 |
| | | | TOTAL CANCER RISK= | 1.43E-06 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 1.80E-06 | 9.00E-02 | 4.93E-08 | 5.48E-07 |
| 1,1-DICHLOROETHENE | 7.33E-07 | 9.00E-03 | 2.01E-08 | 2.23E-06 |
| 1,2- DICHLOROETHENE | 3.60E-05 | 2.00E-02 | 9.86E-07 | 4.93E-05 |
| ALUMINIUM | 5.51E-03 | 1.00E+00 | 1.51E-04 | 1.51E-04 |
| ARSENIC | 4.64E-05 | 3.00E-04 | 1.27E-06 | 4.24E-03 |
| BARIUM | 3.04E-05 | 7.00E-02 | 8.33E-07 | 1.19E-05 |
| BERYLLIUM | 2.29E-07 | 5.00E-03 | 6.27E-09 | 1.25E-06 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-06 | 2.00E-02 | 5.75E-08 | 2.88E-06 |
| BORON | 7.68E-05 | 9.00E-02 | 2.10E-06 | 2.34E-05 |
| CARBON DISULFIDE | 7.00E-07 | 1.00E-01 | 1.92E-08 | 1.92E-07 |
| CHROMIUM | 1.34E-04 | 5.00E-03 | 3.67E-06 | 7.34E-04 |
| COPPER | 4.20E-05 | 4.00E-02 | 1.15E-06 | 2.88E-05 |
| LITHIUM | 5.21E-04 | 2.00E-02 | 1.43E-05 | 7.14E-04 |
| MANGANESE | 5.15E-04 | 5.00E-03 | 1.41E-05 | 2.82E-03 |
| METHYLENE CHLORIDE | 9.50E-06 | 6.00E-02 | 2.60E-07 | 4.34E-06 |
| NICKEL | 2.34E-05 | 2.00E-02 | 6.41E-07 | 3.21E-05 |
| PHENOL | 3.00E-05 | 6.00E-01 | 8.22E-07 | 1.37E-06 |
| SELENIUM | 6.34E-07 | 5.00E-03 | 1.74E-08 | 3.47E-06 |
| TETRACHLOROETHYLENE | 3.63E-05 | 1.00E-02 | 9.95E-07 | 9.95E-05 |
| TOLUENE | 5.78E-07 | 2.00E-01 | 1.58E-08 | 7.92E-08 |
| TRICHLOROETHYLENE | 5.50E-06 | 6.00E-03 | 1.51E-07 | 2.51E-05 |
| VANADIUM | 4.20E-06 | 7.00E-03 | 1.15E-07 | 1.64E-05 |
| VINYL CHLORIDE | 1.90E-05 | ND | 5.21E-07 | ND |
| | | | HAZARD INDEX = | 8.96E-03 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (2.0 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (30 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-17D (D=1000')
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (CHILD)
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1-DICHLOROETHENE | 7.33E-07 | 6.00E-01 | 2.81E-09 | 1.69E-09 |
| ARSENIC | 4.64E-05 | 1.75E+00 | 1.78E-07 | 3.11E-07 |
| BERYLLIUM | 2.00E-07 | 4.30E+00 | 7.67E-10 | 3.30E-09 |
| BIS(2-CHLOROETHYL)ETHER | 6.67E-07 | 1.10E+00 | 2.56E-09 | 2.81E-09 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-06 | 1.40E-02 | 8.05E-09 | 1.13E-10 |
| CHROMIUM(VI) | 1.34E-04 | ND | 5.14E-07 | ND |
| METHYLENE CHLORIDE | 9.50E-06 | 7.50E-03 | 3.64E-08 | 2.73E-10 |
| NICKEL | 2.30E-05 | ND | 8.82E-08 | ND |
| LITHIUM | 5.21E-04 | ND | 2.00E-06 | ND |
| PHENOL | 3.00E-05 | ND | 1.15E-07 | ND |
| TETRACHLOROETHYLENE | 3.63E-05 | 5.20E-02 | 1.39E-07 | 7.24E-09 |
| TRICHLOROETHYLENE | 5.50E-06 | 1.10E-02 | 2.11E-08 | 2.32E-10 |
| VINYL CHLORIDE | 1.90E-05 | 1.90E+00 | 7.29E-08 | 1.38E-07 |
| | | | TOTAL CANCER RISK= | 4.66E-07 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 1.80E-06 | 9.00E-02 | 8.05E-08 | 8.95E-07 |
| 1,1-DICHLOROETHENE | 7.33E-07 | 9.00E-03 | 3.28E-08 | 3.64E-06 |
| 1,2- DICHLOROETHENE | 3.60E-05 | 2.00E-02 | 1.61E-06 | 8.05E-05 |
| ALUMINIUM | 5.51E-03 | 1.00E+00 | 2.47E-04 | 2.47E-04 |
| ARSENIC | 4.64E-05 | 3.00E-04 | 2.08E-06 | 6.92E-03 |
| BARIUM | 3.04E-05 | 7.00E-02 | 1.36E-06 | 1.94E-05 |
| BERYLLIUM | 2.29E-07 | 5.00E-03 | 1.02E-08 | 2.05E-06 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2.10E-06 | 2.00E-02 | 9.40E-08 | 4.70E-06 |
| BORON | 7.68E-05 | 9.00E-02 | 3.44E-06 | 3.82E-05 |
| CARBON DISULFIDE | 7.00E-07 | 1.00E-01 | 3.13E-08 | 3.13E-07 |
| CHROMIUM | 1.34E-04 | 5.00E-03 | 6.00E-06 | 1.20E-03 |
| COPPER | 4.20E-05 | 4.00E-02 | 1.88E-06 | 4.70E-05 |
| LITHIUM | 5.21E-04 | 2.00E-02 | 2.33E-05 | 1.17E-03 |
| MANGANESE | 5.15E-04 | 5.00E-03 | 2.30E-05 | 4.61E-03 |
| METHYLENE CHLORIDE | 9.50E-06 | 6.00E-02 | 4.25E-07 | 7.09E-06 |
| NICKEL | 2.34E-05 | 2.00E-02 | 1.05E-06 | 5.24E-05 |
| PHENOL | 3.00E-05 | 6.00E-01 | 1.34E-06 | 2.24E-06 |
| SELENIUM | 6.34E-07 | 5.00E-03 | 2.84E-08 | 5.67E-06 |
| TETRACHLOROETHYLENE | 3.63E-05 | 1.00E-02 | 1.62E-06 | 1.62E-04 |
| TOLUENE | 5.78E-07 | 2.00E-01 | 2.59E-08 | 1.29E-07 |
| TRICHLOROETHYLENE | 5.50E-06 | 6.00E-03 | 2.46E-07 | 4.10E-05 |
| VANADIUM | 4.20E-06 | 7.00E-03 | 1.88E-07 | 2.68E-05 |
| VINYL CHLORIDE | 1.90E-05 | ND | 8.50E-07 | ND |
| | | | HAZARD INDEX = | 1.46E-02 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.7 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (6 yr)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-18
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE EMPLOYEE
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 9.24E-02 | 1.75E+00 | 6.33E-05 | 1.11E-04 |
| BERYLLIUM | 1.52E-03 | 4.30E+00 | 1.04E-06 | 4.48E-06 |
| BIS(2-CHLOROETHYL)ETHER | 6.83E-03 | 1.10E+00 | 4.68E-06 | 5.15E-06 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-03 | 1.40E-02 | 6.77E-06 | 9.47E-08 |
| CHROMIUM | 3.68E-01 | ND | 2.52E-04 | ND |
| 1,1-DICHLOROETHENE | 7.47E-03 | 6.00E-01 | 5.12E-06 | 3.07E-06 |
| LITHIUM | 1.30E+00 | ND | 8.90E-04 | ND |
| METHYLENE CHLORIDE | 1.26E-02 | 7.50E-03 | 8.63E-06 | 6.47E-08 |
| NICKEL | 7.22E-02 | ND | 4.95E-05 | ND |
| PHENOL | 8.88E-03 | ND | 6.08E-06 | ND |
| TETRACHLOROETHYLENE | 3.86E-01 | 5.20E-02 | 2.64E-04 | 1.37E-05 |
| TRICHLOROETHYLENE | 3.93E-02 | 1.10E-02 | 2.69E-05 | 2.96E-07 |
| VINYL CHLORIDE | 1.03E-01 | 1.90E+00 | 7.05E-05 | 1.34E-04 |
| | | | TOTAL CANCER RISK = | 2.72E-04 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ALUMINIUM | 1.24E+01 | 1.00E+00 | 8.49E-02 | 8.49E-02 |
| ARSENIC | 9.24E-02 | 3.00E-04 | 6.33E-04 | 2.11E+00 |
| BARIUM | 1.77E-01 | 7.00E-02 | 1.21E-03 | 1.73E-02 |
| BERYLLIUM | 1.52E-03 | 5.00E-03 | 1.04E-05 | 2.08E-03 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-03 | 2.00E-02 | 6.77E-05 | 3.38E-03 |
| BORON | 4.27E-01 | 9.00E-02 | 2.92E-03 | 3.25E-02 |
| CARBON DISULFIDE | 8.24E-03 | 1.00E-01 | 5.64E-05 | 5.64E-04 |
| CHROMIUM | 3.68E-01 | 5.00E-03 | 2.52E-03 | 5.04E-01 |
| COPPER | 1.57E-01 | 4.00E-02 | 1.08E-03 | 2.69E-02 |
| 1,1-DICHLOROETHENE | 7.47E-03 | 9.00E-03 | 5.12E-05 | 5.68E-03 |
| 1,2- DICHLOROETHENE | 1.10E-01 | 2.00E-02 | 7.53E-04 | 3.77E-02 |
| LITHIUM | 1.30E+00 | 2.00E-02 | 8.90E-03 | 4.45E-01 |
| MANGANESE | 2.63E+00 | 5.00E-03 | 1.80E-02 | 3.60E+00 |
| METHYLENE CHLORIDE | 1.26E-02 | 6.00E-02 | 8.63E-05 | 1.44E-03 |
| NICKEL | 7.22E-02 | 2.00E-02 | 4.95E-04 | 2.47E-02 |
| PHENOL | 8.88E-03 | 6.00E-01 | 6.08E-05 | 1.01E-04 |
| SELENIUM | 3.71E-03 | 5.00E-03 | 2.54E-05 | 5.08E-03 |
| TETRACHLOROETHYLENE | 3.86E-01 | 1.00E-02 | 2.64E-03 | 2.64E-01 |
| TOLUENE | 3.04E-03 | 2.00E-01 | 2.08E-05 | 1.04E-04 |
| 1,1,1-TRICHLOROETHANE | 7.70E-03 | 9.00E-02 | 5.27E-05 | 5.86E-04 |
| TRICHLOROETHYLENE | 3.93E-02 | 6.00E-03 | 2.69E-04 | 4.49E-02 |
| VANADIUM | 2.80E-02 | 7.00E-03 | 7.05E-04 | 1.01E-01 |
| VINYL CHLORIDE | 1.03E-01 | ND | 7.05E-04 | ND |
| | | | HAZARD INDEX = | 7.31E+00 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.7 l/d)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (7 yr)
BW = Body Weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-18A
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (ADULT)
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 9.24E-04 | 1.75E+00 | 2.28E-06 | 3.99E-06 |
| BERYLLIUM | 1.52E-05 | 4.30E+00 | 3.75E-08 | 1.61E-07 |
| BIS(2-CHLOROETHYL)ETHER | 6.83E-05 | 1.10E+00 | 1.68E-07 | 1.85E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-05 | 1.40E-02 | 2.44E-07 | 3.41E-09 |
| CHROMIUM | 3.68E-03 | ND | 9.07E-06 | ND |
| 1,1-DICHLOROETHENE | 7.47E-05 | 6.00E-01 | 1.84E-07 | 1.11E-07 |
| LITHIUM | 1.30E-02 | ND | 3.21E-05 | ND |
| METHYLENE CHLORIDE | 1.26E-04 | 7.50E-03 | 3.11E-07 | 2.33E-09 |
| NICKEL | 7.22E-04 | ND | 1.78E-06 | ND |
| PHENOL | 8.88E-05 | ND | 2.19E-07 | ND |
| TETRACHLOROETHYLENE | 3.86E-03 | 5.20E-02 | 9.52E-06 | 4.95E-07 |
| TRICHLOROETHYLENE | 3.93E-04 | 1.10E-02 | 9.69E-07 | 1.07E-08 |
| VINYL CHLORIDE | 1.03E-03 | 1.90E+00 | 2.54E-06 | 4.83E-06 |
| | | | TOTAL CANCER RISK = | 9.78E-06 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ALUMINIUM | 1.25E-01 | 1.00E+00 | 2.40E-03 | 2.40E-03 |
| ARSENIC | 9.24E-04 | 3.00E-04 | 1.77E-05 | 5.91E-02 |
| BARIUM | 1.77E-03 | 7.00E-02 | 3.39E-05 | 4.85E-04 |
| BERYLLIUM | 1.52E-05 | 5.00E-03 | 2.92E-07 | 5.83E-05 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-05 | 2.00E-02 | 1.89E-06 | 9.47E-05 |
| BORON | 4.27E-03 | 9.00E-02 | 8.19E-05 | 9.10E-04 |
| CARBON DISULFIDE | 8.24E-05 | 1.00E-01 | 1.58E-06 | 1.58E-05 |
| CHROMIUM | 3.68E-03 | 5.00E-03 | 7.06E-05 | 1.41E-02 |
| COPPER | 1.57E-03 | 4.00E-02 | 3.01E-05 | 7.53E-04 |
| 1,1-DICHLOROETHENE | 7.47E-05 | 9.00E-03 | 1.43E-06 | 1.59E-04 |
| 1,2- DICHLOROETHENE | 1.10E-03 | 2.00E-02 | 2.11E-05 | 1.05E-03 |
| LITHIUM | 1.30E-02 | 2.00E-02 | 2.49E-04 | 1.25E-02 |
| MANGANESE | 2.63E-02 | 5.00E-03 | 5.04E-04 | 1.01E-01 |
| METHYLENE CHLORIDE | 1.26E-04 | 6.00E-02 | 2.42E-06 | 4.03E-05 |
| NICKEL | 7.22E-04 | 2.00E-02 | 1.38E-05 | 6.92E-04 |
| PHENOL | 8.88E-05 | 6.00E-01 | 1.70E-06 | 2.84E-06 |
| SELENIUM | 3.71E-05 | 5.00E-03 | 7.12E-07 | 1.42E-04 |
| TETRACHLOROETHYLENE | 3.86E-03 | 1.00E-02 | 7.40E-05 | 7.40E-03 |
| TOLUENE | 3.04E-05 | 2.00E-01 | 5.83E-07 | 2.92E-06 |
| 1,1,1-TRICHLOROETHANE | 7.70E-05 | 9.00E-02 | 1.48E-06 | 1.64E-05 |
| TRICHLOROETHYLENE | 3.93E-04 | 6.00E-03 | 7.54E-06 | 1.26E-03 |
| VANADIUM | 2.80E-04 | 7.00E-03 | 5.37E-06 | 7.67E-04 |
| VINYL CHLORIDE | 1.03E-03 | ND | 1.98E-05 | ND |
| | | | HAZARD INDEX = | 2.03E-01 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (1.4 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (9 yr)
BW = Body Weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-18B
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (CHILD)
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 9.24E-04 | 1.75E+00 | 2.73E-06 | 4.78E-06 |
| BERYLLIUM | 1.52E-05 | 4.30E+00 | 4.50E-08 | 1.93E-07 |
| BIS(2-CHLOROETHYL)ETHER | 6.83E-05 | 1.10E+00 | 2.02E-07 | 2.22E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-05 | 1.40E-02 | 2.92E-07 | 4.09E-09 |
| CHROMIUM | 3.68E-03 | ND | 1.09E-05 | ND |
| 1,1-DICHLOROETHENE | 7.47E-05 | 6.00E-01 | 2.21E-07 | 1.33E-07 |
| LITHIUM | 1.30E-02 | ND | 3.85E-05 | ND |
| METHYLENE CHLORIDE | 1.26E-04 | 7.50E-03 | 3.73E-07 | 2.80E-09 |
| NICKEL | 7.22E-04 | ND | 2.14E-06 | ND |
| PHENOL | 8.80E-05 | ND | 2.60E-07 | ND |
| TETRACHLOROETHYLENE | 3.86E-03 | 5.20E-02 | 1.14E-05 | 5.94E-07 |
| TRICHLOROETHYLENE | 3.93E-04 | 1.10E-02 | 1.16E-06 | 1.28E-08 |
| VINYL CHLORIDE | 1.03E-03 | 1.90E+00 | 3.05E-06 | 5.79E-06 |
| | | | TOTAL CANCER RISK = | 1.17E-05 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ALUMINIUM | 1.24E-01 | 1.00E+00 | 4.28E-03 | 4.28E-03 |
| ARSENIC | 9.24E-04 | 3.00E-04 | 3.19E-05 | 1.06E-01 |
| BARIUM | 1.77E-03 | 7.00E-02 | 6.11E-05 | 8.73E-04 |
| BERYLLIUM | 1.52E-05 | 5.00E-03 | 5.25E-07 | 1.05E-04 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-05 | 2.00E-02 | 3.41E-06 | 1.71E-04 |
| BORON | 4.27E-03 | 9.00E-02 | 1.47E-04 | 1.64E-03 |
| CARBON DISULFIDE | 8.24E-05 | 1.00E-01 | 2.84E-06 | 2.84E-05 |
| CHROMIUM | 3.68E-03 | 5.00E-03 | 1.27E-04 | 2.54E-02 |
| COPPER | 1.57E-03 | 4.00E-02 | 5.42E-05 | 1.35E-03 |
| 1,1-DICHLOROETHENE | 7.47E-05 | 9.00E-03 | 2.58E-06 | 2.87E-04 |
| 1,2- DICHLOROETHENE | 1.10E-03 | 2.00E-02 | 3.80E-05 | 1.90E-03 |
| LITHIUM | 1.30E-02 | 2.00E-02 | 4.49E-04 | 2.24E-02 |
| MANGANESE | 2.63E-02 | 5.00E-03 | 9.08E-04 | 1.82E-01 |
| METHYLENE CHLORIDE | 1.26E-04 | 6.00E-02 | 4.35E-06 | 7.25E-05 |
| NICKEL | 7.22E-04 | 2.00E-02 | 2.49E-05 | 1.25E-03 |
| PHENOL | 8.88E-05 | 6.00E-01 | 3.07E-06 | 5.11E-06 |
| SELENIUM | 3.71E-05 | 5.00E-03 | 1.28E-06 | 2.56E-04 |
| TETRACHLOROETHYLENE | 3.86E-03 | 1.00E-02 | 1.33E-04 | 1.33E-02 |
| TOLUENE | 3.04E-05 | 2.00E-01 | 1.05E-06 | 5.25E-06 |
| 1,1,1-TRICHLOROETHANE | 7.70E-05 | 9.00E-02 | 2.66E-06 | 2.95E-05 |
| TRICHLOROETHYLENE | 3.93E-04 | 6.00E-03 | 1.36E-05 | 2.26E-03 |
| VANADIUM | 2.80E-04 | 7.00E-03 | 9.67E-06 | 1.38E-03 |
| VINYL CHLORIDE | 1.03E-03 | ND | 3.56E-05 | ND |
| | | | HAZARD INDEX = | 3.65E-01 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.54 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (6 yr)
BW = Body Weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-18C (D@1000')
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (ADULT)
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 8.24E-06 | 1.75E+00 | 2.28E-08 | 3.99E-08 |
| BERYLLIUM | 1.52E-07 | 4.30E+00 | 3.75E-10 | 1.61E-09 |
| BIS(2-CHLOROETHYL)ETHER | 6.83E-07 | 1.10E+00 | 1.68E-09 | 1.85E-09 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-07 | 1.40E-02 | 2.44E-09 | 3.41E-11 |
| CHROMIUM | 3.68E-05 | ND | 9.07E-08 | ND |
| 1,1-DICHLOROETHENE | 7.47E-07 | 6.00E-01 | 1.84E-09 | 1.11E-09 |
| LITHIUM | 1.30E-04 | ND | 3.21E-07 | ND |
| METHYLENE CHLORIDE | 1.26E-06 | 7.50E-03 | 3.11E-09 | 2.33E-11 |
| NICKEL | 7.22E-06 | ND | 1.78E-08 | ND |
| PHENOL | 8.80E-07 | ND | 2.17E-09 | ND |
| TETRACHLOROETHYLENE | 3.86E-05 | 5.20E-02 | 9.52E-08 | 4.95E-09 |
| TRICHLOROETHYLENE | 3.93E-06 | 1.10E-02 | 9.69E-09 | 1.07E-10 |
| VINYL CHLORIDE | 1.03E-05 | 1.90E+00 | 2.54E-08 | 4.83E-08 |
| | | | TOTAL CANCER RISK = | 9.78E-08 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ALUMINIUM | 1.24E-03 | 1.00E+00 | 2.38E-05 | 2.38E-05 |
| ARSENIC | 8.24E-06 | 3.00E-04 | 1.77E-07 | 5.91E-04 |
| BARIUM | 1.77E-05 | 7.00E-02 | 3.39E-07 | 4.85E-06 |
| BERYLLIUM | 1.52E-07 | 5.00E-03 | 2.92E-09 | 5.83E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-07 | 2.00E-02 | 1.89E-08 | 9.47E-07 |
| BORON | 4.27E-05 | 9.00E-02 | 8.19E-07 | 9.10E-06 |
| CARBON DISULFIDE | 8.24E-07 | 1.00E-01 | 1.58E-08 | 1.58E-07 |
| CHROMIUM | 3.68E-05 | 5.00E-03 | 7.06E-07 | 1.41E-04 |
| COPPER | 1.57E-05 | 4.00E-02 | 3.01E-07 | 7.53E-06 |
| 1,1-DICHLOROETHENE | 7.47E-07 | 9.00E-03 | 1.43E-08 | 1.59E-06 |
| 1,2- DICHLOROETHENE | 1.10E-05 | 2.00E-02 | 2.11E-07 | 1.05E-05 |
| LITHIUM | 1.30E-04 | 2.00E-02 | 2.49E-06 | 1.25E-04 |
| MANGANESE | 2.63E-04 | 5.00E-03 | 5.04E-06 | 1.01E-03 |
| METHYLENE CHLORIDE | 1.26E-06 | 6.00E-02 | 2.42E-08 | 4.03E-07 |
| NICKEL | 7.22E-06 | 2.00E-02 | 1.38E-07 | 6.92E-06 |
| PHENOL | 8.80E-07 | 6.00E-01 | 1.69E-08 | 2.81E-08 |
| SELENIUM | 3.71E-07 | 5.00E-03 | 7.12E-09 | 1.42E-06 |
| TETRACHLOROETHYLENE | 3.86E-05 | 1.00E-02 | 7.40E-07 | 7.40E-05 |
| TOLUENE | 3.04E-07 | 2.00E-01 | 5.83E-09 | 2.92E-08 |
| 1,1,1-TRICHLOROETHANE | 7.70E-07 | 9.00E-02 | 1.48E-08 | 1.64E-07 |
| TRICHLOROETHYLENE | 3.93E-06 | 6.00E-03 | 7.54E-08 | 1.26E-05 |
| VANADIUM | 2.80E-06 | 7.00E-03 | 5.37E-08 | 7.67E-06 |
| VINYL CHLORIDE | 1.03E-05 | ND | 1.98E-07 | ND |
| | | | HAZARD INDEX = | 2.03E-03 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (1.4 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (9 yr)
BW = Body Weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-18D (D@1000')
RISK FROM ALLUVIUM GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (CHILD)
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| ARSENIC | 9.24E-06 | 1.75E+00 | 2.73E-08 | 4.78E-08 |
| BERYLLIUM | 1.52E-07 | 4.30E+00 | 4.50E-10 | 1.93E-09 |
| BIS(2-CHLOROETHYL)ETHER | 6.83E-07 | 1.10E+00 | 2.02E-09 | 2.22E-09 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-07 | 1.40E-02 | 2.92E-09 | 4.09E-11 |
| CHROMIUM | 3.68E-05 | ND | 1.09E-07 | ND |
| 1,1-DICHLOROETHENE | 7.47E-07 | 6.00E-01 | 2.21E-09 | 1.33E-09 |
| LITHIUM | 1.30E-04 | ND | 3.85E-07 | ND |
| METHYLENE CHLORIDE | 1.26E-06 | 7.50E-03 | 3.73E-09 | 2.80E-11 |
| NICKEL | 7.22E-06 | ND | 2.14E-08 | ND |
| PHENOL | 8.80E-07 | ND | 2.60E-09 | ND |
| TETRACHLOROETHYLENE | 3.86E-05 | 5.20E-02 | 1.14E-07 | 5.94E-09 |
| TRICHLOROETHYLENE | 3.93E-06 | 1.10E-02 | 1.16E-08 | 1.28E-10 |
| VINYL CHLORIDE | 1.03E-05 | 1.90E+00 | 3.05E-08 | 5.79E-08 |
| | | | TOTAL CANCER RISK = | 1.17E-07 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| ALUMINIUM | 1.24E-03 | 1.00E+00 | 4.28E-05 | 4.28E-05 |
| ARSENIC | 9.24E-06 | 3.00E-04 | 3.19E-07 | 1.06E-03 |
| BARIUM | 1.77E-05 | 7.00E-02 | 6.11E-07 | 8.73E-06 |
| BERYLLIUM | 1.52E-07 | 5.00E-03 | 5.25E-09 | 1.05E-06 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 9.88E-07 | 2.00E-02 | 3.41E-08 | 1.71E-06 |
| BORON | 4.27E-05 | 9.00E-02 | 1.47E-06 | 1.64E-05 |
| CARBON DISULFIDE | 8.24E-07 | 1.00E-01 | 2.84E-08 | 2.84E-07 |
| CHROMIUM | 3.68E-05 | 5.00E-03 | 1.27E-06 | 2.54E-04 |
| COPPER | 1.57E-05 | 4.00E-02 | 5.42E-07 | 1.35E-05 |
| 1,1-DICHLOROETHENE | 7.47E-07 | 9.00E-03 | 2.58E-08 | 2.87E-06 |
| 1,2- DICHLOROETHENE | 1.10E-05 | 2.00E-02 | 3.80E-07 | 1.90E-05 |
| LITHIUM | 1.30E-04 | 2.00E-02 | 4.49E-06 | 2.24E-04 |
| MANGANESE | 2.63E-04 | 5.00E-03 | 9.08E-06 | 1.82E-03 |
| METHYLENE CHLORIDE | 1.26E-06 | 6.00E-02 | 4.35E-08 | 7.25E-07 |
| NICKEL | 7.22E-06 | 2.00E-02 | 2.49E-07 | 1.25E-05 |
| PHENOL | 8.80E-07 | 6.00E-01 | 3.04E-08 | 5.06E-08 |
| SELENIUM | 3.71E-07 | 5.00E-03 | 1.28E-08 | 2.56E-06 |
| TETRACHLOROETHYLENE | 3.86E-05 | 1.00E-02 | 1.33E-06 | 1.33E-04 |
| TOLUENE | 3.04E-07 | 2.00E-01 | 1.05E-08 | 5.25E-08 |
| 1,1,1-TRICHLOROETHANE | 7.70E-07 | 9.00E-02 | 2.66E-08 | 2.95E-07 |
| TRICHLOROETHYLENE | 3.93E-06 | 6.00E-03 | 1.36E-07 | 2.26E-05 |
| VANADIUM | 2.80E-06 | 7.00E-03 | 9.67E-08 | 1.38E-05 |
| VINYL CHLORIDE | 1.03E-07 | ND | 3.56E-09 | ND |
| | | | HAZARD INDEX = | 3.65E-03 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.54 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (6 yr)
BW = Body Weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-19
RISK FROM BEDROCK GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE EMPLOYEE
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 4.00E-02 | 2.00E-01 | 1.40E-04 | 2.80E-05 |
| 1,1-DICHLOROETHENE | 6.75E-03 | 6.00E-01 | 2.36E-05 | 1.42E-05 |
| ARSENIC | 9.06E-03 | 1.75E+00 | 3.17E-05 | 5.54E-05 |
| BENZENE | 1.43E-01 | 2.90E-02 | 4.98E-04 | 1.44E-05 |
| BIS(2-CHLOROETHYL)ETHER | 6.50E-02 | 1.10E+00 | 2.27E-04 | 2.50E-04 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-01 | 1.40E-02 | 1.15E-03 | 1.61E-05 |
| CHLOROFORM | 5.67E-03 | 6.10E-03 | 1.98E-05 | 1.21E-07 |
| LITHIUM | 5.49E+00 | ND | 1.92E-02 | ND |
| METHYLENE CHLORIDE | 3.20E-02 | 7.50E-03 | 1.12E-04 | 8.39E-07 |
| N-NITROSODIPHENYLAMINE | 4.00E-03 | 4.90E-03 | 1.40E-05 | 6.85E-08 |
| TETRACHLOROETHYLENE | 5.70E-01 | 5.20E-02 | 1.99E-03 | 1.04E-04 |
| TRICHLORCETHYLENE | 3.10E-02 | 1.10E-02 | 1.08E-04 | 1.19E-06 |
| VINYL CHLORIDE | 1.80E-01 | 1.90E+00 | 6.29E-04 | 1.20E-03 |
| | | | TOTAL CANCER RISK = | 1.68E-03 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 4.83E-02 | 9.00E-02 | 4.73E-04 | 5.25E-03 |
| 1,1-DICHLOROETHENE | 6.75E-03 | 9.00E-03 | 6.60E-05 | 7.34E-03 |
| 1,2- DICHLOROETHENE | 1.55E-01 | 2.00E-02 | 1.52E-03 | 7.60E-02 |
| ARSENIC | 9.06E-03 | 3.00E-04 | 8.86E-05 | 2.95E-01 |
| BENZENE | 1.43E-01 | ND | 1.39E-03 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-01 | 2.00E-02 | 3.23E-03 | 1.61E-01 |
| BORON | 8.36E-01 | 9.00E-02 | 8.20E-03 | 9.11E-02 |
| CARBON DISULFIDE | 3.44E-03 | 1.00E-01 | 3.37E-05 | 3.37E-04 |
| CHLOROFORM | 5.67E-03 | 1.00E-02 | 5.55E-05 | 5.55E-03 |
| ETHYLBENZENE | 5.63E-03 | 1.00E-01 | 5.50E-05 | 5.50E-04 |
| LITHIUM | 5.49E+00 | 2.00E-02 | 5.37E-02 | 2.68E+00 |
| MANGANESE | 1.02E+01 | 5.00E-03 | 9.98E-02 | 2.00E+01 |
| METHYLENE CHLORIDE | 3.20E-02 | 6.00E-02 | 3.13E-04 | 5.22E-03 |
| NAPHTHALENE | 1.50E-01 | 4.00E-02 | 1.47E-03 | 3.67E-02 |
| N-NITROSODIPHENYLAMINE | 4.00E-03 | 2.00E-02 | 3.91E-05 | 1.96E-03 |
| TETRACHLOROETHYLENE | 5.70E-01 | 1.00E-02 | 5.58E-03 | 5.58E-01 |
| TOLUENE | 1.64E-01 | 2.00E-01 | 1.61E-03 | 8.04E-03 |
| TRICHLOROETHYLENE | 3.10E-02 | 6.00E-03 | 3.03E-04 | 5.05E-02 |
| XYLENES | 1.80E+00 | 2.00E+00 | 1.76E-02 | 8.81E-03 |
| | | | HAZARD INDEX = | 2.40E+01 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (1.0 l/d)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (25 yr)
BW = Body weight (70 kg)
AF = *Averaging frequency (365 d/yr); and*
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-19A
RISK FROM BEDROCK GROUNDWATER INGESTION AT MSS
RECEPTOR: FUTURE RESIDENT (ADULT)
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 4.00E-04 | 2.00E-01 | 4.70E-06 | 9.39E-07 |
| 1,1-DICHLOROETHENE | 6.75E-05 | 6.00E-01 | 7.93E-07 | 4.76E-07 |
| ARSENIC | 9.06E-05 | 1.75E+00 | 1.06E-06 | 1.86E-06 |
| BENZENE | 1.43E-03 | 2.90E-02 | 1.68E-05 | 4.87E-07 |
| BIS(2-CHLOROETHYL)ETHER | 6.50E-04 | 1.10E+00 | 7.63E-06 | 8.40E-06 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-03 | 1.40E-02 | 3.87E-05 | 5.42E-07 |
| CHLOROFORM | 5.67E-05 | 6.10E-03 | 6.66E-07 | 4.06E-09 |
| LITHIUM | 5.49E-02 | ND | 6.45E-04 | ND |
| METHYLENE CHLORIDE | 3.20E-04 | 7.50E-03 | 3.76E-06 | 2.82E-08 |
| N-NITROSODIPHENYLAMINE | 4.00E-05 | 4.90E-03 | 4.70E-07 | 2.30E-09 |
| TETRACHLOROETHYLENE | 5.70E-03 | 5.20E-02 | 6.69E-05 | 3.48E-06 |
| TRICHLOROETHYLENE | 3.10E-04 | 1.10E-02 | 3.64E-06 | 4.00E-08 |
| VINYL CHLORIDE | 1.80E-03 | 1.90E+00 | 2.11E-05 | 4.02E-05 |
| | | | TOTAL CANCER RISK = | 5.64E-05 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 4.83E-04 | 9.00E-02 | 0.00E+00 | 0.00E+00 |
| 1,1-DICHLOROETHENE | 6.75E-05 | 9.00E-03 | 1.85E-06 | 2.05E-04 |
| 1,2- DICHLOROETHENE | 1.55E-03 | 2.00E-02 | 4.25E-05 | 2.12E-03 |
| ARSENIC | 9.06E-05 | 3.00E-04 | 2.48E-06 | 8.27E-03 |
| BENZENE | 1.43E-03 | ND | 3.92E-05 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-03 | 2.00E-02 | 9.04E-05 | 4.52E-03 |
| BORON | 8.38E-03 | 9.00E-02 | 2.30E-04 | 2.55E-03 |
| CARBON DISULFIDE | 3.44E-05 | 1.00E-01 | 9.42E-07 | 9.42E-06 |
| CHLOROFORM | 5.67E-05 | 1.00E-02 | 1.55E-06 | 1.55E-04 |
| ETHYLBENZENE | 5.63E-05 | 1.00E-01 | 1.54E-06 | 1.54E-05 |
| LITHIUM | 5.49E-02 | 2.00E-02 | 1.50E-03 | 7.52E-02 |
| MANGANESE | 1.02E-01 | 5.00E-03 | 2.79E-03 | 5.59E-01 |
| METHYLENE CHLORIDE | 3.20E-04 | 6.00E-02 | 8.77E-06 | 1.46E-04 |
| NAPHTHALENE | 1.50E-03 | 4.00E-02 | 4.11E-05 | 1.03E-03 |
| N-NITROSODIPHENYLAMINE | 4.00E-05 | 2.00E-02 | 1.10E-06 | 5.48E-05 |
| TETRACHLOROETHYLENE | 5.70E-03 | 1.00E-02 | 1.56E-04 | 1.56E-02 |
| TOLUENE | 1.64E-03 | 2.00E-01 | 4.49E-05 | 2.25E-04 |
| TRICHLOROETHYLENE | 3.10E-04 | 6.00E-03 | 8.49E-06 | 1.42E-03 |
| XYLENES | 1.80E-02 | 2.00E+00 | 4.93E-04 | 2.47E-04 |
| | | | HAZARD INDEX = | 6.71E-01 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (2.0 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (30 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-19B
RISK FROM BEDROCK GROUNDWATER INGESTION AT MSS
RECEPTOR: FUTURE RESIDENT (CHILD)
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 4.00E-04 | 2.00E-01 | 1.53E-06 | 3.07E-07 |
| 1,1-DICHLOROETHENE | 6.75E-05 | 6.00E-01 | 2.59E-07 | 1.55E-07 |
| ARSENIC | 9.06E-05 | 1.75E+00 | 3.48E-07 | 6.08E-07 |
| BENZENE | 1.43E-03 | 2.90E-02 | 5.48E-06 | 1.59E-07 |
| BIS(2-CHLOROETHYL)ETHER | 6.50E-04 | 1.10E+00 | 2.49E-06 | 2.74E-06 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-03 | 1.40E-02 | 1.27E-05 | 1.77E-07 |
| CHLOROFORM | 5.67E-05 | 6.10E-03 | 2.17E-07 | 1.33E-09 |
| LITHIUM | 5.49E-02 | ND | 2.11E-04 | ND |
| METHYLENE CHLORIDE | 3.20E-04 | 7.50E-03 | 1.23E-06 | 9.21E-09 |
| N-NITROSODIPHENYLAMINE | 4.00E-05 | 4.90E-03 | 1.53E-07 | 7.52E-10 |
| TETRACHLOROETHYLENE | 5.70E-03 | 5.20E-02 | 2.19E-05 | 1.14E-06 |
| TRICHLOROETHYLENE | 3.10E-04 | 1.10E-02 | 1.19E-06 | 1.31E-08 |
| VINYL CHLORIDE | 1.80E-03 | 1.90E+00 | 6.90E-06 | 1.31E-05 |
| | | | TOTAL CANCER RISK = | 1.84E-05 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 4.83E-04 | 9.00E-02 | 2.16E-05 | 2.40E-04 |
| 1,1-DICHLOROETHENE | 6.75E-05 | 9.00E-03 | 3.02E-06 | 3.36E-04 |
| 1,2- DICHLOROETHENE | 1.55E-03 | 2.00E-02 | 6.94E-05 | 3.47E-03 |
| ARSENIC | 9.06E-05 | 3.00E-04 | 4.05E-06 | 1.35E-02 |
| BENZENE | 1.43E-03 | ND | 6.40E-05 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-03 | 2.00E-02 | 1.48E-04 | 7.38E-03 |
| BORON | 8.38E-03 | 9.00E-02 | 3.75E-04 | 4.17E-03 |
| CARBON DISULFIDE | 3.44E-05 | 1.00E-01 | 1.54E-06 | 1.54E-05 |
| CHLOROFORM | 5.67E-05 | 1.00E-02 | 2.54E-06 | 2.54E-04 |
| ETHYLBENZENE | 5.63E-05 | 1.00E-01 | 2.52E-06 | 2.52E-05 |
| LITHIUM | 5.49E-02 | 2.00E-02 | 2.46E-03 | 1.23E-01 |
| MANGANESE | 1.02E-01 | 5.00E-03 | 4.56E-03 | 9.13E-01 |
| METHYLENE CHLORIDE | 3.20E-04 | 6.00E-02 | 1.43E-05 | 2.39E-04 |
| NAPHTHALENE | 1.50E-03 | 4.00E-02 | 6.71E-05 | 1.68E-03 |
| N-NITROSODIPHENYLAMINE | 4.00E-05 | 2.00E-02 | 1.79E-06 | 8.95E-05 |
| TETRACHLOROETHYLENE | 5.70E-03 | 1.00E-02 | 2.55E-04 | 2.55E-02 |
| TOLUENE | 1.64E-03 | 2.00E-01 | 7.34E-05 | 3.67E-04 |
| TRICHLOROETHYLENE | 3.10E-04 | 6.00E-03 | 1.39E-05 | 2.31E-03 |
| XYLENES | 1.80E-02 | 2.00E+00 | 8.05E-04 | 4.03E-04 |
| | | | HAZARD INDEX = | 1.10E+00 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.7 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (6 yr)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-19C (D@1000')
RISK FROM BEDROCK GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (ADULT)
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 4.00E-06 | 2.00E-01 | 4.70E-08 | 9.39E-09 |
| 1,1-DICHLOROETHENE | 6.75E-07 | 6.00E-01 | 7.93E-09 | 4.76E-09 |
| ARSENIC | 9.06E-07 | 1.75E+00 | 1.06E-08 | 1.86E-08 |
| BENZENE | 1.43E-05 | 2.90E-02 | 1.68E-07 | 4.87E-09 |
| BIS(2-CHLOROETHYL)ETHER | 6.50E-06 | 1.10E+00 | 7.63E-08 | 8.40E-08 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-05 | 1.40E-02 | 3.87E-07 | 5.42E-09 |
| CHLOROFORM | 5.67E-07 | 6.10E-03 | 6.66E-09 | 4.06E-11 |
| LITHIUM | 5.49E-04 | ND | 6.45E-06 | ND |
| METHYLENE CHLORIDE | 3.20E-06 | 7.50E-03 | 3.76E-08 | 2.82E-10 |
| N-NITROSODIPHENYLAMINE | 4.00E-07 | 4.90E-03 | 4.70E-09 | 2.30E-11 |
| TETRACHLOROETHYLENE | 5.70E-05 | 5.20E-02 | 6.69E-07 | 3.48E-08 |
| TRICHLOROETHYLENE | 3.10E-06 | 1.10E-02 | 3.64E-08 | 4.00E-10 |
| VINYL CHLORIDE | 1.80E-05 | 1.90E+00 | 2.11E-07 | 4.02E-07 |
| | | | TOTAL CANCER RISK = | 5.64E-07 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 4.83E-06 | 9.00E-02 | 1.32E-07 | 1.47E-06 |
| 1,1-DICHLOROETHENE | 6.75E-07 | 9.00E-03 | 1.85E-08 | 2.05E-06 |
| 1,2- DICHLOROETHENE | 1.55E-05 | 2.00E-02 | 4.25E-07 | 2.12E-05 |
| ARSENIC | 9.06E-07 | 3.00E-04 | 2.48E-08 | 8.27E-05 |
| BENZENE | 1.43E-05 | ND | 3.92E-07 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-05 | 2.00E-02 | 9.04E-07 | 4.52E-05 |
| BORON | 8.38E-05 | 9.00E-02 | 2.30E-06 | 2.55E-05 |
| CARBON DISULFIDE | 3.44E-07 | 1.00E-01 | 9.42E-09 | 9.42E-08 |
| CHLOROFORM | 5.67E-07 | 1.00E-02 | 1.55E-08 | 1.55E-06 |
| ETHYLBENZENE | 5.63E-07 | 1.00E-01 | 1.54E-08 | 1.54E-07 |
| LITHIUM | 5.49E-04 | 2.00E-02 | 1.50E-05 | 7.52E-04 |
| MANGANESE | 1.02E-03 | 5.00E-03 | 2.79E-05 | 5.59E-03 |
| METHYLENE CHLORIDE | 3.20E-06 | 6.00E-02 | 8.77E-08 | 1.46E-06 |
| NAPHTHALENE | 1.50E-05 | 4.00E-02 | 4.11E-07 | 1.03E-05 |
| N-NITROSODIPHENYLAMINE | 4.00E-07 | 2.00E-02 | 1.10E-08 | 5.48E-07 |
| TETRACHLOROETHYLENE | 5.70E-05 | 1.00E-02 | 1.56E-06 | 1.56E-04 |
| TOLUENE | 1.64E-05 | 2.00E-01 | 4.49E-07 | 2.25E-06 |
| TRICHLOROETHYLENE | 3.10E-06 | 6.00E-03 | 8.49E-08 | 1.42E-05 |
| XYLENES | 1.80E-04 | 2.00E+00 | 4.93E-06 | 2.47E-06 |
| | | | HAZARD INDEX = | 6.71E-03 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (2.0 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (30 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-19D (D@1000')
RISK FROM BEDROCK GROUNDWATER INGESTION AT MSS
RECEPTOR: FUTURE RESIDENT (CHILD)
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 4.00E-06 | 2.00E-01 | 1.53E-08 | 3.07E-09 |
| 1,1-DICHLOROETHENE | 6.75E-07 | 6.00E-01 | 2.59E-09 | 1.55E-09 |
| ARSENIC | 9.06E-07 | 1.75E+00 | 3.48E-09 | 6.08E-09 |
| BENZENE | 1.43E-05 | 2.90E-02 | 5.48E-08 | 1.59E-09 |
| BIS(2-CHLOROETHYL)ETHER | 6.50E-06 | 1.10E+00 | 2.49E-08 | 2.74E-08 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-05 | 1.40E-02 | 1.27E-07 | 1.77E-09 |
| CHLOROFORM | 5.67E-07 | 6.10E-03 | 2.17E-09 | 1.33E-11 |
| LITHIUM | 5.49E-04 | ND | 2.11E-06 | ND |
| METHYLENE CHLORIDE | 3.20E-06 | 7.50E-03 | 1.23E-08 | 9.21E-11 |
| N-NITROSODIPHENYLAMINE | 4.00E-07 | 4.90E-03 | 1.53E-09 | 7.52E-12 |
| TETRACHLOROETHYLENE | 5.70E-05 | 5.20E-02 | 2.19E-07 | 1.14E-08 |
| TRICHLOROETHYLENE | 3.10E-06 | 1.10E-02 | 1.19E-08 | 1.31E-10 |
| VINYL CHLORIDE | 1.80E-05 | 1.90E+00 | 6.90E-08 | 1.31E-07 |
| | | | TOTAL CANCER RISK = | 1.84E-07 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 4.83E-06 | 9.00E-02 | 2.16E-07 | 2.40E-06 |
| 1,1-DICHLOROETHENE | 6.75E-07 | 9.00E-03 | 3.02E-08 | 3.36E-06 |
| 1,2- DICHLOROETHENE | 1.55E-05 | 2.00E-02 | 6.94E-07 | 3.47E-05 |
| ARSENIC | 9.06E-07 | 3.00E-04 | 4.05E-08 | 1.35E-04 |
| BENZENE | 1.43E-05 | ND | 6.40E-07 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3.30E-05 | 2.00E-02 | 1.48E-06 | 7.38E-05 |
| BORON | 8.38E-05 | 9.00E-02 | 3.75E-06 | 4.17E-05 |
| CARBON DISULFIDE | 3.44E-07 | 1.00E-01 | 1.54E-08 | 1.54E-07 |
| CHLOROFORM | 5.67E-07 | 1.00E-02 | 2.54E-08 | 2.54E-06 |
| ETHYLBENZENE | 5.63E-07 | 1.00E-01 | 2.52E-08 | 2.52E-07 |
| LITHIUM | 5.49E-04 | 2.00E-02 | 2.46E-05 | 1.23E-03 |
| MANGANESE | 1.02E-03 | 5.00E-03 | 4.56E-05 | 9.13E-03 |
| METHYLENE CHLORIDE | 3.20E-06 | 6.00E-02 | 1.43E-07 | 2.39E-06 |
| NAPHTHALENE | 1.50E-05 | 4.00E-02 | 6.71E-07 | 1.68E-05 |
| N-NITROSODIPHENYLAMINE | 4.00E-07 | 2.00E-02 | 1.79E-08 | 8.95E-07 |
| TETRACHLOROETHYLENE | 5.70E-05 | 1.00E-02 | 2.55E-06 | 2.55E-04 |
| TOLUENE | 1.64E-05 | 2.00E-01 | 7.34E-07 | 3.67E-06 |
| TRICHLOROETHYLENE | 3.10E-06 | 6.00E-03 | 1.39E-07 | 2.31E-05 |
| XYLENES | 1.80E-04 | 2.00E+00 | 8.05E-06 | 4.03E-06 |
| | | | HAZARD INDEX = | 1.10E-02 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.7 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (6 yr)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-20
RISK FROM BEDROCK GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE EMPLOYEE
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 1.00E-02 | 2.00E-01 | 6.85E-06 | 1.37E-06 |
| 1,1-DICHLOROETHENE | 3.70E-03 | 6.00E-01 | 2.53E-06 | 1.52E-06 |
| ARSENIC | 6.19E-03 | 1.75E+00 | 4.24E-06 | 7.42E-06 |
| BENZENE | 3.57E-02 | 2.90E-02 | 2.45E-05 | 7.09E-07 |
| BIS(2-CHLOROETHYL)ETHER | 2.25E-02 | 1.10E+00 | 1.54E-05 | 1.70E-05 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-02 | 1.40E-02 | 2.97E-05 | 4.16E-07 |
| CHLOROFORM | 3.70E-03 | 6.10E-03 | 2.53E-06 | 1.55E-08 |
| LITHIUM | 2.20E+00 | ND | 1.51E-03 | ND |
| METHYLENE CHLORIDE | 4.53E-03 | 7.50E-03 | 3.10E-06 | 2.33E-08 |
| N-NITROSODIPHENYLAMINE | 4.00E-03 | 4.90E-03 | 2.74E-06 | 1.34E-08 |
| TETRACHLOROETHYLENE | 7.89E-02 | 5.20E-02 | 5.40E-05 | 2.81E-06 |
| TRICHLOROETHYLENE | 1.11E-02 | 1.10E-02 | 7.60E-06 | 8.36E-08 |
| VINYL CHLORIDE | 2.29E-02 | 1.90E+00 | 1.57E-05 | 2.98E-05 |
| | | | TOTAL CANCER RISK = | 6.11E-05 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 6.67E-03 | 9.00E-02 | 4.57E-05 | 5.08E-04 |
| 1,1-DICHLOROETHENE | 3.70E-03 | 9.00E-03 | 2.53E-05 | 2.82E-03 |
| 1,2- DICHLOROETHENE | 4.02E-02 | 2.00E-02 | 2.75E-04 | 1.38E-02 |
| ARSENIC | 6.19E-03 | 3.00E-04 | 4.24E-05 | 1.41E-01 |
| BENZENE | 3.57E-02 | ND | 2.45E-04 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-02 | 2.00E-02 | 2.97E-04 | 1.49E-02 |
| BORON | 5.62E-01 | 9.00E-02 | 3.85E-03 | 4.28E-02 |
| CARBON DISULFIDE | 3.01E-03 | 1.00E-01 | 2.06E-05 | 2.06E-04 |
| CHLOROFORM | 3.70E-03 | 1.00E-02 | 2.53E-05 | 2.53E-03 |
| ETHYLBENZENE | 5.84E-03 | 1.00E-01 | 4.00E-05 | 4.00E-04 |
| LITHIUM | 2.20E+00 | 2.00E-02 | 1.51E-02 | 7.53E-01 |
| MANGANESE | 4.85E+00 | 5.00E-03 | 3.32E-02 | 6.64E+00 |
| METHYLENE CHLORIDE | 4.53E-03 | 6.00E-02 | 3.10E-05 | 5.17E-04 |
| NAPHTHALENE | 2.95E-02 | 4.00E-02 | 2.02E-04 | 5.05E-03 |
| N-NITROSODIPHENYLAMINE | 4.00E-03 | 2.00E-02 | 2.74E-05 | 1.37E-03 |
| TETRACHLOROETHYLENE | 7.89E-02 | 1.00E-02 | 5.40E-04 | 5.40E-02 |
| TOLUENE | 3.52E-02 | 2.00E-01 | 2.41E-04 | 1.21E-03 |
| TRICHLOROETHYLENE | 1.11E-02 | 6.00E-03 | 7.60E-05 | 1.27E-02 |
| XYLENES | 2.76E-01 | 2.00E+00 | 1.89E-03 | 9.45E-04 |
| | | | HAZARD INDEX = | 7.69E+00 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.7 l/d)
EF = Exposure frequency (250 d/yr)
ED = Exposure duration (7 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-20A
RISK FROM BEDROCK GROUNDWATER INGESTION AT MSS
RECEPTOR: FUTURE RESIDENT (ADULT)
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 1.00E-04 | 2.00E-01 | 2.47E-07 | 4.93E-08 |
| 1,1-DICHLOROETHENE | 3.70E-05 | 6.00E-01 | 9.12E-08 | 5.47E-08 |
| ARSENIC | 6.19E-05 | 1.75E+00 | 1.53E-07 | 2.67E-07 |
| BENZENE | 3.57E-04 | 2.90E-02 | 8.80E-07 | 2.55E-08 |
| BIS(2-CHLOROETHYL)ETHER | 2.25E-04 | 1.10E+00 | 5.55E-07 | 6.10E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-04 | 1.40E-02 | 1.07E-06 | 1.50E-08 |
| CHLOROFORM | 3.70E-05 | 6.10E-03 | 9.12E-08 | 5.57E-10 |
| LITHIUM | 2.20E-02 | ND | 5.42E-05 | ND |
| METHYLENE CHLORIDE | 4.53E-05 | 7.50E-03 | 1.12E-07 | 8.38E-10 |
| N-NITROSODIPHENYLAMINE | 4.00E-05 | 4.90E-03 | 9.86E-08 | 4.83E-10 |
| TETRACHLOROETHYLENE | 7.89E-04 | 5.20E-02 | 1.95E-06 | 1.01E-07 |
| TRICHLOROETHYLENE | 1.11E-04 | 1.10E-02 | 2.74E-07 | 3.01E-09 |
| VINYL CHLORIDE | 2.29E-04 | 1.90E+00 | 5.65E-07 | 1.07E-06 |
| | | | TOTAL CANCER RISK = | 2.20E-06 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 6.67E-05 | 9.00E-02 | 1.28E-06 | 1.42E-05 |
| 1,1-DICHLOROETHENE | 3.70E-05 | 9.00E-03 | 7.10E-07 | 7.88E-05 |
| 1,2- DICHLOROETHENE | 4.02E-04 | 2.00E-02 | 7.71E-06 | 3.85E-04 |
| ARSENIC | 6.19E-05 | 3.00E-04 | 1.19E-06 | 3.96E-03 |
| BENZENE | 3.57E-04 | ND | 6.85E-06 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-04 | 2.00E-02 | 8.32E-06 | 4.16E-04 |
| BORON | 5.62E-03 | 9.00E-02 | 1.08E-04 | 1.20E-03 |
| CARBON DISULFIDE | 3.01E-05 | 1.00E-01 | 5.77E-07 | 5.77E-06 |
| CHLOROFORM | 3.70E-05 | 1.00E-02 | 7.10E-07 | 7.10E-05 |
| ETHYLBENZENE | 5.84E-05 | 1.00E-01 | 1.12E-06 | 1.12E-05 |
| LITHIUM | 2.20E-02 | 2.00E-02 | 4.22E-04 | 2.11E-02 |
| MANGANESE | 4.85E-02 | 5.00E-03 | 9.30E-04 | 1.86E-01 |
| METHYLENE CHLORIDE | 4.53E-05 | 6.00E-02 | 8.69E-07 | 1.45E-05 |
| NAPHTHALENE | 2.95E-04 | 4.00E-02 | 5.66E-06 | 1.41E-04 |
| N-NITROSODIPHENYLAMINE | 4.00E-05 | 2.00E-02 | 7.67E-07 | 3.84E-05 |
| TETRACHLOROETHYLENE | 7.89E-04 | 1.00E-02 | 1.51E-05 | 1.51E-03 |
| TOLUENE | 3.52E-04 | 2.00E-01 | 6.75E-06 | 3.38E-05 |
| TRICHLOROETHYLENE | 1.11E-04 | 6.00E-03 | 2.13E-06 | 3.55E-04 |
| XYLENES | 2.76E-03 | 2.00E+00 | 5.29E-05 | 2.65E-05 |
| | | | HAZARD INDEX = | 2.15E-01 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (1.4 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (9 yr)
BW = Body weight (70 kg)
AF = Averaging frequency (365 d/yr); and
AD = *Averaging duration, yr (equal to ED for noncarcinogens and 70* years for carcinogens)

TABLE E-20B
RISK FROM BEDROCK GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (CHILD)
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 1.00E-04 | 2.00E-01 | 2.96E-07 | 5.92E-08 |
| 1,1-DICHLOROETHENE | 3.70E-05 | 6.00E-01 | 1.09E-07 | 6.57E-08 |
| ARSENIC | 6.19E-05 | 1.75E+00 | 1.83E-07 | 3.21E-07 |
| BENZENE | 3.57E-04 | 2.90E-02 | 1.06E-06 | 3.06E-08 |
| BIS(2-CHLOROETHYL)ETHER | 2.25E-04 | 1.10E+00 | 6.66E-07 | 7.32E-07 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-04 | 1.40E-02 | 1.28E-06 | 1.80E-08 |
| CHLOROFORM | 3.70E-05 | 6.10E-03 | 1.09E-07 | 6.68E-10 |
| LITHIUM | 2.20E-02 | ND | 6.51E-05 | ND |
| METHYLENE CHLORIDE | 4.53E-05 | 7.50E-03 | 1.34E-07 | 1.01E-09 |
| N-NITROSODIPHENYLAMINE | 4.00E-05 | 4.90E-03 | 1.18E-07 | 5.80E-10 |
| TETRACHLOROETHYLENE | 7.89E-04 | 5.20E-02 | 2.33E-06 | 1.21E-07 |
| TRICHLOROETHYLENE | 1.11E-04 | 1.10E-02 | 3.28E-07 | 3.61E-09 |
| VINYL CHLORIDE | 2.29E-04 | 1.90E+00 | 6.78E-07 | 1.29E-06 |
| | | | TOTAL CANCER RISK = | 2.64E-06 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 6.67E-05 | 9.00E-02 | 2.30E-06 | 2.56E-05 |
| 1,1-DICHLOROETHENE | 3.70E-05 | 9.00E-03 | 1.28E-06 | 1.42E-04 |
| 1,2- DICHLOROETHENE | 4.02E-04 | 2.00E-02 | 1.39E-05 | 6.94E-04 |
| ARSENIC | 6.19E-05 | 3.00E-04 | 2.14E-06 | 7.12E-03 |
| BENZENE | 3.57E-04 | ND | 1.23E-05 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-04 | 2.00E-02 | 1.50E-05 | 7.49E-04 |
| BORON | 5.62E-03 | 9.00E-02 | 1.94E-04 | 2.16E-03 |
| CARBON DISULFIDE | 3.01E-05 | 1.00E-01 | 1.04E-06 | 1.04E-05 |
| CHLOROFORM | 3.70E-05 | 1.00E-02 | 1.28E-06 | 1.28E-04 |
| ETHYLBENZENE | 5.84E-05 | 1.00E-01 | 2.02E-06 | 2.02E-05 |
| LITHIUM | 2.20E-02 | 2.00E-02 | 7.59E-04 | 3.80E-02 |
| MANGANESE | 4.85E-02 | 5.00E-03 | 1.67E-03 | 3.35E-01 |
| METHYLENE CHLORIDE | 4.53E-05 | 6.00E-02 | 1.56E-06 | 2.61E-05 |
| NAPHTHALENE | 2.95E-04 | 4.00E-02 | 1.02E-05 | 2.55E-04 |
| N-NITROSODIPHENYLAMINE | 4.00E-05 | 2.00E-02 | 1.38E-06 | 6.90E-05 |
| TETRACHLOROETHYLENE | 7.89E-04 | 1.00E-02 | 2.72E-05 | 2.72E-03 |
| TOLUENE | 3.52E-04 | 2.00E-01 | 1.22E-05 | 6.08E-05 |
| TRICHLOROETHYLENE | 1.11E-04 | 6.00E-03 | 3.83E-06 | 6.39E-04 |
| XYLENES | 2.76E-03 | 2.00E+00 | 9.53E-05 | 4.76E-05 |
| | | | HAZARD INDEX = | 3.88E-01 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.5l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (6 yr)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-20C (D@1000')
RISK FROM BEDROCK GROUNDWATER INGESTION AT MSS
RECEPTOR: FUTURE RESIDENT (ADULT)
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 1.00E-06 | 2.00E-01 | 2.47E-09 | 4.93E-10 |
| 1,1-DICHLOROETHENE | 3.70E-07 | 6.00E-01 | 9.12E-10 | 5.47E-10 |
| ARSENIC | 6.19E-07 | 1.75E+00 | 1.53E-09 | 2.67E-09 |
| BENZENE | 3.57E-06 | 2.90E-02 | 8.80E-09 | 2.55E-10 |
| BIS(2-CHLOROETHYL)ETHER | 2.25E-06 | 1.10E+00 | 5.55E-09 | 6.10E-09 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-06 | 1.40E-02 | 1.07E-08 | 1.50E-10 |
| CHLOROFORM | 3.70E-07 | 6.10E-03 | 9.12E-10 | 5.57E-12 |
| LITHIUM | 2.20E-04 | ND | 5.42E-07 | ND |
| METHYLENE CHLORIDE | 4.53E-07 | 7.50E-03 | 1.12E-09 | 8.38E-12 |
| N-NITROSODIPHENYLAMINE | 4.00E-07 | 4.90E-03 | 9.86E-10 | 4.83E-12 |
| TETRACHLOROETHYLENE | 7.89E-06 | 5.20E-02 | 1.95E-08 | 1.01E-09 |
| TRICHLOROETHYLENE | 1.11E-06 | 1.10E-02 | 2.74E-09 | 3.01E-11 |
| VINYL CHLORIDE | 2.29E-06 | 1.90E+00 | 5.65E-09 | 1.07E-08 |
| | | | TOTAL CANCER RISK = | 2.20E-08 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 6.67E-07 | 9.00E-02 | 1.28E-08 | 1.42E-07 |
| 1,1-DICHLOROETHENE | 3.70E-07 | 9.00E-03 | 7.10E-09 | 7.88E-07 |
| 1,2- DICHLOROETHENE | 4.02E-06 | 2.00E-02 | 7.71E-08 | 3.85E-06 |
| ARSENIC | 6.19E-07 | 3.00E-04 | 1.19E-08 | 3.96E-05 |
| BENZENE | 3.57E-06 | ND | 6.85E-08 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-06 | 2.00E-02 | 8.32E-08 | 4.16E-06 |
| BORON | 5.62E-05 | 9.00E-02 | 1.08E-06 | 1.20E-05 |
| CARBON DISULFIDE | 3.01E-07 | 1.00E-01 | 5.77E-09 | 5.77E-08 |
| CHLOROFORM | 3.70E-07 | 1.00E-02 | 7.10E-09 | 7.10E-07 |
| ETHYLBENZENE | 5.84E-07 | 1.00E-01 | 1.12E-08 | 1.12E-07 |
| LITHIUM | 2.20E-04 | 2.00E-02 | 4.22E-06 | 2.11E-04 |
| MANGANESE | 4.85E-04 | 5.00E-03 | 9.30E-06 | 1.86E-03 |
| METHYLENE CHLORIDE | 4.53E-07 | 6.00E-02 | 8.69E-09 | 1.45E-07 |
| NAPHTHALENE | 2.95E-06 | 4.00E-02 | 5.66E-08 | 1.41E-06 |
| N-NITROSODIPHENYLAMINE | 4.00E-07 | 2.00E-02 | 7.67E-09 | 3.84E-07 |
| TETRACHLOROETHYLENE | 7.89E-06 | 1.00E-02 | 1.51E-07 | 1.51E-05 |
| TOLUENE | 3.52E-06 | 2.00E-01 | 6.75E-08 | 3.38E-07 |
| TRICHLOROETHYLENE | 1.11E-06 | 6.00E-03 | 2.13E-08 | 3.55E-06 |
| XYLENES | 2.76E-05 | 2.00E+00 | 5.29E-07 | 2.65E-07 |
| | | | HAZARD INDEX = | 2.15E-03 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (1.4 l/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (9 yr)
BW = Body weight (70 kg)
AF = *Averaging frequency* (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-20D (D@1000')
RISK FROM BEDROCK GROUNDWATER INGESTION AT MISS
RECEPTOR: FUTURE RESIDENT (CHILD)
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 1.00E-06 | 2.00E-01 | 2.96E-09 | 5.92E-10 |
| 1,1-DICHLOROETHENE | 3.70E-07 | 6.00E-01 | 1.09E-09 | 6.57E-10 |
| ARSENIC | 6.19E-07 | 1.75E+00 | 1.83E-09 | 3.21E-09 |
| BENZENE | 3.57E-06 | 2.90E-02 | 1.06E-08 | 3.06E-10 |
| BIS(2-CHLOROETHYL)ETHER | 2.25E-06 | 1.10E+00 | 6.66E-09 | 7.32E-09 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-06 | 1.40E-02 | 1.28E-08 | 1.80E-10 |
| CHLOROFORM | 3.70E-07 | 6.10E-03 | 1.09E-09 | 6.68E-12 |
| LITHIUM | 2.20E-04 | ND | 6.51E-07 | ND |
| METHYLENE CHLORIDE | 4.53E-07 | 7.50E-03 | 1.34E-09 | 1.01E-11 |
| N-NITROSODIPHENYLAMINE | 4.00E-07 | 4.90E-03 | 1.18E-09 | 5.80E-12 |
| TETRACHLOROETHYLENE | 7.89E-06 | 5.20E-02 | 2.33E-08 | 1.21E-09 |
| TRICHLOROETHYLENE | 1.11E-06 | 1.10E-02 | 3.28E-09 | 3.61E-11 |
| VINYL CHLORIDE | 2.29E-06 | 1.90E+00 | 6.78E-09 | 1.29E-08 |
| | | | TOTAL CANCER RISK = | 2.64E-08 |

| NONCARCINOGENS | GROUNDWATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | 6.67E-07 | 9.00E-02 | 2.30E-08 | 2.56E-07 |
| 1,1-DICHLOROETHENE | 3.70E-07 | 9.00E-03 | 1.28E-08 | 1.42E-06 |
| 1,2- DICHLOROETHENE | 4.02E-06 | 2.00E-02 | 1.39E-07 | 6.94E-06 |
| ARSENIC | 6.19E-07 | 3.00E-04 | 2.14E-08 | 7.12E-05 |
| BENZENE | 3.57E-06 | ND | 1.23E-07 | ND |
| BIS(2-ETHYLHEXYL)PHTHALATE | 4.34E-06 | 2.00E-02 | 1.50E-07 | 7.49E-06 |
| BORON | 5.62E-05 | 9.00E-02 | 1.94E-06 | 2.16E-05 |
| CARBON DISULFIDE | 3.01E-07 | 1.00E-01 | 1.04E-08 | 1.04E-07 |
| CHLOROFORM | 3.70E-07 | 1.00E-02 | 1.28E-08 | 1.28E-06 |
| ETHYLBENZENE | 5.84E-07 | 1.00E-01 | 2.02E-08 | 2.02E-07 |
| LITHIUM | 2.20E-04 | 2.00E-02 | 7.59E-06 | 3.80E-04 |
| MANGANESE | 4.85E-04 | 5.00E-03 | 1.67E-05 | 3.35E-03 |
| METHYLENE CHLORIDE | 4.53E-07 | 6.00E-02 | 1.56E-08 | 2.61E-07 |
| NAPHTHALENE | 2.95E-06 | 4.00E-02 | 1.02E-07 | 2.55E-06 |
| N-NITROSODIPHENYLAMINE | 4.00E-07 | 2.00E-02 | 1.38E-08 | 6.90E-07 |
| TETRACHLOROETHYLENE | 7.89E-06 | 1.00E-02 | 2.72E-07 | 2.72E-05 |
| TOLUENE | 3.52E-06 | 2.00E-01 | 1.22E-07 | 6.08E-07 |
| TRICHLOROETHYLENE | 1.11E-06 | 6.00E-03 | 3.83E-08 | 6.39E-06 |
| XYLENES | 2.76E-05 | 2.00E+00 | 9.53E-07 | 4.76E-07 |
| | | | HAZARD INDEX = | 3.88E-03 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times IR \times EF \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in groundwater (mg/l)
IR = Water ingestion rate (0.54/d)
EF = Exposure frequency (350 d/yr)
ED = Exposure duration (6 yr)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-21
RISK FROM SURFACE WATER INGESTION
RECEPTOR: CHILD WADING IN WESTERLY BROOK
USING: RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | SURFACE WATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 4.20E-02 | 2.00E-01 | 2.30E-07 | 4.60E-08 |
| ARSENIC | 3.19E-02 | 1.75E+00 | 1.75E-07 | 3.06E-07 |
| LITHIUM | 6.20E-01 | ND | 3.40E-06 | ND |
| TRICHLOROETHYLENE | 1.30E-02 | 1.10E-02 | 7.12E-08 | 7.84E-10 |
| | | | TOTAL CANCER RISK = | 3.53E-07 |

| NON-CARCINOGENS | SURFACE WATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,2- DICHLOROETHENE | 3.80E-02 | 2.00E-02 | 2.43E-06 | 1.21E-04 |
| ARSENIC | 3.19E-02 | 3.00E-04 | 2.04E-06 | 6.80E-03 |
| LITHIUM | 6.20E-01 | 2.00E-02 | 3.96E-05 | 1.98E-03 |
| TRICHLOROETHYLENE | 1.30E-02 | 6.00E-03 | 8.31E-07 | 1.39E-04 |
| | | | HAZARD INDEX = | 9.04E-03 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times CR \times EF \times ET \times ED)}{(BW \times AF \times AD)}$$

CW = UL95 chemical concentration in surface water (mg/l)
CR = Contact rate (0.05 l/hr)
EF = Exposure frequency (7 d/yr)
ED = Exposure duration (6 yr)
ET = Exposure time (1 hr/event)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-22
RISK FROM SURFACE WATER INGESTION
RECEPTOR: CHILD WADING IN WESTERLY BROOK
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | SURFACE WATER CONCENTRATION (mg/l) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg-d) | RISK |
|---|---|---|---|---|
| 1,1,2,2-TETRACHLOROETHANE | 4.20E-02 | 2.00E-01 | 2.30E-07 | 4.60E-08 |
| ARSENIC | 1.12E-02 | 1.75E+00 | 6.14E-08 | 1.07E-07 |
| LITHIUM | 3.41E-01 | ND | 1.87E-06 | ND |
| TRICHLOROETHENE | 1.30E-02 | 1.10E-02 | 7.12E-08 | 7.84E-10 |
| | | | TOTAL CANCER RISK = | 1.54E-07 |

| NON-CARCINOGENS | SURFACE WATER CONCENTRATION (mg/l) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| 1,2- DICHLOROETHENE | 3.80E-02 | 2.00E-02 | 2.43E-06 | 1.21E-04 |
| ARSENIC | 1.12E-02 | 3.00E-04 | 7.16E-07 | 2.39E-03 |
| LITHIUM | 3.41E-01 | 2.00E-02 | 2.18E-05 | 1.09E-03 |
| TRICHLOROETHENE | 1.30E-02 | 6.00E-03 | 8.31E-07 | 1.39E-04 |
| | | | HAZARD INDEX = | 3.74E-03 |

$$\text{Intake(mg/kg-d)} = \frac{(CW \times CR \times EF \times ET \times ED)}{(BW \times AF \times AD)}$$

CW = Mean chemical concentration in surface water (mg/l)
CR = Contact rate (0.05 l/hr)
EF = Exposure frequency (7 d/yr)
ED = Exposure duration (6 yr)
ET = Exposure time (1 hr/event)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-23
RISK FROM SEDIMENT INGESTION
RECEPTOR: CHILD WADING IN LODI BROOK
USING RME VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | SEDIMENT CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg/-d) | RISK |
|---|---|---|---|---|
| CHROMIUM | 6.69E+01 | ND | 1.47E-06 | ND |
| | | | TOTAL CANCER RISK = | ND |

| NONCARCINOGENS | SEDIMENT CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg/-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| CHROMIUM | 6.69E+01 | 5.00E-03 | 1.71E-05 | 3.42E-03 |
| MANGANESE | 3.16E+02 | 5.00E-03 | 8.08E-05 | 1.62E-02 |
| | | | HAZARD INDEX = | 1.96E-02 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AF \times AD}$$

CS = UL95 chemical concentration in sediment (mg/kg)
IR = Ingestion rate (200 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (7 d/yr)
ED = Exposure duration (6 yr)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

TABLE E-24
RISK FROM SEDIMENT INGESTION
RECEPTOR: CHILD WADING IN LODI BROOK
USING MEAN VALUES

CONTAMINANTS OF CONCERN

| CARCINOGENS | SEDIMENT CONCENTRATION (mg/kg) | ORAL SLOPE FACTOR (mg/kg/d)-1 | INTAKE (mg/kg/-d) | RISK |
|---|---|---|---|---|
| CHROMIUM | 3.63E+01 | ND | 3.98E-07 | ND |
| | | | TOTAL CANCER RISK = | ND |

| NONCARCINOGENS | SEDIMENT CONCENTRATION (mg/kg) | ORAL RfD (mg/kg/d) | INTAKE (mg/kg/-d) | HAZARD QUOTIENT |
|---|---|---|---|---|
| CHROMIUM | 3.63E+01 | 5.00E-03 | 4.64E-06 | 9.28E-04 |
| MANGANESE | 2.07E+02 | 5.00E-03 | 2.65E-05 | 5.30E-03 |
| | | | HAZARD INDEX = | 6.23E-03 |

$$\text{Intake(mg/kg-d)} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AF \times AD}$$

CS = Mean chemical concentration in sediment (mg/kg)
IR = Ingestion rate (100 mg/d)
FI = Fraction ingested from contaminated source (1)
CF = Conversion factor (10-6 kg/mg)
EF = Exposure frequency (7 d/yr)
ED = Exposure duration (6 yr)
BW = Body weight (15 kg)
AF = Averaging frequency (365 d/yr); and
AD = Averaging duration, yr (equal to ED for noncarcinogens and 70 years for carcinogens)

# APPENDIX F

## SAMPLE RESRAD OUTPUTS FOR MEAN PARAMETER AND RESIDENT SCENARIO

# Appendix F

## Sample RESRAD Outputs for Mean Parameters and Resident Scenario


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# APPENDIX F-1

# RADIOLOGICAL DOSE FROM SURFACE SOILS

Summary : Maywood residences, unit 1, mean resident surface, MFMAY1.001, EPA df
File : MFMAY1.001

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Summary : Maywood residences, unit 1, mean resident surface, MFMAY1.001, EPA df
File : MFMAY1.001

Dose Conversion Factor (and Related) Parameter Summary

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| A-1 | Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3): | | | |
| A-1 | Ac-227+D, soil density = 1.0 g/cm**3 | 2.760E+00 | 2.760E+00 | DCF1( 1,1) |
| A-1 | Ac-227+D, soil density = 1.8 g/cm**3 | 1.520E+00 | 1.520E+00 | DCF1( 1,2) |
| A-1 | | | | |
| A-1 | Pa-231 , soil density = 1.0 g/cm**3 | 2.210E-01 | 2.210E-01 | DCF1( 2,1) |
| A-1 | Pa-231 , soil density = 1.8 g/cm**3 | 1.210E-01 | 1.210E-01 | DCF1( 2,2) |
| A-1 | | | | |
| A-1 | Pb-210+D, soil density = 1.0 g/cm**3 | 4.870E-03 | 4.870E-03 | DCF1( 3,1) |
| A-1 | Pb-210+D, soil density = 1.8 g/cm**3 | 2.310E-03 | 2.310E-03 | DCF1( 3,2) |
| A-1 | | | | |
| A-1 | Ra-226+D, soil density = 1.0 g/cm**3 | 1.550E+01 | 1.550E+01 | DCF1( 4,1) |
| A-1 | Ra-226+D, soil density = 1.8 g/cm**3 | 8.560E+00 | 8.560E+00 | DCF1( 4,2) |
| A-1 | | | | |
| A-1 | Ra-228+D, soil density = 1.0 g/cm**3 | 8.180E+00 | 8.180E+00 | DCF1( 5,1) |
| A-1 | Ra-228+D, soil density = 1.8 g/cm**3 | 4.510E+00 | 4.510E+00 | DCF1( 5,2) |
| A-1 | | | | |
| A-1 | Th-228+D, soil density = 1.0 g/cm**3 | 1.330E+01 | 1.330E+01 | DCF1( 6,1) |
| A-1 | Th-228+D, soil density = 1.8 g/cm**3 | 7.360E+00 | 7.360E+00 | DCF1( 6,2) |
| A-1 | | | | |
| A-1 | Th-230 , soil density = 1.0 g/cm**3 | 2.110E-03 | 2.110E-03 | DCF1( 7,1) |
| A-1 | Th-230 , soil density = 1.8 g/cm**3 | 1.030E-03 | 1.030E-03 | DCF1( 7,2) |
| A-1 | | | | |
| A-1 | Th-232 , soil density = 1.0 g/cm**3 | 1.350E-03 | 1.350E-03 | DCF1( 8,1) |
| A-1 | Th-232 , soil density = 1.8 g/cm**3 | 6.040E-04 | 6.040E-04 | DCF1( 8,2) |
| A-1 | | | | |
| A-1 | U-234 , soil density = 1.0 g/cm**3 | 1.580E-03 | 1.580E-03 | DCF1( 9,1) |
| A-1 | U-234 , soil density = 1.8 g/cm**3 | 6.970E-04 | 6.970E-04 | DCF1( 9,2) |
| A-1 | | | | |
| A-1 | U-235+D , soil density = 1.0 g/cm**3 | 8.940E-01 | 8.940E-01 | DCF1(10,1) |
| A-1 | U-235+D , soil density = 1.8 g/cm**3 | 4.900E-01 | 4.900E-01 | DCF1(10,2) |
| A-1 | | | | |
| A-1 | U-238+D , soil density = 1.0 g/cm**3 | 1.270E-01 | 1.270E-01 | DCF1(11,1) |
| A-1 | U-238+D , soil density = 1.8 g/cm**3 | 6.970E-02 | 6.970E-02 | DCF1(11,2) |
| | | | | |
| A-3 | Depth factors, ground external gamma, dimensionless: | | | |
| A-3 | Ac-227+D, soil density = 1.0 g/cm**3, thickness = .15 m | 7.900E-01 | 7.900E-01 | FD( 1,1,1) |
| A-3 | Ac-227+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 9.700E-01 | 9.700E-01 | FD( 1,2,1) |
| A-3 | Ac-227+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 1,3,1) |
| A-3 | Ac-227+D, soil density = 1.8 g/cm**3, thickness = .15 m | 9.100E-01 | 9.100E-01 | FD( 1,1,2) |
| A-3 | Ac-227+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 1,2,2) |
| A-3 | Ac-227+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 1,3,2) |
| A-3 | | | | |
| A-3 | Pa-231 , soil density = 1.0 g/cm**3, thickness = .15 m | 7.900E-01 | 7.900E-01 | FD( 2,1,1) |
| A-3 | Pa-231 , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 2,2,1) |
| A-3 | Pa-231 , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 2,3,1) |
| A-3 | Pa-231 , soil density = 1.8 g/cm**3, thickness = .15 m | 9.200E-01 | 9.200E-01 | FD( 2,1,2) |
| A-3 | Pa-231 , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 2,2,2) |
| A-3 | Pa-231 , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 2,3,2) |
| A-3 | | | | |

Dose Conversion Factor (and Related) Parameter Summary (continued)

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| A-3 | Pb-210+D, soil density = 1.0 g/cm**3, thickness = .15 m | 8.800E-01 | 8.800E-01 | FD( 3,1,1) |
| A-3 | Pb-210+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 3,2,1) |
| A-3 | Pb-210+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 3,3,1) |
| A-3 | Pb-210+D, soil density = 1.8 g/cm**3, thickness = .15 m | 9.700E-01 | 9.700E-01 | FD( 3,1,2) |
| A-3 | Pb-210+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 3,2,2) |
| A-3 | Pb-210+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 3,3,2) |
| A-3 | | | | |
| A-3 | Ra-226+D, soil density = 1.0 g/cm**3, thickness = .15 m | 6.300E-01 | 6.300E-01 | FD( 4,1,1) |
| A-3 | Ra-226+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 9.200E-01 | 9.200E-01 | FD( 4,2,1) |
| A-3 | Ra-226+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 4,3,1) |
| A-3 | Ra-226+D, soil density = 1.8 g/cm**3, thickness = .15 m | 8.500E-01 | 8.500E-01 | FD( 4,1,2) |
| A-3 | Ra-226+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 4,2,2) |
| A-3 | Ra-226+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 4,3,2) |
| A-3 | | | | |
| A-3 | Ra-228+D, soil density = 1.0 g/cm**3, thickness = .15 m | 6.800E-01 | 6.800E-01 | FD( 5,1,1) |
| A-3 | Ra-228+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 9.700E-01 | 9.700E-01 | FD( 5,2,1) |
| A-3 | Ra-228+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 5,3,1) |
| A-3 | Ra-228+D, soil density = 1.8 g/cm**3, thickness = .15 m | 8.500E-01 | 8.500E-01 | FD( 5,1,2) |
| A-3 | Ra-228+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 5,2,2) |
| A-3 | Ra-228+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 5,3,2) |
| A-3 | | | | |
| A-3 | Th-228+D, soil density = 1.0 g/cm**3, thickness = .15 m | 6.100E-01 | 6.100E-01 | FD( 6,1,1) |
| A-3 | Th-228+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 9.400E-01 | 9.400E-01 | FD( 6,2,1) |
| A-3 | Th-228+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 6,3,1) |
| A-3 | Th-228+D, soil density = 1.8 g/cm**3, thickness = .15 m | 7.500E-01 | 7.500E-01 | FD( 6,1,2) |
| A-3 | Th-228+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 6,2,2) |
| A-3 | Th-228+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 6,3,2) |
| A-3 | | | | |
| A-3 | Th-230 , soil density = 1.0 g/cm**3, thickness = .15 m | 9.300E-01 | 9.300E-01 | FD( 7,1,1) |
| A-3 | Th-230 , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 7,2,1) |
| A-3 | Th-230 , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 7,3,1) |
| A-3 | Th-230 , soil density = 1.8 g/cm**3, thickness = .15 m | 1.000E+00 | 1.000E+00 | FD( 7,1,2) |
| A-3 | Th-230 , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 7,2,2) |
| A-3 | Th-230 , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 7,3,2) |
| A-3 | | | | |
| A-3 | Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m | 9.500E-01 | 9.500E-01 | FD( 8,1,1) |
| A-3 | Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 8,2,1) |
| A-3 | Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 8,3,1) |
| A-3 | Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m | 1.000E+00 | 1.000E+00 | FD( 8,1,2) |
| A-3 | Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 8,2,2) |
| A-3 | Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 8,3,2) |
| A-3 | | | | |
| A-3 | U-234 , soil density = 1.0 g/cm**3, thickness = .15 m | 9.000E-01 | 9.000E-01 | FD( 9,1,1) |
| A-3 | U-234 , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 9,2,1) |
| A-3 | U-234 , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 9,3,1) |
| A-3 | U-234 , soil density = 1.8 g/cm**3, thickness = .15 m | 1.000E+00 | 1.000E+00 | FD( 9,1,2) |
| A-3 | U-234 , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 9,2,2) |
| A-3 | U-234 , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 9,3,2) |
| A-3 | | | | |

Dose Conversion Factor (and Related) Parameter Summary (continued)

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| A-3 | U-235+D , soil density = 1.0 g/cm**3, thickness = .15 m | 8.700E-01 | 8.700E-01 | FD(10,1,1) |
| A-3 | U-235+D , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD(10,2,1) |
| A-3 | U-235+D , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD(10,3,1) |
| A-3 | U-235+D , soil density = 1.8 g/cm**3, thickness = .15 m | 1.000E+00 | 1.000E+00 | FD(10,1,2) |
| A-3 | U-235+D , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD(10,2,2) |
| A-3 | U-235+D , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD(10,3,2) |
| A-3 | | | | |
| A-3 | U-238+D , soil density = 1.0 g/cm**3, thickness = .15 m | 7.800E-01 | 7.800E-01 | FD(11,1,1) |
| A-3 | U-238+D , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD(11,2,1) |
| A-3 | U-238+D , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD(11,3,1) |
| A-3 | U-238+D , soil density = 1.8 g/cm**3, thickness = .15 m | 8.800E-01 | 8.800E-01 | FD(11,1,2) |
| A-3 | U-238+D , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD(11,2,2) |
| A-3 | U-238+D , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD(11,3,2) |
| | | | | |
| B-1 | Dose conversion factors for dust inhalation, mrem/pCi: | | | |
| B-1 | Ac-227+D | 6.700E+00 | 6.700E+00 | DCF2( 1) |
| B-1 | Pa-231 | 1.300E+00 | 1.300E+00 | DCF2( 2) |
| B-1 | Pb-210+D | 2.100E-02 | 2.100E-02 | DCF2( 3) |
| B-1 | Ra-226+D | 7.900E-03 | 7.900E-03 | DCF2( 4) |
| B-1 | Ra-228+D | 4.500E-03 | 4.500E-03 | DCF2( 5) |
| B-1 | Th-228+D | 3.100E-01 | 3.100E-01 | DCF2( 6) |
| B-1 | Th-230 | 3.200E-01 | 3.200E-01 | DCF2( 7) |
| B-1 | Th-232 | 1.600E+00 | 1.600E+00 | DCF2( 8) |
| B-1 | U-234 | 1.300E-01 | 1.300E-01 | DCF2( 9) |
| B-1 | U-235+D | 1.200E-01 | 1.200E-01 | DCF2(10) |
| B-1 | U-238+D | 1.200E-01 | 1.200E-01 | DCF2(11) |
| | | | | |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Ac-227+D | 1.500E-02 | 1.500E-02 | DCF3( 1) |
| D-1 | Pa-231 | 1.100E-02 | 1.100E-02 | DCF3( 2) |
| D-1 | Pb-210+D | 6.700E-03 | 6.700E-03 | DCF3( 3) |
| D-1 | Ra-226+D | 1.100E-03 | 1.100E-03 | DCF3( 4) |
| D-1 | Ra-228+D | 1.200E-03 | 1.200E-03 | DCF3( 5) |
| D-1 | Th-228+D | 7.500E-04 | 7.500E-04 | DCF3( 6) |
| D-1 | Th-230 | 5.300E-04 | 5.300E-04 | DCF3( 7) |
| D-1 | Th-232 | 2.800E-03 | 2.800E-03 | DCF3( 8) |
| D-1 | U-234 | 2.600E-04 | 2.600E-04 | DCF3( 9) |
| D-1 | U-235+D | 2.500E-04 | 2.500E-04 | DCF3(10) |
| D-1 | U-238+D | 2.500E-04 | 2.500E-04 | DCF3(11) |
| | | | | |
| D-34 | Food transfer factors: | | | |
| D-34 | Ac-227+D, plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 1,1) |
| D-34 | Ac-227+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 1,2) |
| D-34 | Ac-227+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 1,3) |
| D-34 | | | | |
| D-34 | Pa-231 , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 2,1) |
| D-34 | Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 2,2) |
| D-34 | Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 2,3) |
| D-34 | | | | |

Dose Conversion Factor (and Related) Parameter Summary (continued)

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| D-34 | Pb-210+D, plant/soil concentration ratio, dimensionless | 6.800E-02 | 6.800E-02 | RTF( 3,1) |
| D-34 | Pb-210+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 9.900E-04 | 9.900E-04 | RTF( 3,2) |
| D-34 | Pb-210+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 1.000E-05 | 1.000E-05 | RTF( 3,3) |
| D-34 | | | | |
| D-34 | Ra-226+D, plant/soil concentration ratio, dimensionless | 1.400E-03 | 1.400E-03 | RTF( 4,1) |
| D-34 | Ra-226+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 9.900E-04 | 9.900E-04 | RTF( 4,2) |
| D-34 | Ra-226+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-04 | 2.000E-04 | RTF( 4,3) |
| D-34 | | | | |
| D-34 | Ra-228+D, plant/soil concentration ratio, dimensionless | 1.400E-03 | 1.400E-03 | RTF( 5,1) |
| D-34 | Ra-228+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 9.900E-04 | 9.900E-04 | RTF( 5,2) |
| D-34 | Ra-228+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-04 | 2.000E-04 | RTF( 5,3) |
| D-34 | | | | |
| D-34 | Th-228+D, plant/soil concentration ratio, dimensionless | 4.200E-03 | 4.200E-03 | RTF( 6,1) |
| D-34 | Th-228+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 6,2) |
| D-34 | Th-228+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 6,3) |
| D-34 | | | | |
| D-34 | Th-230 , plant/soil concentration ratio, dimensionless | 4.200E-03 | 4.200E-03 | RTF( 7,1) |
| D-34 | Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 7,2) |
| D-34 | Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 7,3) |
| D-34 | | | | |
| D-34 | Th-232 , plant/soil concentration ratio, dimensionless | 4.200E-03 | 4.200E-03 | RTF( 8,1) |
| D-34 | Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 8,2) |
| D-34 | Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 8,3) |
| D-34 | | | | |
| D-34 | U-234 , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 9,1) |
| D-34 | U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 9,2) |
| D-34 | U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 9,3) |
| D-34 | | | | |
| D-34 | U-235+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(10,1) |
| D-34 | U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF(10,2) |
| D-34 | U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF(10,3) |
| D-34 | | | | |
| D-34 | U-238+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(11,1) |
| D-34 | U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF(11,2) |
| D-34 | U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF(11,3) |
| | | | | |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Ac-227+D, fish | 2.500E+01 | 2.500E+01 | BIOFAC( 1,1) |
| D-5 | Ac-227+D, crustacea and mollusks | 1.000E+03 | 1.000E+03 | BIOFAC( 1,2) |
| D-5 | | | | |
| D-5 | Pa-231 , fish | 1.100E+01 | 1.100E+01 | BIOFAC( 2,1) |
| D-5 | Pa-231 , crustacea and mollusks | 1.100E+02 | 1.100E+02 | BIOFAC( 2,2) |
| D-5 | | | | |
| D-5 | Pb-210+D, fish | 1.000E+02 | 1.000E+02 | BIOFAC( 3,1) |
| D-5 | Pb-210+D, crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 3,2) |
| D-5 | | | | |
| D-5 | Ra-226+D, fish | 5.000E+01 | 5.000E+01 | BIOFAC( 4,1) |
| D-5 | Ra-226+D, crustacea and mollusks | 2.500E+02 | 2.500E+02 | BIOFAC( 4,2) |
| D-5 | | | | |
| D-5 | Ra-228+D, fish | 5.000E+01 | 5.000E+01 | BIOFAC( 5,1) |
| D-5 | Ra-228+D, crustacea and mollusks | 2.500E+02 | 2.500E+02 | BIOFAC( 5,2) |

Dose Conversion Factor (and Related) Parameter Summary (continued)

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| D-5 | Th-228+D, fish | 3.000E+01 | 3.000E+01 | BIOFAC( 6,1) |
| D-5 | Th-228+D, crustacea and mollusks | 5.000E+02 | 5.000E+02 | BIOFAC( 6,2) |
| D-5 | | | | |
| D-5 | Th-230 , fish | 3.000E+01 | 3.000E+01 | BIOFAC( 7,1) |
| D-5 | Th-230 , crustacea and mollusks | 5.000E+02 | 5.000E+02 | BIOFAC( 7,2) |
| D-5 | | | | |
| D-5 | Th-232 , fish | 3.000E+01 | 3.000E+01 | BIOFAC( 8,1) |
| D-5 | Th-232 , crustacea and mollusks | 5.000E+02 | 5.000E+02 | BIOFAC( 8,2) |
| D-5 | | | | |
| D-5 | U-234 , fish | 2.000E+00 | 2.000E+00 | BIOFAC( 9,1) |
| D-5 | U-234 , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 9,2) |
| D-5 | | | | |
| D-5 | U-235+D , fish | 2.000E+00 | 2.000E+00 | BIOFAC(10,1) |
| D-5 | U-235+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC(10,2) |
| D-5 | | | | |
| D-5 | U-238+D , fish | 2.000E+00 | 2.000E+00 | BIOFAC(11,1) |
| D-5 | U-238+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC(11,2) |

Site-Specific Parameter Summary

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 8.000E+02 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 1.500E-01 | 1.000E+00 | --- | THICK0 |
| R011 | Length parallel to aquifer flow (m) | 1.000E+02 | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 1.000E+02 | 1.000E+02 | --- | BRLD |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 3.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 3.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 1.500E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 3.000E+02 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | 1.000E+03 | 3.000E+03 | --- | T( 9) |
| R011 | Times for calculations (yr) | 3.000E+03 | 1.000E+04 | --- | T(10) |
| R012 | Initial principal radionuclide (pCi/g): Ac-227 | 1.700E-01 | 0.000E+00 | --- | S( 1) |
| R012 | Initial principal radionuclide (pCi/g): Pa-231 | 1.700E-01 | 0.000E+00 | --- | S( 2) |
| R012 | Initial principal radionuclide (pCi/g): Pb-210 | 5.200E-01 | 0.000E+00 | --- | S( 3) |
| R012 | Initial principal radionuclide (pCi/g): Ra-226 | 5.200E-01 | 0.000E+00 | --- | S( 4) |
| R012 | Initial principal radionuclide (pCi/g): Ra-228 | 2.880E+00 | 0.000E+00 | --- | S( 5) |
| R012 | Initial principal radionuclide (pCi/g): Th-228 | 2.880E+00 | 0.000E+00 | --- | S( 6) |
| R012 | Initial principal radionuclide (pCi/g): Th-230 | 3.390E+00 | 0.000E+00 | --- | S( 7) |
| R012 | Initial principal radionuclide (pCi/g): Th-232 | 2.880E+00 | 0.000E+00 | --- | S( 8) |
| R012 | Initial principal radionuclide (pCi/g): U-234 | 3.390E+00 | 0.000E+00 | --- | S( 9) |
| R012 | Initial principal radionuclide (pCi/g): U-235 | 1.700E-01 | 0.000E+00 | --- | S(10) |
| R012 | Initial principal radionuclide (pCi/g): U-238 | 3.390E+00 | 0.000E+00 | --- | S(11) |
| R012 | Concentration in groundwater (pCi/L): Ac-227 | not used | 0.000E+00 | --- | W( 1) |
| R012 | Concentration in groundwater (pCi/L): Pa-231 | not used | 0.000E+00 | --- | W( 2) |
| R012 | Concentration in groundwater (pCi/L): Pb-210 | not used | 0.000E+00 | --- | W( 3) |
| R012 | Concentration in groundwater (pCi/L): Ra-226 | not used | 0.000E+00 | --- | W( 4) |
| R012 | Concentration in groundwater (pCi/L): Ra-228 | not used | 0.000E+00 | --- | W( 5) |
| R012 | Concentration in groundwater (pCi/L): Th-228 | not used | 0.000E+00 | --- | W( 6) |
| R012 | Concentration in groundwater (pCi/L): Th-230 | not used | 0.000E+00 | --- | W( 7) |
| R012 | Concentration in groundwater (pCi/L): Th-232 | not used | 0.000E+00 | --- | W( 8) |
| R012 | Concentration in groundwater (pCi/L): U-234 | not used | 0.000E+00 | --- | W( 9) |
| R012 | Concentration in groundwater (pCi/L): U-235 | not used | 0.000E+00 | --- | W(10) |
| R012 | Concentration in groundwater (pCi/L): U-238 | not used | 0.000E+00 | --- | W(11) |
| R013 | Cover depth (m) | 0.000E+00 | 0.000E+00 | --- | COVER0 |
| R013 | Density of cover material (g/cm**3) | not used | 1.600E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | not used | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.600E+00 | 1.600E+00 | --- | DENSCZ |
| R013 | Contaminated zone erosion rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VCZ |
| R013 | Contaminated zone total porosity | 4.500E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone effective porosity | 2.600E-01 | 2.000E-01 | --- | EPCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 1.230E+02 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 5.300E+00 | 5.300E+00 | --- | BCZ |
| R013 | Humidity in air (g/cm**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 4.600E-01 | 6.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 1.070E+00 | 1.000E+00 | --- | PRECIP |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R013 | Irrigation (m/yr) | 2.000E-02 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 2.500E-01 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | 5.575E+04 | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | 1.000E-03 | 1.000E-03 | --- | EPS |
| R014 | Density of saturated zone (g/cm**3) | 1.600E+00 | 1.600E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | 4.500E-01 | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | 2.600E-01 | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | 1.230E+02 | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | 1.000E-01 | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | 5.300E+00 | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | 1.000E-04 | 1.000E-03 | --- | VWT |
| R014 | Well pump intake depth (m below water table) | 1.000E+00 | 1.000E+01 | --- | DWIBWT |
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | ND | ND | --- | MODEL |
| R014 | Individual's use of groundwater (m**3/yr) | not used | 1.500E+02 | --- | UW |
| R015 | Number of unsaturated zone strata | 1 | 1 | --- | NS |
| R015 | Unsat. zone 1, thickness (m) | 1.000E-01 | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | 1.600E+00 | 1.600E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | 4.500E-01 | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | 2.600E-01 | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | 5.900E+00 | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | 1.230E+00 | 1.000E+02 | --- | HCUZ(1) |
| R016 | Distribution coefficients for Ac-227 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCACTC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCACTU( 1,1) |
| R016 | Saturated zone (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCACTS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 9.168E-02 | RLEACH( 1) |
| R016 | Distribution coefficients for Pa-231 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTU( 2,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.688E-02 | RLEACH( 2) |
| R016 | Distribution coefficients for Pb-210 | | | | |
| R016 | Contaminated zone (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCACTC( 3) |
| R016 | Unsaturated zone 1 (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCACTU( 3,1) |
| R016 | Saturated zone (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCACTS( 3) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 1.847E-02 | RLEACH( 3) |
| R016 | Distribution coefficients for Ra-226 | | | | |
| R016 | Contaminated zone (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTC( 4) |
| R016 | Unsaturated zone 1 (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTU( 4,1) |
| R016 | Saturated zone (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTS( 4) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.637E-02 | RLEACH( 4) |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R016 | Distribution coefficients for Ra-228 | | | | |
| R016 | Contaminated zone (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTC( 5) |
| R016 | Unsaturated zone 1 (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTU( 5,1) |
| R016 | Saturated zone (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTS( 5) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.637E-02 | RLEACH( 5) |
| R016 | Distribution coefficients for Th-228 | | | | |
| R016 | Contaminated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTC( 6) |
| R016 | Unsaturated zone 1 (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTU( 6,1) |
| R016 | Saturated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTS( 6) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.084E-05 | RLEACH( 6) |
| R016 | Distribution coefficients for Th-230 | | | | |
| R016 | Contaminated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTC( 7) |
| R016 | Unsaturated zone 1 (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTU( 7,1) |
| R016 | Saturated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTS( 7) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.084E-05 | RLEACH( 7) |
| R016 | Distribution coefficients for Th-232 | | | | |
| R016 | Contaminated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTC( 8) |
| R016 | Unsaturated zone 1 (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTU( 8,1) |
| R016 | Saturated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTS( 8) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.084E-05 | RLEACH( 8) |
| R016 | Distribution coefficients for U-234 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTC( 9) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTU( 9,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTS( 9) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.688E-02 | RLEACH( 9) |
| R016 | Distribution coefficients for U-235 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTC(10) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTU(10,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTS(10) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.688E-02 | RLEACH(10) |
| R016 | Distribution coefficients for U-238 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTC(11) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTU(11,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTS(11) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.688E-02 | RLEACH(11) |
| R017 | Inhalation rate (m**3/yr) | 5.430E+03 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 1.500E-05 | 2.000E-04 | --- | MLINH |
| R017 | Dilution length for airborne dust, inhalation (m) | 3.000E+00 | 3.000E+00 | --- | LM |
| R017 | Exposure duration | 9.000E+00 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 4.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 8.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 6.500E-01 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 2.000E-02 | 2.500E-01 | --- | FOTD |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R017 | Shape factor, external gamma | 1.000E+00 | 1.000E+00 | --- | FS1 |
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Outer annular radius (m) = √(1/π) | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Outer annular radius (m) = √(10/π) | not used | 1.000E+00 | --- | FRACA( 2) |
| R017 | Outer annular radius (m) = √(20/π) | not used | 1.000E+00 | --- | FRACA( 3) |
| R017 | Outer annular radius (m) = √(50/π) | not used | 1.000E+00 | --- | FRACA( 4) |
| R017 | Outer annular radius (m) = √(100/π) | not used | 1.000E+00 | --- | FRACA( 5) |
| R017 | Outer annular radius (m) = √(200/π) | not used | 1.000E+00 | --- | FRACA( 6) |
| R017 | Outer annular radius (m) = √(500/π) | not used | 1.000E+00 | --- | FRACA( 7) |
| R017 | Outer annular radius (m) = √(1000/π) | not used | 1.000E+00 | --- | FRACA( 8) |
| R017 | Outer annular radius (m) = √(5000/π) | not used | 1.000E+00 | --- | FRACA( 9) |
| R017 | Outer annular radius (m) = √(1.E+04/π) | not used | 1.000E+00 | --- | FRACA(10) |
| R017 | Outer annular radius (m) = √(1.E+05/π) | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Outer annular radius (m) = √(1.E+06/π) | not used | 0.000E+00 | --- | FRACA(12) |
| | | | | | |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | 1.350E+01 | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | 4.000E+00 | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | not used | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | not used | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | 0.000E+00 | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | 0.000E+00 | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 2.100E+01 | 3.650E+01 | --- | SOIL |
| R018 | Drinking water intake (L/yr) | 4.900E+02 | 5.100E+02 | --- | DWI |
| R018 | Fraction of drinking water from site | 1.000E-02 | 1.000E+00 | --- | FDW |
| R018 | Fraction of aquatic food from site | 1.000E-02 | 5.000E-01 | --- | FR9 |
| | | | | | |
| R019 | Livestock fodder intake for meat (kg/day) | not used | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | not used | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | not used | 5.000E+01 | --- | LWI5 |
| R019 | Livestock water intake for milk (L/day) | not used | 1.600E+02 | --- | LWI6 |
| R019 | Mass loading for foliar deposition (g/m**3) | 1.000E-04 | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | 9.000E-01 | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWDW |
| R019 | Livestock water fraction from ground water | not used | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWIR |
| | | | | | |
| R021 | Thickness of building foundation (m) | 1.500E-01 | 1.500E-01 | --- | FLOOR |
| R021 | Bulk density of building foundation (g/cm**3) | 2.400E+00 | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | not used | 4.000E-01 | --- | TPCV |
| R021 | Total porosity of the building foundation | 1.000E-01 | 1.000E-01 | --- | TPFL |
| R021 | Volumetric water content of the cover material | not used | 1.000E-01 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | 1.000E-02 | 5.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | not used | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | 2.000E-08 | 2.000E-08 | --- | DIFFL |
| R021 | in contaminated zone soil | 2.000E-06 | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | 2.000E+00 | 2.000E+00 | --- | HMIX |
| R021 | Average annual wind speed (m/sec) | 5.300E+00 | 2.000E+00 | --- | WIND |
| R021 | Average building air exchange rate (1/hr) | 2.000E+00 | 1.000E+00 | --- | REXG |
| R021 | Height of the building (room) (m) | 2.500E+00 | 2.500E+00 | --- | HRM |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R021 | Building interior area factor | 1.000E+00 | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | 1.000E+00 | 1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | 2.000E-01 | 2.000E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | 1.000E-01 | 1.000E-01 | --- | EMANA(2) |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation | active |
| 3 -- plant ingestion | active |
| 4 -- meat ingestion | suppressed |
| 5 -- milk ingestion | suppressed |
| 6 -- aquatic foods | active |
| 7 -- drinking water | active |
| 8 -- soil ingestion | active |
| 9 -- radon | active |

Summary : Maywood residences, unit 1, mean resident surface, MFMAY1.001, EPA df
File : MFMAY1.001

| Contaminated Zone Dimensions | |
|---|---|
| Area: | 800.00 square meters |
| Thickness: | 0.15 meters |
| Cover Depth: | 0.00 meters |

| Initial Soil Concentrations, pCi/g | |
|---|---|
| Ac-227 | 1.700E-01 |
| Pa-231 | 1.700E-01 |
| Pb-210 | 5.200E-01 |
| Ra-226 | 5.200E-01 |
| Ra-228 | 2.880E+00 |
| Th-228 | 2.880E+00 |
| Th-230 | 3.390E+00 |
| Th-232 | 2.880E+00 |
| U-234 | 3.390E+00 |
| U-235 | 1.700E-01 |
| U-238 | 3.390E+00 |

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 100 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

| t (years): | 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 1.500E+02 | 3.000E+02 | 1.000E+03 | 3.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| TDOSE(t): | 2.713E+01 | 2.665E+01 | 2.561E+01 | 2.267E+01 | 1.897E+01 | 9.842E+00 | 7.819E-02 | 3.967E-03 | 4.443E-05 | 1.862E-09 |
| M(t): | 2.713E-01 | 2.665E-01 | 2.561E-01 | 2.267E-01 | 1.897E-01 | 9.842E-02 | 7.819E-04 | 3.967E-05 | 4.443E-07 | 1.862E-11 |

Maximum TDOSE(t): 2.713E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 2.020E-01 | 0.0074 | 2.349E-02 | 0.0009 | 0.000E+00 | 0.0000 | 7.602E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.200E-02 | 0.0004 |
| Pa-231 | 1.624E-02 | 0.0006 | 4.557E-03 | 0.0002 | 0.000E+00 | 0.0000 | 5.575E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.796E-03 | 0.0003 |
| Pb-210 | 1.049E-03 | 0.0000 | 2.252E-04 | 0.0000 | 0.000E+00 | 0.0000 | 2.766E-01 | 0.0102 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.639E-02 | 0.0006 |
| Ra-226 | 3.141E+00 | 0.1158 | 8.470E-05 | 0.0000 | 6.188E-03 | 0.0002 | 9.711E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.691E-03 | 0.0001 |
| Ra-228 | 9.315E+00 | 0.3433 | 2.672E-04 | 0.0000 | 0.000E+00 | 0.0000 | 5.868E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.626E-02 | 0.0006 |
| Th-228 | 1.345E+01 | 0.4956 | 1.841E-02 | 0.0007 | 7.994E-02 | 0.0029 | 1.072E-02 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.016E-02 | 0.0004 |
| Th-230 | 3.141E-03 | 0.0001 | 2.237E-02 | 0.0008 | 0.000E+00 | 0.0000 | 8.920E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.452E-03 | 0.0003 |
| Th-232 | 1.607E-03 | 0.0001 | 9.501E-02 | 0.0035 | 0.000E+00 | 0.0000 | 4.003E-02 | 0.0015 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.793E-02 | 0.0014 |
| U-234 | 2.163E-03 | 0.0001 | 9.087E-03 | 0.0003 | 0.000E+00 | 0.0000 | 2.628E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.146E-03 | 0.0002 |
| U-235 | 7.168E-02 | 0.0026 | 4.206E-04 | 0.0000 | 0.000E+00 | 0.0000 | 1.267E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.999E-04 | 0.0000 |
| U-238 | 1.796E-01 | 0.0066 | 8.388E-03 | 0.0003 | 0.000E+00 | 0.0000 | 2.527E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.987E-03 | 0.0001 |
| Total | 2.638E+01 | 0.9723 | 1.823E-01 | 0.0067 | 8.613E-02 | 0.0032 | 3.616E-01 | 0.0133 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.210E-01 | 0.0045 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.451E-01 | 0.0090 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.517E-02 | 0.0013 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.943E-01 | 0.0108 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.151E+00 | 0.1161 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.337E+00 | 0.3441 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.357E+01 | 0.5000 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.288E-02 | 0.0016 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.746E-01 | 0.0064 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.802E-02 | 0.0007 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.243E-02 | 0.0027 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.945E-01 | 0.0072 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.713E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.782E-01 | 0.0067 | 2.062E-02 | 0.0008 | 0.000E+00 | 0.0000 | 6.673E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.053E-02 | 0.0004 |
| Pa-231 | 2.156E-02 | 0.0008 | 5.049E-03 | 0.0002 | 0.000E+00 | 0.0000 | 5.559E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.772E-03 | 0.0003 |
| Pb-210 | 9.977E-04 | 0.0000 | 2.128E-04 | 0.0000 | 0.000E+00 | 0.0000 | 2.615E-01 | 0.0098 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.549E-02 | 0.0006 |
| Ra-226 | 3.050E+00 | 0.1144 | 8.860E-05 | 0.0000 | 5.985E-03 | 0.0002 | 9.160E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.089E-03 | 0.0001 |
| Ra-228 | 1.179E+01 | 0.4425 | 5.376E-03 | 0.0002 | 2.250E-02 | 0.0008 | 8.031E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.679E-02 | 0.0006 |
| Th-228 | 9.328E+00 | 0.3500 | 1.273E-02 | 0.0005 | 5.564E-02 | 0.0021 | 7.414E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.025E-03 | 0.0003 |
| Th-230 | 1.187E-02 | 0.0004 | 2.222E-02 | 0.0008 | 1.713E-05 | 0.0000 | 8.874E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.403E-03 | 0.0003 |
| Th-232 | 1.289E+00 | 0.0484 | 9.474E-02 | 0.0036 | 1.475E-03 | 0.0001 | 4.061E-02 | 0.0015 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.967E-02 | 0.0015 |
| U-234 | 2.084E-03 | 0.0001 | 8.700E-03 | 0.0003 | 7.651E-11 | 0.0000 | 2.516E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.969E-03 | 0.0001 |
| U-235 | 6.903E-02 | 0.0026 | 4.028E-04 | 0.0000 | 0.000E+00 | 0.0000 | 1.214E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.916E-04 | 0.0000 |
| U-238 | 1.727E-01 | 0.0065 | 8.030E-03 | 0.0003 | 7.187E-17 | 0.0000 | 2.419E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.817E-03 | 0.0001 |
| Total | 2.592E+01 | 0.9724 | 1.782E-01 | 0.0067 | 8.561E-02 | 0.0032 | 3.529E-01 | 0.0132 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.177E-01 | 0.0044 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.160E-01 | 0.0081 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.094E-02 | 0.0015 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.782E-01 | 0.0104 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.068E+00 | 0.1151 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.185E+01 | 0.4445 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.411E+00 | 0.3531 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.138E-02 | 0.0019 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.465E+00 | 0.0550 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.727E-02 | 0.0006 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.975E-02 | 0.0026 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.870E-01 | 0.0070 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.665E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : Maywood residences, unit 1, mean resident surface, MFMAY1.001, EPA df
File : MFMAY1.001

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.386E-01 | 0.0054 | 1.589E-02 | 0.0006 | 0.000E+00 | 0.0000 | 5.142E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.114E-03 | 0.0003 |
| Pa-231 | 2.960E-02 | 0.0012 | 5.734E-03 | 0.0002 | 0.000E+00 | 0.0000 | 5.453E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.604E-03 | 0.0003 |
| Pb-210 | 9.015E-04 | 0.0000 | 1.902E-04 | 0.0000 | 0.000E+00 | 0.0000 | 2.336E-01 | 0.0091 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.384E-02 | 0.0005 |
| Ra-226 | 2.875E+00 | 0.1123 | 9.495E-05 | 0.0000 | 5.598E-03 | 0.0002 | 2.343E-02 | 0.0009 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.769E-03 | 0.0001 |
| Ra-228 | 1.281E+01 | 0.5003 | 9.467E-03 | 0.0004 | 4.120E-02 | 0.0016 | 9.119E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.539E-02 | 0.0006 |
| Th-228 | 4.489E+00 | 0.1753 | 6.083E-03 | 0.0002 | 2.696E-02 | 0.0011 | 3.544E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.358E-03 | 0.0001 |
| Th-230 | 2.850E-02 | 0.0011 | 2.192E-02 | 0.0009 | 4.938E-05 | 0.0000 | 8.847E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.309E-03 | 0.0003 |
| Th-232 | 4.309E+00 | 0.1683 | 9.536E-02 | 0.0037 | 9.661E-03 | 0.0004 | 4.218E-02 | 0.0016 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.303E-02 | 0.0017 |
| U-234 | 1.933E-03 | 0.0001 | 7.973E-03 | 0.0003 | 6.514E-10 | 0.0000 | 2.306E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.638E-03 | 0.0001 |
| U-235 | 6.402E-02 | 0.0025 | 3.694E-04 | 0.0000 | 0.000E+00 | 0.0000 | 1.115E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.759E-04 | 0.0000 |
| U-238 | 1.597E-01 | 0.0062 | 7.359E-03 | 0.0003 | 1.821E-15 | 0.0000 | 2.217E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.498E-03 | 0.0001 |
| Total | 2.491E+01 | 0.9726 | 1.704E-01 | 0.0067 | 8.346E-02 | 0.0033 | 3.360E-01 | 0.0131 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.117E-01 | 0.0044 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.677E-01 | 0.0066 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.939E-02 | 0.0019 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.486E-01 | 0.0097 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.908E+00 | 0.1135 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.289E+01 | 0.5032 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.529E+00 | 0.1768 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.762E-02 | 0.0026 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.499E+00 | 0.1757 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.585E-02 | 0.0006 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.468E-02 | 0.0025 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.728E-01 | 0.0067 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.561E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 5.749E-02 | 0.0025 | 6.370E-03 | 0.0003 | 0.000E+00 | 0.0000 | 2.062E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.254E-03 | 0.0[illegible] |
| Pa-231 | 4.018E-02 | 0.0018 | 6.174E-03 | 0.0003 | 0.000E+00 | 0.0000 | 4.644E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.328E-03 | 0.0[illegible] |
| Pb-210 | 6.317E-04 | 0.0000 | 1.280E-04 | 0.0000 | 0.000E+00 | 0.0000 | 1.573E-01 | 0.0069 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.319E-03 | 0.0004 |
| Ra-226 | 2.334E+00 | 0.1030 | 1.052E-04 | 0.0000 | 4.422E-03 | 0.0002 | 5.559E-02 | 0.0025 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.174E-03 | 0.0002 |
| Ra-228 | 6.535E+00 | 0.2883 | 5.944E-03 | 0.0003 | 2.739E-02 | 0.0012 | 4.692E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.748E-03 | 0.0[illegible] |
| Th-228 | 3.464E-01 | 0.0153 | 4.586E-04 | 0.0000 | 2.134E-03 | 0.0001 | 2.671E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.531E-04 | 0.0000 |
| Th-230 | 7.870E-02 | 0.0035 | 2.087E-02 | 0.0009 | 1.432E-04 | 0.0000 | 9.227E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.000E-03 | 0.0004 |
| Th-232 | 1.243E+01 | 0.5484 | 9.769E-02 | 0.0043 | 4.134E-02 | 0.0018 | 4.598E-02 | 0.0020 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.987E-02 | 0.0[illegible] |
| U-234 | 1.489E-03 | 0.0001 | 5.867E-03 | 0.0003 | 5.961E-09 | 0.0000 | 1.697E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.677E-03 | 0.0[illegible] |
| U-235 | 4.915E-02 | 0.0022 | 2.725E-04 | 0.0000 | 0.000E+00 | 0.0000 | 8.267E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.304E-04 | 0.0000 |
| U-238 | 1.213E-01 | 0.0054 | 5.414E-03 | 0.0002 | 5.402E-14 | 0.0000 | 1.631E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.573E-03 | 0.0[illegible] |
| Total | 2.199E+01 | 0.9704 | 1.493E-01 | 0.0066 | 7.543E-02 | 0.0033 | 2.832E-01 | 0.0125 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.533E-02 | 0.0042 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 5.206E-02 | 0.0023 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.798E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.260E-01 | 0.00[illegible] |
| Pa-231 | 1.037E-02 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.552E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.965E-02 | 0.003[illegible] |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.674E-01 | 0.0074 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.399E+00 | 0.10[illegible] |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.580E+00 | 0.29[illegible] |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.495E-01 | 0.0154 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.169E-01 | 0.00[illegible] |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.266E+01 | 0.5[illegible] |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.173E-02 | 0.0005 |
| U-235 | 8.695E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.013E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.964E-02 | 0.0022 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.309E-01 | 0.00[illegible] |
| Total | 6.243E-02 | 0.0028 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.753E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.267E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways

| Radio-Nuclide | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 4.601E-03 | 0.0002 | 4.612E-04 | 0.0000 | 0.000E+00 | 0.0000 | 1.493E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.356E-04 | 0.0000 |
| Pa-231 | 2.611E-02 | 0.0014 | 3.321E-03 | 0.0002 | 0.000E+00 | 0.0000 | 2.159E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.407E-03 | 0.0002 |
| Pb-210 | 2.268E-04 | 0.0000 | 4.073E-05 | 0.0000 | 0.000E+00 | 0.0000 | 5.004E-02 | 0.0026 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.965E-03 | 0.0002 |
| Ra-226 | 1.271E+00 | 0.0670 | 8.480E-05 | 0.0000 | 2.222E-03 | 0.0001 | 6.728E-02 | 0.0035 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.929E-03 | 0.0003 |
| Ra-228 | 3.488E-01 | 0.0184 | 3.056E-04 | 0.0000 | 1.644E-03 | 0.0001 | 2.340E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.267E-04 | 0.0000 |
| Th-228 | 2.266E-04 | 0.0000 | 2.800E-07 | 0.0000 | 1.520E-06 | 0.0000 | 1.631E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.545E-07 | 0.0000 |
| Th-230 | 1.683E-01 | 0.0089 | 1.788E-02 | 0.0009 | 2.888E-04 | 0.0000 | 1.144E-02 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.131E-03 | 0.0004 |
| Th-232 | 1.641E+01 | 0.8649 | 8.794E-02 | 0.0046 | 6.417E-02 | 0.0034 | 4.268E-02 | 0.0022 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.737E-02 | 0.0025 |
| U-234 | 7.137E-04 | 0.0000 | 2.407E-03 | 0.0001 | 3.088E-08 | 0.0000 | 6.968E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.098E-03 | 0.0001 |
| U-235 | 2.294E-02 | 0.0012 | 1.130E-04 | 0.0000 | 0.000E+00 | 0.0000 | 3.477E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.486E-05 | 0.0000 |
| U-238 | 5.467E-02 | 0.0029 | 2.220E-03 | 0.0001 | 7.720E-13 | 0.0000 | 6.687E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.055E-03 | 0.0001 |
| Total | 1.831E+01 | 0.9649 | 1.148E-01 | 0.0060 | 6.832E-02 | 0.0036 | 1.754E-01 | 0.0092 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.858E-02 | 0.0036 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

| Radio-Nuclide | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 9.481E-02 | 0.0050 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.738E-03 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.090E-01 | 0.0057 |
| Pa-231 | 8.753E-02 | 0.0046 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.066E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.306E-01 | 0.0069 |
| Pb-210 | 3.046E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.852E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.661E-02 | 0.0030 |
| Ra-226 | 7.803E-03 | 0.0004 | 0.000E+00 | 0.0000 | 5.403E-04 | 0.0000 | 7.257E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.355E+00 | 0.0714 |
| Ra-228 | 1.674E-03 | 0.0001 | 0.000E+00 | 0.0000 | 3.220E-12 | 0.0000 | 1.542E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.531E-01 | 0.0186 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.287E-04 | 0.0000 |
| Th-230 | 1.640E-04 | 0.0000 | 0.000E+00 | 0.0000 | 1.259E-05 | 0.0000 | 1.524E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.052E-01 | 0.0108 |
| Th-232 | 2.125E-03 | 0.0001 | 0.000E+00 | 0.0000 | 7.246E-12 | 0.0000 | 1.958E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.665E+01 | 0.8777 |
| U-234 | 1.079E-02 | 0.0006 | 0.000E+00 | 0.0000 | 2.738E-08 | 0.0000 | 9.947E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.670E-02 | 0.0009 |
| U-235 | 5.449E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.022E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.374E-02 | 0.0013 |
| U-238 | 1.038E-02 | 0.0005 | 0.000E+00 | 0.0000 | 9.487E-13 | 0.0000 | 9.565E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.995E-02 | 0.0037 |
| Total | 2.189E-01 | 0.0115 | 0.000E+00 | 0.0000 | 5.529E-04 | 0.0000 | 2.018E-02 | 0.0011 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.897E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 5.000E-07 | 0.0000 | 3.365E-08 | 0.0000 | 0.000E+00 | 0.0000 | 1.089E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.719E-08 | 0.[illegible]00 |
| Pa-231 | 1.306E-03 | 0.0001 | 1.099E-04 | 0.0000 | 0.000E+00 | 0.0000 | 6.971E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.100E-04 | 0.[illegible]00 |
| Pb-210 | 4.881E-06 | 0.0000 | 5.287E-07 | 0.0000 | 0.000E+00 | 0.0000 | 6.496E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.848E-05 | 0.0000 |
| Ra-226 | 1.112E-01 | 0.0113 | 8.242E-06 | 0.0000 | 1.424E-04 | 0.0000 | 7.770E-03 | 0.0008 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.205E-04 | 0.[illegible]01 |
| Ra-228 | 6.668E-06 | 0.0000 | 4.422E-09 | 0.0000 | 5.700E-08 | 0.0000 | 3.386E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.725E-09 | 0.[illegible]00 |
| Th-228 | 1.180E-15 | 0.0000 | 1.126E-18 | 0.0000 | 1.463E-17 | 0.0000 | 6.556E-19 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.213E-19 | 0.0000 |
| Th-230 | 1.611E-01 | 0.0164 | 7.433E-03 | 0.0008 | 2.033E-04 | 0.0000 | 8.217E-03 | 0.0008 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.203E-03 | 0.[illegible]03 |
| Th-232 | 9.248E+00 | 0.9396 | 3.667E-02 | 0.0037 | 6.525E-02 | 0.0066 | 1.783E-02 | 0.0018 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.981E-02 | 0.[illegible]20 |
| U-234 | 7.381E-05 | 0.0000 | 7.757E-05 | 0.0000 | 4.349E-08 | 0.0000 | 2.366E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.534E-05 | 0.[illegible]00 |
| U-235 | 1.265E-03 | 0.0001 | 3.725E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.199E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.892E-06 | 0.0000 |
| U-238 | 2.496E-03 | 0.0003 | 7.001E-05 | 0.0000 | 2.609E-12 | 0.0000 | 2.109E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.328E-05 | 0.[illegible]00 |
| Total | 9.525E+00 | 0.9678 | 4.437E-02 | 0.0045 | 6.559E-02 | 0.0067 | 3.458E-02 | 0.0035 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.375E-02 | 0.0024 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathway | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 8.125E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.488E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.930E-05 | 0.0[illegible]0 |
| Pa-231 | 4.916E-02 | 0.0050 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.531E-03 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.529E-02 | 0.0056 |
| Pb-210 | 7.396E-03 | 0.0008 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.924E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.782E-03 | 0.0009 |
| Ra-226 | 2.365E-02 | 0.0024 | 0.000E+00 | 0.0000 | 1.231E-03 | 0.0001 | 2.203E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.468E-01 | 0.0[illegible]9 |
| Ra-228 | 1.847E-03 | 0.0002 | 0.000E+00 | 0.0000 | 3.553E-12 | 0.0000 | 1.702E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.024E-03 | 0.0002 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.197E-15 | 0.0000 |
| Th-230 | 2.888E-03 | 0.0003 | 0.000E+00 | 0.0000 | 1.612E-04 | 0.0000 | 2.689E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.835E-01 | 0.0[illegible]5 |
| Th-232 | 1.312E-02 | 0.0013 | 0.000E+00 | 0.0000 | 3.845E-11 | 0.0000 | 1.209E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.402E+00 | 0.9[illegible]3 |
| U-234 | 1.808E-02 | 0.0018 | 0.000E+00 | 0.0000 | 7.053E-08 | 0.0000 | 1.667E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.996E-02 | 0.0020 |
| U-235 | 9.110E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.395E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.267E-03 | 0.0[illegible]2 |
| U-238 | 1.739E-02 | 0.0018 | 0.000E+00 | 0.0000 | 4.272E-12 | 0.0000 | 1.603E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.161E-02 | 0.0[illegible]2 |
| Total | 1.345E-01 | 0.0137 | 0.000E+00 | 0.0000 | 1.392E-03 | 0.0001 | 1.243E-02 | 0.0013 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.842E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+02 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 7.335E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.760E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.011E-08 | 0.0000 |
| Pa-231 | 8.349E-03 | 0.1068 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.695E-04 | 0.0098 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.119E-03 | 0.1166 |
| Pb-210 | 7.453E-03 | 0.0953 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.978E-04 | 0.0089 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.151E-03 | 0.1042 |
| Ra-226 | 2.482E-02 | 0.3174 | 0.000E+00 | 0.0000 | 1.269E-03 | 0.0162 | 2.312E-03 | 0.0296 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.840E-02 | 0.3632 |
| Ra-228 | 1.853E-03 | 0.0237 | 0.000E+00 | 0.0000 | 3.564E-12 | 0.0000 | 1.707E-04 | 0.0022 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.023E-03 | 0.0259 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 4.142E-03 | 0.0530 | 0.000E+00 | 0.0000 | 2.200E-04 | 0.0028 | 3.858E-04 | 0.0049 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.747E-03 | 0.0607 |
| Th-232 | 1.627E-02 | 0.2081 | 0.000E+00 | 0.0000 | 4.736E-11 | 0.0000 | 1.499E-03 | 0.0192 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.777E-02 | 0.2273 |
| U-234 | 3.629E-03 | 0.0464 | 0.000E+00 | 0.0000 | 8.383E-08 | 0.0000 | 3.345E-04 | 0.0043 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.964E-03 | 0.0507 |
| U-235 | 1.870E-04 | 0.0024 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.723E-05 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.042E-04 | 0.0026 |
| U-238 | 3.490E-03 | 0.0446 | 0.000E+00 | 0.0000 | 5.227E-12 | 0.0000 | 3.216E-04 | 0.0041 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.811E-03 | 0.0487 |
| Total | 7.020E-02 | 0.8977 | 0.000E+00 | 0.0000 | 1.489E-03 | 0.0190 | 6.509E-03 | 0.0832 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.819E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 1.168E-04 | 0.0294 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.094E-05 | 0.0028 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.277E-04 | 0.0322 |
| Ra-226 | 1.624E-03 | 0.4094 | 0.000E+00 | 0.0000 | 5.931E-07 | 0.0001 | 1.520E-04 | 0.0383 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.776E-03 | 0.4478 |
| Ra-228 | 1.221E-09 | 0.0000 | 0.000E+00 | 0.0000 | 2.737E-12 | 0.0000 | 1.125E-10 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.336E-09 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 1.372E-03 | 0.3459 | 0.000E+00 | 0.0000 | 4.350E-06 | 0.0011 | 1.284E-04 | 0.0324 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.505E-03 | 0.3795 |
| Th-232 | 5.094E-04 | 0.1284 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.693E-05 | 0.0118 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.564E-04 | 0.1403 |
| U-234 | 1.010E-06 | 0.0003 | 0.000E+00 | 0.0000 | 5.784E-08 | 0.0000 | 9.402E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.162E-06 | 0.0003 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 2.502E-11 | 0.0000 | 0.000E+00 | 0.0000 | 9.229E-13 | 0.0000 | 2.334E-12 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.828E-11 | 0.0000 |
| Total | 3.623E-03 | 0.9134 | 0.000E+00 | 0.0000 | 5.001E-06 | 0.0013 | 3.384E-04 | 0.0853 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.967E-03 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 3.767E-05 | 0.8478 | 0.000E+00 | 0.0000 | 1.640E-06 | 0.0369 | 3.512E-06 | 0.0790 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.282E-05 | 0.9637 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 1.393E-06 | 0.0314 | 0.000E+00 | 0.0000 | 8.813E-08 | 0.0020 | 1.296E-07 | 0.0029 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.611E-06 | 0.0363 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 2.704E-11 | 0.0000 | 0.000E+00 | 0.0000 | 2.084E-12 | 0.0000 | 2.513E-12 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.164E-11 | 0.0000 |
| Total | 3.906E-05 | 0.8791 | 0.000E+00 | 0.0000 | 1.729E-06 | 0.0389 | 3.642E-06 | 0.0820 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.443E-05 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+03 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathway | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 1.705E-09 | 0.9156 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.572E-10 | 0.0844 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.862E-09 | 1.0000 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 4.552E-14 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.197E-15 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.972E-14 | 0.0000 |
| Total | 1.705E-09 | 0.9156 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.572E-10 | 0.0844 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.862E-09 | 1.0000 |

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

| Parent (i) | Product (j) | Branch Fraction | DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 1.500E+02 | 3.000E+02 | 1.000E+03 | 3.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ac-227 | Ac-227 | 1.000E+00 | 1.442E+00 | 1.271E+00 | 9.867E-01 | 7.414E-01 | 6.412E-01 | 5.253E-04 | 4.713E-07 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Pa-231 | Pa-231 | 1.000E+00 | 2.069E-01 | 1.985E-01 | 1.827E-01 | 1.366E-01 | 2.059E-01 | 2.487E-01 | 4.939E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Pa-231 | Ac-227 | | 0.000E+00 | 4.233E-02 | 1.078E-01 | 2.731E-01 | 5.623E-01 | 7.657E-02 | 4.249E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Pa-231 | ΣDSR(j) | | 2.069E-01 | 2.408E-01 | 2.905E-01 | 4.097E-01 | 7.682E-01 | 3.252E-01 | 5.364E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Pb-210 | Pb-210 | 1.000E+00 | 5.659E-01 | 5.350E-01 | 4.780E-01 | 3.219E-01 | 1.089E-01 | 1.689E-02 | 1.568E-02 | 2.456E-04 | 0.000E+00 | 0.000E+00 |
| Ra-226 | Ra-226 | 1.000E+00 | 6.060E+00 | 5.884E+00 | 5.545E+00 | 4.502E+00 | 2.458E+00 | 2.322E-01 | 1.850E-02 | 8.646E-06 | 0.000E+00 | 0.000E+00 |
| Ra-226 | Pb-210 | | 0.000E+00 | 1.682E-02 | 4.613E-02 | 1.123E-01 | 1.466E-01 | 5.005E-02 | 3.613E-02 | 3.408E-03 | 0.000E+00 | 0.000E+00 |
| Ra-226 | ΣDSR(j) | | 6.060E+00 | 5.900E+00 | 5.591E+00 | 4.614E+00 | 2.605E+00 | 2.822E-01 | 5.462E-02 | 3.416E-03 | 0.000E+00 | 0.000E+00 |
| Ra-228 | Ra-228 | 1.000E+00 | 3.242E+00 | 2.792E+00 | 2.071E+00 | 7.269E-01 | 3.668E-02 | 7.011E-04 | 7.026E-04 | 5.166E-14 | 0.000E+00 | 0.000E+00 |
| Ra-228 | Th-228 | | 0.000E+00 | 1.321E+00 | 2.403E+00 | 1.558E+00 | 8.592E-02 | 1.619E-06 | 6.038E-10 | 4.638E-10 | 0.000E+00 | 0.000E+00 |
| Ra-228 | ΣDSR(j) | | 3.242E+00 | 4.114E+00 | 4.474E+00 | 2.285E+00 | 1.226E-01 | 7.027E-04 | 7.026E-04 | 4.638E-10 | 0.000E+00 | 0.000E+00 |
| Th-228 | Th-228 | 1.000E+00 | 4.711E+00 | 3.268E+00 | 1.572E+00 | 1.214E-01 | 7.941E-05 | 4.155E-16 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Th-230 | Th-230 | 1.000E+00 | 1.265E-02 | 1.257E-02 | 1.241E-02 | 1.186E-02 | 1.027E-02 | 4.587E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Th-230 | Ra-226 | | 0.000E+00 | 2.583E-03 | 7.504E-03 | 2.236E-02 | 4.889E-02 | 4.727E-02 | 4.919E-04 | 9.727E-06 | 3.668E-06 | 0.000E+00 |
| Th-230 | Pb-210 | | 0.000E+00 | 3.690E-06 | 3.115E-05 | 2.772E-04 | 1.368E-03 | 2.263E-03 | 9.085E-04 | 4.342E-04 | 8.964E-06 | 0.000E+00 |
| Th-230 | ΣDSR(j) | | 1.265E-02 | 1.516E-02 | 1.995E-02 | 3.450E-02 | 6.053E-02 | 5.413E-02 | 1.400E-03 | 4.439E-04 | 1.263E-05 | 0.000E+00 |
| Th-232 | Th-232 | 1.000E+00 | 6.062E-02 | 6.022E-02 | 5.941E-02 | 5.660E-02 | 4.855E-02 | 2.039E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Th-232 | Ra-228 | | 0.000E+00 | 3.619E-01 | 9.392E-01 | 1.989E+00 | 2.381E+00 | 1.392E+00 | 6.170E-03 | 1.932E-04 | 0.000E+00 | 0.000E+00 |
| Th-232 | Th-228 | | 0.000E+00 | 8.661E-02 | 5.635E-01 | 2.352E+00 | 3.353E+00 | 1.853E+00 | 8.025E-09 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Th-232 | ΣDSR(j) | | 6.062E-02 | 5.087E-01 | 1.562E+00 | 4.397E+00 | 5.782E+00 | 3.265E+00 | 6.171E-03 | 1.932E-04 | 0.000E+00 | 0.000E+00 |
| U-234 | U-234 | 1.000E+00 | 5.317E-03 | 5.094E-03 | 4.675E-03 | 3.458E-03 | 4.920E-03 | 5.877E-03 | 1.169E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| U-234 | Th-230 | | 0.000E+00 | 1.111E-07 | 3.173E-07 | 8.929E-07 | 1.679E-06 | 1.093E-06 | 1.874E-10 | 1.407E-10 | 2.340E-10 | 5.493E-10 |
| U-234 | Ra-226 | | 0.000E+00 | 1.154E-08 | 9.898E-08 | 9.308E-07 | 5.286E-06 | 1.019E-05 | 1.875E-07 | 1.293E-07 | 1.971E-07 | 0.000E+00 |
| U-234 | Pb-210 | | 0.000E+00 | 1.104E-11 | 2.780E-10 | 8.068E-09 | 1.590E-07 | 4.991E-07 | 2.379E-07 | 2.132E-07 | 2.779E-07 | 0.000E+00 |
| U-234 | ΣDSR(j) | | 5.317E-03 | 5.094E-03 | 4.675E-03 | 3.460E-03 | 4.927E-03 | 5.888E-03 | 1.169E-03 | 3.427E-07 | 4.752E-07 | 5.493E-10 |
| U-235 | U-235 | 1.000E+00 | 4.260E-01 | 4.103E-01 | 3.804E-01 | 2.919E-01 | 1.394E-01 | 1.307E-02 | 1.124E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| U-235 | Pa-231 | | 0.000E+00 | 4.195E-06 | 1.158E-05 | 2.887E-05 | 9.590E-05 | 1.656E-04 | 6.761E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| U-235 | Ac-227 | | 0.000E+00 | 4.537E-07 | 3.566E-06 | 3.052E-05 | 1.633E-04 | 1.027E-04 | 9.734E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| U-235 | ΣDSR(j) | | 4.260E-01 | 4.103E-01 | 3.805E-01 | 2.920E-01 | 1.396E-01 | 1.334E-02 | 1.201E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| U-238 | U-238 | 1.000E+00 | 5.738E-02 | 5.516E-02 | 5.098E-02 | 3.863E-02 | 2.063E-02 | 6.375E-03 | 1.124E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| U-238 | U-234 | | 0.000E+00 | 1.441E-08 | 3.968E-08 | 9.784E-08 | 3.079E-07 | 5.229E-07 | 2.141E-07 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| U-238 | Th-230 | | 0.000E+00 | 1.562E-13 | 1.322E-12 | 1.186E-11 | 5.839E-11 | 7.598E-11 | 1.295E-14 | 1.146E-15 | 2.598E-15 | 1.467E-14 |
| U-238 | Ra-226 | | 0.000E+00 | 1.084E-14 | 2.767E-13 | 8.435E-12 | 1.327E-10 | 6.115E-10 | 1.169E-11 | 2.064E-12 | 4.661E-12 | 0.000E+00 |
| U-238 | Pb-210 | | 0.000E+00 | 7.795E-18 | 5.868E-16 | 5.604E-14 | 3.627E-12 | 2.676E-11 | 1.319E-11 | 6.278E-12 | 4.669E-12 | 0.000E+00 |
| U-238 | ΣDSR(j) | | 5.738E-02 | 5.516E-02 | 5.098E-02 | 3.863E-02 | 2.063E-02 | 6.376E-03 | 1.124E-03 | 8.343E-12 | 9.333E-12 | 1.467E-14 |

The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Summary : Maywood residences, unit 1, mean resident surface, MFMAY1.001, EPA df
File : MFMAY1.001

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 100 mrem/yr

| Nuclide (i) | t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 1.500E+02 | 3.000E+02 | 1.000E+03 | 3.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ac-227 | 6.936E+01 | 7.871E+01 | 1.013E+02 | 1.349E+02 | 1.560E+02 | 1.904E+05 | 2.122E+08 | *7.244E+13 | *7.244E+13 | *7.244E+1 |
| Pa-231 | 4.834E+02 | 4.152E+02 | 3.442E+02 | 2.441E+02 | 1.302E+02 | 3.075E+02 | 1.864E+03 | *4.716E+10 | *4.716E+10 | *4.716E+10 |
| Pb-210 | 1.767E+02 | 1.869E+02 | 2.092E+02 | 3.107E+02 | 9.186E+02 | 5.921E+03 | 6.379E+03 | 4.071E+05 | *7.631E+13 | *7.631E+13 |
| Ra-226 | 1.650E+01 | 1.695E+01 | 1.788E+01 | 2.167E+01 | 3.839E+01 | 3.543E+02 | 1.831E+03 | 2.927E+04 | *9.882E+11 | *9.882E+1 |
| Ra-228 | 3.085E+01 | 2.431E+01 | 2.235E+01 | 4.377E+01 | 8.156E+02 | 1.423E+05 | 1.423E+05 | 2.156E+11 | *2.721E+14 | *2.721E+1 |
| Th-228 | 2.123E+01 | 3.060E+01 | 6.360E+01 | 8.240E+02 | 1.259E+06 | *8.192E+14 | *8.192E+14 | *8.192E+14 | *8.192E+14 | *8.192E+14 |
| Th-230 | 7.906E+03 | 6.598E+03 | 5.013E+03 | 2.899E+03 | 1.652E+03 | 1.848E+03 | 7.141E+04 | 2.253E+05 | 7.917E+06 | *2.018E+1 |
| Th-232 | 1.650E+03 | 1.966E+02 | 6.402E+01 | 2.274E+01 | 1.729E+01 | 3.063E+01 | 1.621E+04 | *1.092E+05 | *1.092E+05 | *1.092E+0 |
| U-234 | 1.881E+04 | 1.963E+04 | 2.139E+04 | 2.890E+04 | 2.029E+04 | 1.698E+04 | 8.553E+04 | 2.918E+08 | 2.105E+08 | *6.233E+09 |
| U-235 | 2.347E+02 | 2.437E+02 | 2.628E+02 | 3.425E+02 | 7.162E+02 | 7.499E+03 | 8.324E+04 | *2.160E+06 | *2.160E+06 | *2.160E+0 |
| U-238 | 1.743E+03 | 1.813E+03 | 1.962E+03 | 2.589E+03 | 4.847E+03 | 1.568E+04 | 8.895E+04 | *3.360E+05 | *3.360E+05 | *3.360E+0 |

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

| Nuclide (i) | Initial pCi/g | tmin (years) | DSR(i,tmin) | G(i,tmin) (pCi/g) | DSR(i,tmax) | G(i,tmax) (pCi/g) |
|---|---|---|---|---|---|---|
| Ac-227 | 1.700E-01 | 0.000E+00 | 1.442E+00 | 6.936E+01 | 1.442E+00 | 6.936E+01 |
| Pa-231 | 1.700E-01 | 47.22 ± 0.05 | 8.810E-01 | 1.135E+02 | 2.069E-01 | 4.834E+02 |
| Pb-210 | 5.200E-01 | 0.000E+00 | 5.659E-01 | 1.767E+02 | 5.659E-01 | 1.767E+02 |
| Ra-226 | 5.200E-01 | 0.000E+00 | 6.060E+00 | 1.650E+01 | 6.060E+00 | 1.650E+01 |
| Ra-228 | 2.880E+00 | 2.541 ± 0.003 | 4.498E+00 | 2.223E+01 | 3.242E+00 | 3.085E+01 |
| Th-228 | 2.880E+00 | 0.000E+00 | 4.711E+00 | 2.123E+01 | 4.711E+00 | 2.123E+01 |
| Th-230 | 3.390E+00 | 57.34 ± 0.06 | 7.084E-02 | 1.412E+03 | 1.265E-02 | 7.906E+03 |
| Th-232 | 2.880E+00 | 26.44 ± 0.03 | 5.804E+00 | 1.723E+01 | 6.062E-02 | 1.650E+03 |
| U-234 | 3.390E+00 | 115.0 ± 0.1 | 5.897E-03 | 1.696E+04 | 5.317E-03 | 1.881E+04 |
| U-235 | 1.700E-01 | 0.000E+00 | 4.260E-01 | 2.347E+02 | 4.260E-01 | 2.347E+02 |
| U-238 | 3.390E+00 | 0.000E+00 | 5.738E-02 | 1.743E+03 | 5.738E-02 | 1.743E+03 |

# APPENDIX F-2

# RADIOLOGICAL DOSE FROM SUBSURFACE SOILS

Summary : Maywood residences, unit 1 mean resident subsrface, MFMAY1.002, EPA
File : MFMAY1.002

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Dose Conversion Factor (and Related) Parameter Summary

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| A-1 | Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3): | | | |
| A-1 | Ac-227+D, soil density = 1.0 g/cm**3 | 2.760E+00 | 2.760E+00 | DCF1( 1,1) |
| A-1 | Ac-227+D, soil density = 1.8 g/cm**3 | 1.520E+00 | 1.520E+00 | DCF1( 1,2) |
| A-1 | | | | |
| A-1 | Pa-231 , soil density = 1.0 g/cm**3 | 2.210E-01 | 2.210E-01 | DCF1( 2,1) |
| A-1 | Pa-231 , soil density = 1.8 g/cm**3 | 1.210E-01 | 1.210E-01 | DCF1( 2,2) |
| A-1 | | | | |
| A-1 | Pb-210+D, soil density = 1.0 g/cm**3 | 4.870E-03 | 4.870E-03 | DCF1( 3,1) |
| A-1 | Pb-210+D, soil density = 1.8 g/cm**3 | 2.310E-03 | 2.310E-03 | DCF1( 3,2) |
| A-1 | | | | |
| A-1 | Ra-226+D, soil density = 1.0 g/cm**3 | 1.550E+01 | 1.550E+01 | DCF1( 4,1) |
| A-1 | Ra-226+D, soil density = 1.8 g/cm**3 | 8.560E+00 | 8.560E+00 | DCF1( 4,2) |
| A-1 | | | | |
| A-1 | Ra-228+D, soil density = 1.0 g/cm**3 | 8.180E+00 | 8.180E+00 | DCF1( 5,1) |
| A-1 | Ra-228+D, soil density = 1.8 g/cm**3 | 4.510E+00 | 4.510E+00 | DCF1( 5,2) |
| A-1 | | | | |
| A-1 | Th-228+D, soil density = 1.0 g/cm**3 | 1.330E+01 | 1.330E+01 | DCF1( 6,1) |
| A-1 | Th-228+D, soil density = 1.8 g/cm**3 | 7.360E+00 | 7.360E+00 | DCF1( 6,2) |
| A-1 | | | | |
| A-1 | Th-230 , soil density = 1.0 g/cm**3 | 2.110E-03 | 2.110E-03 | DCF1( 7,1) |
| A-1 | Th-230 , soil density = 1.8 g/cm**3 | 1.030E-03 | 1.030E-03 | DCF1( 7,2) |
| A-1 | | | | |
| A-1 | Th-232 , soil density = 1.0 g/cm**3 | 1.350E-03 | 1.350E-03 | DCF1( 8,1) |
| A-1 | Th-232 , soil density = 1.8 g/cm**3 | 6.040E-04 | 6.040E-04 | DCF1( 8,2) |
| A-1 | | | | |
| A-1 | U-234 , soil density = 1.0 g/cm**3 | 1.580E-03 | 1.580E-03 | DCF1( 9,1) |
| A-1 | U-234 , soil density = 1.8 g/cm**3 | 6.970E-04 | 6.970E-04 | DCF1( 9,2) |
| A-1 | | | | |
| A-1 | U-235+D , soil density = 1.0 g/cm**3 | 8.940E-01 | 8.940E-01 | DCF1(10,1) |
| A-1 | U-235+D , soil density = 1.8 g/cm**3 | 4.900E-01 | 4.900E-01 | DCF1(10,2) |
| A-1 | | | | |
| A-1 | U-238+D , soil density = 1.0 g/cm**3 | 1.270E-01 | 1.270E-01 | DCF1(11,1) |
| A-1 | U-238+D , soil density = 1.8 g/cm**3 | 6.970E-02 | 6.970E-02 | DCF1(11,2) |
| | | | | |
| A-3 | Depth factors, ground external gamma, dimensionless: | | | |
| A-3 | Ac-227+D, soil density = 1.0 g/cm**3, thickness = .15 m | 7.900E-01 | 7.900E-01 | FD( 1,1,1) |
| A-3 | Ac-227+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 9.700E-01 | 9.700E-01 | FD( 1,2,1) |
| A-3 | Ac-227+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 1,3,1) |
| A-3 | Ac-227+D, soil density = 1.8 g/cm**3, thickness = .15 m | 9.100E-01 | 9.100E-01 | FD( 1,1,2) |
| A-3 | Ac-227+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 1,2,2) |
| A-3 | Ac-227+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 1,3,2) |
| A-3 | | | | |
| A-3 | Pa-231 , soil density = 1.0 g/cm**3, thickness = .15 m | 7.900E-01 | 7.900E-01 | FD( 2,1,1) |
| A-3 | Pa-231 , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 2,2,1) |
| A-3 | Pa-231 , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 2,3,1) |
| A-3 | Pa-231 , soil density = 1.8 g/cm**3, thickness = .15 m | 9.200E-01 | 9.200E-01 | FD( 2,1,2) |
| A-3 | Pa-231 , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 2,2,2) |
| A-3 | Pa-231 , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 2,3,2) |
| A-3 | | | | |

Dose Conversion Factor (and Related) Parameter Summary (continued)

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| A-3 | Pb-210+D, soil density = 1.0 g/cm**3, thickness = .15 m | 8.800E-01 | 8.800E-01 | FD( 3,1,1) |
| A-3 | Pb-210+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 3,2,1) |
| A-3 | Pb-210+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 3,3,1) |
| A-3 | Pb-210+D, soil density = 1.8 g/cm**3, thickness = .15 m | 9.700E-01 | 9.700E-01 | FD( 3,1,2) |
| A-3 | Pb-210+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 3,2,2) |
| A-3 | Pb-210+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 3,3,2) |
| A-3 | | | | |
| A-3 | Ra-226+D, soil density = 1.0 g/cm**3, thickness = .15 m | 6.300E-01 | 6.300E-01 | FD( 4,1,1) |
| A-3 | Ra-226+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 9.200E-01 | 9.200E-01 | FD( 4,2,1) |
| A-3 | Ra-226+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 4,3,1) |
| A-3 | Ra-226+D, soil density = 1.8 g/cm**3, thickness = .15 m | 8.500E-01 | 8.500E-01 | FD( 4,1,2) |
| A-3 | Ra-226+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 4,2,2) |
| A-3 | Ra-226+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 4,3,2) |
| A-3 | | | | |
| A-3 | Ra-228+D, soil density = 1.0 g/cm**3, thickness = .15 m | 6.800E-01 | 6.800E-01 | FD( 5,1,1) |
| A-3 | Ra-228+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 9.700E-01 | 9.700E-01 | FD( 5,2,1) |
| A-3 | Ra-228+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 5,3,1) |
| A-3 | Ra-228+D, soil density = 1.8 g/cm**3, thickness = .15 m | 8.500E-01 | 8.500E-01 | FD( 5,1,2) |
| A-3 | Ra-228+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 5,2,2) |
| A-3 | Ra-228+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 5,3,2) |
| A-3 | | | | |
| A-3 | Th-228+D, soil density = 1.0 g/cm**3, thickness = .15 m | 6.100E-01 | 6.100E-01 | FD( 6,1,1) |
| A-3 | Th-228+D, soil density = 1.0 g/cm**3, thickness = 0.5 m | 9.400E-01 | 9.400E-01 | FD( 6,2,1) |
| A-3 | Th-228+D, soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 6,3,1) |
| A-3 | Th-228+D, soil density = 1.8 g/cm**3, thickness = .15 m | 7.500E-01 | 7.500E-01 | FD( 6,1,2) |
| A-3 | Th-228+D, soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 6,2,2) |
| A-3 | Th-228+D, soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 6,3,2) |
| A-3 | | | | |
| A-3 | Th-230 , soil density = 1.0 g/cm**3, thickness = .15 m | 9.300E-01 | 9.300E-01 | FD( 7,1,1) |
| A-3 | Th-230 , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 7,2,1) |
| A-3 | Th-230 , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 7,3,1) |
| A-3 | Th-230 , soil density = 1.8 g/cm**3, thickness = .15 m | 1.000E+00 | 1.000E+00 | FD( 7,1,2) |
| A-3 | Th-230 , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 7,2,2) |
| A-3 | Th-230 , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 7,3,2) |
| A-3 | | | | |
| A-3 | Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m | 9.500E-01 | 9.500E-01 | FD( 8,1,1) |
| A-3 | Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 8,2,1) |
| A-3 | Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 8,3,1) |
| A-3 | Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m | 1.000E+00 | 1.000E+00 | FD( 8,1,2) |
| A-3 | Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 8,2,2) |
| A-3 | Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 8,3,2) |
| A-3 | | | | |
| A-3 | U-234 , soil density = 1.0 g/cm**3, thickness = .15 m | 9.000E-01 | 9.000E-01 | FD( 9,1,1) |
| A-3 | U-234 , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 9,2,1) |
| A-3 | U-234 , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 9,3,1) |
| A-3 | U-234 , soil density = 1.8 g/cm**3, thickness = .15 m | 1.000E+00 | 1.000E+00 | FD( 9,1,2) |
| A-3 | U-234 , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD( 9,2,2) |
| A-3 | U-234 , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD( 9,3,2) |
| A-3 | | | | |

Dose Conversion Factor (and Related) Parameter Summary (continued)

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| A-3 | U-235+D , soil density = 1.0 g/cm**3, thickness = .15 m | 8.700E-01 | 8.700E-01 | FD(10,1,1) |
| A-3 | U-235+D , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD(10,2,1) |
| A-3 | U-235+D , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD(10,3,1) |
| A-3 | U-235+D , soil density = 1.8 g/cm**3, thickness = .15 m | 1.000E+00 | 1.000E+00 | FD(10,1,2) |
| A-3 | U-235+D , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD(10,2,2) |
| A-3 | U-235+D , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD(10,3,2) |
| A-3 | | | | |
| A-3 | U-238+D , soil density = 1.0 g/cm**3, thickness = .15 m | 7.800E-01 | 7.800E-01 | FD(11,1,1) |
| A-3 | U-238+D , soil density = 1.0 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD(11,2,1) |
| A-3 | U-238+D , soil density = 1.0 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD(11,3,1) |
| A-3 | U-238+D , soil density = 1.8 g/cm**3, thickness = .15 m | 8.800E-01 | 8.800E-01 | FD(11,1,2) |
| A-3 | U-238+D , soil density = 1.8 g/cm**3, thickness = 0.5 m | 1.000E+00 | 1.000E+00 | FD(11,2,2) |
| A-3 | U-238+D , soil density = 1.8 g/cm**3, thickness = 1.0 m | 1.000E+00 | 1.000E+00 | FD(11,3,2) |
| | | | | |
| B-1 | Dose conversion factors for dust inhalation, mrem/pCi: | | | |
| B-1 | Ac-227+D | 6.700E+00 | 6.700E+00 | DCF2( 1) |
| B-1 | Pa-231 | 1.300E+00 | 1.300E+00 | DCF2( 2) |
| B-1 | Pb-210+D | 2.100E-02 | 2.100E-02 | DCF2( 3) |
| B-1 | Ra-226+D | 7.900E-03 | 7.900E-03 | DCF2( 4) |
| B-1 | Ra-228+D | 4.500E-03 | 4.500E-03 | DCF2( 5) |
| B-1 | Th-228+D | 3.100E-01 | 3.100E-01 | DCF2( 6) |
| B-1 | Th-230 | 3.200E-01 | 3.200E-01 | DCF2( 7) |
| B-1 | Th-232 | 1.600E+00 | 1.600E+00 | DCF2( 8) |
| B-1 | U-234 | 1.300E-01 | 1.300E-01 | DCF2( 9) |
| B-1 | U-235+D | 1.200E-01 | 1.200E-01 | DCF2(10) |
| B-1 | U-238+D | 1.200E-01 | 1.200E-01 | DCF2(11) |
| | | | | |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Ac-227+D | 1.500E-02 | 1.500E-02 | DCF3( 1) |
| D-1 | Pa-231 | 1.100E-02 | 1.100E-02 | DCF3( 2) |
| D-1 | Pb-210+D | 6.700E-03 | 6.700E-03 | DCF3( 3) |
| D-1 | Ra-226+D | 1.100E-03 | 1.100E-03 | DCF3( 4) |
| D-1 | Ra-228+D | 1.200E-03 | 1.200E-03 | DCF3( 5) |
| D-1 | Th-228+D | 7.500E-04 | 7.500E-04 | DCF3( 6) |
| D-1 | Th-230 | 5.300E-04 | 5.300E-04 | DCF3( 7) |
| D-1 | Th-232 | 2.800E-03 | 2.800E-03 | DCF3( 8) |
| D-1 | U-234 | 2.600E-04 | 2.600E-04 | DCF3( 9) |
| D-1 | U-235+D | 2.500E-04 | 2.500E-04 | DCF3(10) |
| D-1 | U-238+D | 2.500E-04 | 2.500E-04 | DCF3(11) |
| | | | | |
| D-34 | Food transfer factors: | | | |
| D-34 | Ac-227+D, plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 1,1) |
| D-34 | Ac-227+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 1,2) |
| D-34 | Ac-227+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 1,3) |
| D-34 | | | | |
| D-34 | Pa-231 , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 2,1) |
| D-34 | Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 2,2) |
| D-34 | Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 2,3) |
| D-34 | | | | |

Dose Conversion Factor (and Related) Parameter Summary (continued)

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| D-34 | Pb-210+D, plant/soil concentration ratio, dimensionless | 6.800E-02 | 6.800E-02 | RTF( 3,1) |
| D-34 | Pb-210+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 9.900E-04 | 9.900E-04 | RTF( 3,2) |
| D-34 | Pb-210+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 1.000E-05 | 1.000E-05 | RTF( 3,3) |
| D-34 | | | | |
| D-34 | Ra-226+D, plant/soil concentration ratio, dimensionless | 1.400E-03 | 1.400E-03 | RTF( 4,1) |
| D-34 | Ra-226+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 9.900E-04 | 9.900E-04 | RTF( 4,2) |
| D-34 | Ra-226+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-04 | 2.000E-04 | RTF( 4,3) |
| D-34 | | | | |
| D-34 | Ra-228+D, plant/soil concentration ratio, dimensionless | 1.400E-03 | 1.400E-03 | RTF( 5,1) |
| D-34 | Ra-228+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 9.900E-04 | 9.900E-04 | RTF( 5,2) |
| D-34 | Ra-228+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-04 | 2.000E-04 | RTF( 5,3) |
| D-34 | | | | |
| D-34 | Th-228+D, plant/soil concentration ratio, dimensionless | 4.200E-03 | 4.200E-03 | RTF( 6,1) |
| D-34 | Th-228+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 6,2) |
| D-34 | Th-228+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 6,3) |
| D-34 | | | | |
| D-34 | Th-230 , plant/soil concentration ratio, dimensionless | 4.200E-03 | 4.200E-03 | RTF( 7,1) |
| D-34 | Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 7,2) |
| D-34 | Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 7,3) |
| D-34 | | | | |
| D-34 | Th-232 , plant/soil concentration ratio, dimensionless | 4.200E-03 | 4.200E-03 | RTF( 8,1) |
| D-34 | Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 8,2) |
| D-34 | Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.500E-06 | 2.500E-06 | RTF( 8,3) |
| D-34 | | | | |
| D-34 | U-234 , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 9,1) |
| D-34 | U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 9,2) |
| D-34 | U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 9,3) |
| D-34 | | | | |
| D-34 | U-235+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(10,1) |
| D-34 | U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF(10,2) |
| D-34 | U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF(10,3) |
| D-34 | | | | |
| D-34 | U-238+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF(11,1) |
| D-34 | U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF(11,2) |
| D-34 | U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF(11,3) |
| | | | | |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Ac-227+D, fish | 2.500E+01 | 2.500E+01 | BIOFAC( 1,1) |
| D-5 | Ac-227+D, crustacea and mollusks | 1.000E+03 | 1.000E+03 | BIOFAC( 1,2) |
| D-5 | | | | |
| D-5 | Pa-231 , fish | 1.100E+01 | 1.100E+01 | BIOFAC( 2,1) |
| D-5 | Pa-231 , crustacea and mollusks | 1.100E+02 | 1.100E+02 | BIOFAC( 2,2) |
| D-5 | | | | |
| D-5 | Pb-210+D, fish | 1.000E+02 | 1.000E+02 | BIOFAC( 3,1) |
| D-5 | Pb-210+D, crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 3,2) |
| D-5 | | | | |
| D-5 | Ra-226+D, fish | 5.000E+01 | 5.000E+01 | BIOFAC( 4,1) |
| D-5 | Ra-226+D, crustacea and mollusks | 2.500E+02 | 2.500E+02 | BIOFAC( 4,2) |
| D-5 | | | | |
| D-5 | Ra-228+D, fish | 5.000E+01 | 5.000E+01 | BIOFAC( 5,1) |
| D-5 | Ra-228+D, crustacea and mollusks | 2.500E+02 | 2.500E+02 | BIOFAC( 5,2) |

Dose Conversion Factor (and Related) Parameter Summary (continued)

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| D-5 | Th-228+D, fish | 3.000E+01 | 3.000E+01 | BIOFAC( 6,1) |
| D-5 | Th-228+D, crustacea and mollusks | 5.000E+02 | 5.000E+02 | BIOFAC( 6,2) |
| D-5 | | | | |
| D-5 | Th-230 , fish | 3.000E+01 | 3.000E+01 | BIOFAC( 7,1) |
| D-5 | Th-230 , crustacea and mollusks | 5.000E+02 | 5.000E+02 | BIOFAC( 7,2) |
| D-5 | | | | |
| D-5 | Th-232 , fish | 3.000E+01 | 3.000E+01 | BIOFAC( 8,1) |
| D-5 | Th-232 , crustacea and mollusks | 5.000E+02 | 5.000E+02 | BIOFAC( 8,2) |
| D-5 | | | | |
| D-5 | U-234 , fish | 2.000E+00 | 2.000E+00 | BIOFAC( 9,1) |
| D-5 | U-234 , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 9,2) |
| D-5 | | | | |
| D-5 | U-235+D , fish | 2.000E+00 | 2.000E+00 | BIOFAC(10,1) |
| D-5 | U-235+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC(10,2) |
| D-5 | | | | |
| D-5 | U-238+D , fish | 2.000E+00 | 2.000E+00 | BIOFAC(11,1) |
| D-5 | U-238+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC(11,2) |

Site-Specific Parameter Summary

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 8.000E+02 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 2.000E+00 | 1.000E+00 | --- | THICKO |
| R011 | Length parallel to aquifer flow (m) | 1.000E+02 | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 1.000E+02 | 1.000E+02 | --- | BRLD |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 3.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 3.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 1.500E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 3.000E+02 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | 1.000E+03 | 3.000E+03 | --- | T( 9) |
| R011 | Times for calculations (yr) | 3.000E+03 | 1.000E+04 | --- | T(10) |
| R012 | Initial principal radionuclide (pCi/g): Ac-227 | 1.200E-01 | 0.000E+00 | --- | S( 1) |
| R012 | Initial principal radionuclide (pCi/g): Pa-231 | 1.200E-01 | 0.000E+00 | --- | S( 2) |
| R012 | Initial principal radionuclide (pCi/g): Pb-210 | 3.000E-01 | 0.000E+00 | --- | S( 3) |
| R012 | Initial principal radionuclide (pCi/g): Ra-226 | 3.000E-01 | 0.000E+00 | --- | S( 4) |
| R012 | Initial principal radionuclide (pCi/g): Ra-228 | 1.570E+00 | 0.000E+00 | --- | S( 5) |
| R012 | Initial principal radionuclide (pCi/g): Th-228 | 1.570E+00 | 0.000E+00 | --- | S( 6) |
| R012 | Initial principal radionuclide (pCi/g): Th-230 | 2.320E+00 | 0.000E+00 | --- | S( 7) |
| R012 | Initial principal radionuclide (pCi/g): Th-232 | 1.570E+00 | 0.000E+00 | --- | S( 8) |
| R012 | Initial principal radionuclide (pCi/g): U-234 | 2.320E+00 | 0.000E+00 | --- | S( 9) |
| R012 | Initial principal radionuclide (pCi/g): U-235 | 1.200E-01 | 0.000E+00 | --- | S(10) |
| R012 | Initial principal radionuclide (pCi/g): U-238 | 2.320E+00 | 0.000E+00 | --- | S(11) |
| R012 | Concentration in groundwater (pCi/L): Ac-227 | not used | 0.000E+00 | --- | W( 1) |
| R012 | Concentration in groundwater (pCi/L): Pa-231 | not used | 0.000E+00 | --- | W( 2) |
| R012 | Concentration in groundwater (pCi/L): Pb-210 | not used | 0.000E+00 | --- | W( 3) |
| R012 | Concentration in groundwater (pCi/L): Ra-226 | not used | 0.000E+00 | --- | W( 4) |
| R012 | Concentration in groundwater (pCi/L): Ra-228 | not used | 0.000E+00 | --- | W( 5) |
| R012 | Concentration in groundwater (pCi/L): Th-228 | not used | 0.000E+00 | --- | W( 6) |
| R012 | Concentration in groundwater (pCi/L): Th-230 | not used | 0.000E+00 | --- | W( 7) |
| R012 | Concentration in groundwater (pCi/L): Th-232 | not used | 0.000E+00 | --- | W( 8) |
| R012 | Concentration in groundwater (pCi/L): U-234 | not used | 0.000E+00 | --- | W( 9) |
| R012 | Concentration in groundwater (pCi/L): U-235 | not used | 0.000E+00 | --- | W(10) |
| R012 | Concentration in groundwater (pCi/L): U-238 | not used | 0.000E+00 | --- | W(11) |
| R013 | Cover depth (m) | 1.500E-01 | 0.000E+00 | --- | COVERO |
| R013 | Density of cover material (g/cm**3) | 1.600E+00 | 1.600E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.600E+00 | 1.600E+00 | --- | DENSCZ |
| R013 | Contaminated zone erosion rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VCZ |
| R013 | Contaminated zone total porosity | 4.500E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone effective porosity | 2.600E-01 | 2.000E-01 | --- | EPCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 1.230E+02 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 5.300E+00 | 5.300E+00 | --- | BCZ |
| R013 | Humidity in air (g/cm**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 4.600E-01 | 6.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 1.070E+00 | 1.000E+00 | --- | PRECIP |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R013 | Irrigation (m/yr) | 2.000E-02 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 2.500E-01 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | 5.575E+04 | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | 1.000E-03 | 1.000E-03 | --- | EPS |
| | | | | | |
| R014 | Density of saturated zone (g/cm**3) | 1.600E+00 | 1.600E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | 4.500E-01 | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | 2.600E-01 | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | 1.230E+02 | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | 1.000E-01 | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | 5.900E+00 | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VWT |
| R014 | Well pump intake depth (m below water table) | 1.000E+00 | 1.000E+01 | --- | DWIBWT |
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | ND | ND | --- | MODEL |
| R014 | Individual's use of groundwater (m**3/yr) | not used | 1.500E+02 | --- | UW |
| | | | | | |
| R015 | Number of unsaturated zone strata | 1 | 1 | --- | NS |
| R015 | Unsat. zone 1, thickness (m) | 1.500E-01 | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | 1.600E+00 | 1.600E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | 4.500E-01 | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | 2.600E-01 | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | 5.900E+00 | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | 1.230E+00 | 1.000E+02 | --- | HCUZ(1) |
| | | | | | |
| R016 | Distribution coefficients for Ac-227 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCACTC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCACTU( 1,1) |
| R016 | Saturated zone (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCACTS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 6.876E-03 | RLEACH( 1) |
| | | | | | |
| R016 | Distribution coefficients for Pa-231 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTU( 2,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.766E-03 | RLEACH( 2) |
| | | | | | |
| R016 | Distribution coefficients for Pb-210 | | | | |
| R016 | Contaminated zone (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCACTC( 3) |
| R016 | Unsaturated zone 1 (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCACTU( 3,1) |
| R016 | Saturated zone (cm**3/g) | 1.000E+02 | 1.000E+02 | --- | DCACTS( 3) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 1.385E-03 | RLEACH( 3) |
| | | | | | |
| R016 | Distribution coefficients for Ra-226 | | | | |
| R016 | Contaminated zone (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTC( 4) |
| R016 | Unsaturated zone 1 (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTU( 4,1) |
| R016 | Saturated zone (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTS( 4) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 1.978E-03 | RLEACH( 4) |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R016 | Distribution coefficients for Ra-228 | | | | |
| R016 | Contaminated zone (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTC( 5) |
| R016 | Unsaturated zone 1 (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTU( 5,1) |
| R016 | Saturated zone (cm**3/g) | 7.000E+01 | 7.000E+01 | --- | DCACTS( 5) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 1.978E-03 | RLEACH( 5) |
| R016 | Distribution coefficients for Th-228 | | | | |
| R016 | Contaminated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTC( 6) |
| R016 | Unsaturated zone 1 (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTU( 6,1) |
| R016 | Saturated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTS( 6) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.313E-06 | RLEACH( 6) |
| R016 | Distribution coefficients for Th-230 | | | | |
| R016 | Contaminated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTC( 7) |
| R016 | Unsaturated zone 1 (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTU( 7,1) |
| R016 | Saturated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTS( 7) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.313E-06 | RLEACH( 7) |
| R016 | Distribution coefficients for Th-232 | | | | |
| R016 | Contaminated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTC( 8) |
| R016 | Unsaturated zone 1 (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTU( 8,1) |
| R016 | Saturated zone (cm**3/g) | 6.000E+04 | 6.000E+04 | --- | DCACTS( 8) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.313E-06 | RLEACH( 8) |
| R016 | Distribution coefficients for U-234 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTC( 9) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTU( 9,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTS( 9) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.766E-03 | RLEACH( 9) |
| R016 | Distribution coefficients for U-235 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTC(10) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTU(10,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTS(10) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.766E-03 | RLEACH(10) |
| R016 | Distribution coefficients for U-238 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTC(11) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTU(11,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCACTS(11) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.766E-03 | RLEACH(11) |
| R017 | Inhalation rate (m**3/yr) | 5.430E+03 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 1.500E-05 | 2.000E-04 | --- | MLINH |
| R017 | Dilution length for airborne dust, inhalation (m) | 3.000E+00 | 3.000E+00 | --- | LM |
| R017 | Exposure duration | 9.000E+00 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 4.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 8.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 6.500E-01 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 2.000E-02 | 2.500E-01 | --- | FOTD |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R017 | Shape factor, external gamma | 1.000E+00 | 1.000E+00 | --- | FS1 |
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Outer annular radius (m) = √(1/π) | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Outer annular radius (m) = √(10/π) | not used | 1.000E+00 | --- | FRACA( 2) |
| R017 | Outer annular radius (m) = √(20/π) | not used | 1.000E+00 | --- | FRACA( 3) |
| R017 | Outer annular radius (m) = √(50/π) | not used | 1.000E+00 | --- | FRACA( 4) |
| R017 | Outer annular radius (m) = √(100/π) | not used | 1.000E+00 | --- | FRACA( 5) |
| R017 | Outer annular radius (m) = √(200/π) | not used | 1.000E+00 | --- | FRACA( 6) |
| R017 | Outer annular radius (m) = √(500/π) | not used | 1.000E+00 | --- | FRACA( 7) |
| R017 | Outer annular radius (m) = √(1000/π) | not used | 1.000E+00 | --- | FRACA( 8) |
| R017 | Outer annular radius (m) = √(5000/π) | not used | 1.000E+00 | --- | FRACA( 9) |
| R017 | Outer annular radius (m) = √(1.E+04/π) | not used | 1.000E+00 | --- | FRACA(10) |
| R017 | Outer annular radius (m) = √(1.E+05/π) | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Outer annular radius (m) = √(1.E+06/π) | not used | 0.000E+00 | --- | FRACA(12) |
| | | | | | |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | 1.350E+01 | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | 4.000E+00 | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | not used | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | not used | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | 0.000E+00 | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | 0.000E+00 | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 2.100E+01 | 3.650E+01 | --- | SOIL |
| R018 | Drinking water intake (L/yr) | 4.900E+02 | 5.100E+02 | --- | DWI |
| R018 | Fraction of drinking water from site | 1.000E-02 | 1.000E+00 | --- | FDW |
| R018 | Fraction of aquatic food from site | 1.000E-02 | 5.000E-01 | --- | FR9 |
| | | | | | |
| R019 | Livestock fodder intake for meat (kg/day) | not used | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | not used | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | not used | 5.000E+01 | --- | LWI5 |
| R019 | Livestock water intake for milk (L/day) | not used | 1.600E+02 | --- | LWI6 |
| R019 | Mass loading for foliar deposition (g/m**3) | 1.000E-04 | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | 9.000E-01 | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWDW |
| R019 | Livestock water fraction from ground water | not used | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWIR |
| | | | | | |
| R021 | Thickness of building foundation (m) | 1.500E-01 | 1.500E-01 | --- | FLOOR |
| R021 | Bulk density of building foundation (g/cm**3) | 2.400E+00 | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | 4.000E-01 | 4.000E-01 | --- | TPCV |
| R021 | Total porosity of the building foundation | 1.000E-01 | 1.000E-01 | --- | TPFL |
| R021 | Volumetric water content of the cover material | 5.000E-02 | 1.000E-01 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | 1.000E-02 | 5.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | 2.000E-06 | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | 2.000E-08 | 2.000E-08 | --- | DIFFL |
| R021 | in contaminated zone soil | 2.000E-06 | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | 2.000E+00 | 2.000E+00 | --- | HMIX |
| R021 | Average annual wind speed (m/sec) | 5.300E+00 | 2.000E+00 | --- | WIND |
| R021 | Average building air exchange rate (1/hr) | 1.000E+00 | 1.000E+00 | --- | REXG |
| R021 | Height of the building (room) (m) | 2.500E+00 | 2.500E+00 | --- | HRM |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R021 | Building interior area factor | 1.000E+00 | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | 1.000E+00 | 1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | 2.000E-01 | 2.000E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | 1.000E-01 | 1.000E-01 | --- | EMANA(2) |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation | active |
| 3 -- plant ingestion | active |
| 4 -- meat ingestion | suppressed |
| 5 -- milk ingestion | suppressed |
| 6 -- aquatic foods | active |
| 7 -- drinking water | active |
| 8 -- soil ingestion | active |
| 9 -- radon | active |

Summary : Maywood residences, unit 1 mean resident subsrface, MFMAY1.002, EPA
File : MFMAY1.002

| Contaminated Zone Dimensions | | Initial Soil Concentrations, pCi/g | |
|---|---|---|---|
| Area: | 800.00 square meters | Ac-227 | 1.200E-01 |
| Thickness: | 2.00 meters | Pa-231 | 1.200E-01 |
| Cover Depth: | 0.15 meters | Pb-210 | 3.000E-01 |
| | | Ra-226 | 3.000E-01 |
| | | Ra-228 | 1.570E+00 |
| | | Th-228 | 1.570E+00 |
| | | Th-230 | 2.320E+00 |
| | | Th-232 | 1.570E+00 |
| | | U-234 | 2.320E+00 |
| | | U-235 | 1.200E-01 |
| | | U-238 | 2.320E+00 |

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 100 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

| t (years): | 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 1.500E+02 | 3.000E+02 | 1.000E+03 | 3.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| TDOSE(t): | 6.078E+00 | 6.121E+00 | 6.204E+00 | 6.545E+00 | 7.857E+00 | 1.410E+01 | 2.160E+01 | 2.167E+01 | 2.160E+01 | 1.731E-04 |
| M(t): | 6.078E-02 | 6.121E-02 | 6.204E-02 | 6.545E-02 | 7.857E-02 | 1.410E-01 | 2.160E-01 | 2.167E-01 | 2.160E-01 | 1.731E-06 |

Maximum TDOSE(t): 2.167E+01 mrem/yr at t = 385.3 ± 0.4 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 385.3 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 5.275E-08 | 0.0000 | 5.397E-09 | 0.0000 | 0.000E+00 | 0.0000 | 1.029E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.757E-09 | 0.0000 |
| Pa-231 | 5.349E-02 | 0.0025 | 6.121E-03 | 0.0003 | 0.000E+00 | 0.0000 | 1.750E-02 | 0.0008 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.687E-03 | 0.0002 |
| Pb-210 | 2.358E-09 | 0.0000 | 4.794E-10 | 0.0000 | 0.000E+00 | 0.0000 | 3.531E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.489E-08 | 0.0000 |
| Ra-226 | 9.007E-01 | 0.0416 | 7.236E-05 | 0.0000 | 1.546E-01 | 0.0071 | 3.922E-01 | 0.0181 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.475E-03 | 0.0002 |
| Ra-228 | 7.423E-20 | 0.0000 | 5.216E-23 | 0.0000 | 0.000E+00 | 0.0000 | 2.420E-22 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.874E-23 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 1.914E+00 | 0.0884 | 1.538E-02 | 0.0007 | 3.283E-01 | 0.0152 | 7.670E-01 | 0.0354 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.426E-02 | 0.0007 |
| Th-232 | 1.626E+01 | 0.7505 | 6.176E-02 | 0.0029 | 4.301E-02 | 0.0020 | 1.818E-01 | 0.0084 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.482E-02 | 0.0016 |
| U-234 | 3.225E-03 | 0.0001 | 2.173E-03 | 0.0001 | 4.631E-04 | 0.0000 | 4.691E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.000E-03 | 0.0000 |
| U-235 | 1.843E-02 | 0.0009 | 1.494E-04 | 0.0000 | 0.000E+00 | 0.0000 | 3.189E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.542E-05 | 0.0000 |
| U-238 | 4.953E-02 | 0.0023 | 1.980E-03 | 0.0001 | 1.511E-07 | 0.0000 | 3.514E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.410E-04 | 0.0000 |
| Total | 1.920E+01 | 0.8862 | 8.763E-02 | 0.0040 | 5.264E-01 | 0.0243 | 1.367E+00 | 0.0631 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.026E-02 | 0.0028 |

Summary : Maywood residences, unit 1 mean resident subsrface, MFMAY1.002, EPA
File : MFMAY1.002

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 385.3 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 3.717E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.426E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.772E-07 | 0.0[redacted]0 |
| Pa-231 | 1.993E-01 | 0.0092 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.836E-02 | 0.0008 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.994E-01 | 0.0[redacted]8 |
| Pb-210 | 5.347E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.006E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.205E-05 | 0.0000 |
| Ra-226 | 6.949E-02 | 0.0032 | 0.000E+00 | 0.0000 | 2.919E-03 | 0.0001 | 6.488E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.531E+00 | 0.0[redacted]7 |
| Ra-228 | 1.998E-12 | 0.0000 | 0.000E+00 | 0.0000 | 4.515E-15 | 0.0000 | 1.842E-13 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.187E-12 | 0.0[redacted]0 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 6.250E-02 | 0.0029 | 0.000E+00 | 0.0000 | 3.216E-03 | 0.0001 | 5.832E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.111E+00 | 0.1436 |
| Th-232 | 4.275E-05 | 0.0000 | 0.000E+00 | 0.0000 | 3.070E-12 | 0.0000 | 3.939E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.658E+01 | 0.7[redacted]3 |
| U-234 | 2.515E-02 | 0.0012 | 0.000E+00 | 0.0000 | 5.233E-06 | 0.0000 | 2.318E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.902E-02 | 0.0[redacted]8 |
| U-235 | 2.664E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.455E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.189E-02 | 0.0010 |
| U-238 | 2.414E-02 | 0.0011 | 0.000E+00 | 0.0000 | 1.645E-09 | 0.0000 | 2.225E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.234E-02 | 0.0[redacted]8 |
| Total | 3.833E-01 | 0.0177 | 0.000E+00 | 0.0000 | 6.140E-03 | 0.0003 | 3.548E-02 | 0.0016 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.167E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : Maywood residences, unit 1 mean resident subsrface, MFMAY1.002, EPA
File : MFMAY1.002

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.944E-02 | 0.0032 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.625E-02 | 0.0043 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 1.453E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.925E-02 | 0.0032 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 3.355E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.973E-01 | 0.1312 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 4.673E-01 | 0.0769 | 0.000E+00 | 0.0000 | 3.899E-01 | 0.0641 | 2.695E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 1.210E+00 | 0.1991 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.539E-02 | 0.0025 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 2.922E+00 | 0.4807 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.885E-02 | 0.0047 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 3.829E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.013E-02 | 0.0050 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 1.109E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.077E-01 | 0.0177 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 3.796E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.797E-03 | 0.0014 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 1.700E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.375E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 2.085E-02 | 0.0034 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.458E-03 | 0.0014 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 4.643E+00 | 0.7639 | 0.000E+00 | 0.0000 | 3.899E-01 | 0.0641 | 1.045E+00 | 0.1720 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.569E-02 | 0.0075 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.070E-02 | 0.0034 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.973E-01 | 0.1312 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.599E-01 | 0.1415 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.226E+00 | 0.2017 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.951E+00 | 0.4855 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.016E-02 | 0.0050 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.077E-01 | 0.0177 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.835E-03 | 0.0015 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.137E-03 | 0.0004 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.931E-02 | 0.0048 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.078E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.897E-02 | 0.0031 | 1.063E-04 | 0.0000 | 0.000E+00 | 0.0000 | 2.529E-02 | 0.0041 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.430E-05 | 0.[illegible]00 |
| Pa-231 | 2.086E-03 | 0.0003 | 2.484E-05 | 0.0000 | 0.000E+00 | 0.0000 | 2.004E-02 | 0.0033 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.304E-05 | 0.[illegible]00 |
| Pb-210 | 3.312E-05 | 0.0000 | 8.383E-07 | 0.0000 | 0.000E+00 | 0.0000 | 7.729E-01 | 0.1263 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.102E-05 | 0.0000 |
| Ra-226 | 4.712E-01 | 0.0770 | 3.515E-07 | 0.0000 | 3.890E-01 | 0.0636 | 2.708E-02 | 0.0044 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.225E-05 | 0.[illegible]00 |
| Ra-228 | 1.923E+00 | 0.3142 | 1.993E-05 | 0.0000 | 0.000E+00 | 0.0000 | 2.187E-02 | 0.0036 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.281E-05 | 0.[illegible]00 |
| Th-228 | 2.051E+00 | 0.3351 | 4.657E-05 | 0.0000 | 0.000E+00 | 0.0000 | 2.011E-02 | 0.0033 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.570E-05 | 0.0000 |
| Th-230 | 1.620E-03 | 0.0003 | 1.021E-04 | 0.0000 | 1.305E-03 | 0.0002 | 3.022E-02 | 0.0049 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.860E-05 | 0.0000 |
| Th-232 | 1.934E-01 | 0.0316 | 3.467E-04 | 0.0001 | 0.000E+00 | 0.0000 | 1.101E-01 | 0.0180 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.452E-04 | 0.[illegible]00 |
| U-234 | 3.880E-05 | 0.0000 | 4.134E-05 | 0.0000 | 5.869E-09 | 0.0000 | 8.785E-03 | 0.0014 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.886E-05 | 0.[illegible]00 |
| U-235 | 1.734E-03 | 0.0003 | 1.974E-06 | 0.0000 | 0.000E+00 | 0.0000 | 4.373E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.391E-07 | 0.0000 |
| U-238 | 2.106E-02 | 0.0034 | 3.816E-05 | 0.0000 | 5.533E-15 | 0.0000 | 8.446E-03 | 0.0014 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.814E-05 | 0.[illegible]00 |
| Total | 4.684E+00 | 0.7653 | 7.290E-04 | 0.0001 | 3.903E-01 | 0.0638 | 1.045E+00 | 0.1708 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.809E-04 | 0.0001 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.442E-02 | 0.0[illegible] |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.220E-02 | 0.0036 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.730E-01 | 0.1263 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.872E-01 | 0.1[illegible] |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.945E+00 | 0.3[illegible] |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.071E+00 | 0.3384 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.328E-02 | 0.0[illegible] |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.041E-01 | 0.0[illegible] |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.884E-03 | 0.0015 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.174E-03 | 0.0[illegible] |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.956E-02 | 0.0[illegible] |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.121E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.806E-02 | 0.0029 | 2.951E-04 | 0.0000 | 0.000E+00 | 0.0000 | 2.346E-02 | 0.0038 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.508E-04 | 0.0000 |
| Pa-231 | 3.330E-03 | 0.0005 | 9.362E-05 | 0.0000 | 0.000E+00 | 0.0000 | 2.154E-02 | 0.0035 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.384E-04 | 0.0000 |
| Pb-210 | 3.228E-05 | 0.0000 | 2.357E-06 | 0.0000 | 0.000E+00 | 0.0000 | 7.262E-01 | 0.1171 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.716E-04 | 0.0000 |
| Ra-226 | 4.789E-01 | 0.0772 | 1.200E-06 | 0.0000 | 3.872E-01 | 0.0624 | 7.355E-02 | 0.0119 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.756E-05 | 0.0000 |
| Ra-228 | 2.475E+00 | 0.3990 | 1.098E-04 | 0.0000 | 0.000E+00 | 0.0000 | 2.625E-02 | 0.0042 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.823E-04 | 0.0000 |
| Th-228 | 1.010E+00 | 0.1629 | 6.769E-05 | 0.0000 | 0.000E+00 | 0.0000 | 9.768E-03 | 0.0016 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.736E-05 | 0.0000 |
| Th-230 | 4.872E-03 | 0.0008 | 3.062E-04 | 0.0000 | 3.905E-03 | 0.0006 | 3.064E-02 | 0.0049 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.161E-04 | 0.0000 |
| Th-232 | 7.492E-01 | 0.1208 | 1.062E-03 | 0.0002 | 0.000E+00 | 0.0000 | 1.164E-01 | 0.0188 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.809E-04 | 0.0001 |
| U-234 | 4.059E-05 | 0.0000 | 1.234E-04 | 0.0000 | 5.265E-08 | 0.0000 | 8.760E-03 | 0.0014 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.628E-05 | 0.0000 |
| U-235 | 1.805E-03 | 0.0003 | 5.894E-06 | 0.0000 | 0.000E+00 | 0.0000 | 4.370E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.807E-06 | 0.0000 |
| U-238 | 2.149E-02 | 0.0035 | 1.139E-04 | 0.0000 | 1.488E-13 | 0.0000 | 8.423E-03 | 0.0014 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.412E-05 | 0.0000 |
| Total | 4.763E+00 | 0.7679 | 2.181E-03 | 0.0004 | 3.911E-01 | 0.0630 | 1.045E+00 | 0.1685 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.438E-03 | 0.0002 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.197E-02 | 0.0068 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.510E-02 | 0.0040 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.264E-01 | 0.1171 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.397E-01 | 0.1515 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.502E+00 | 0.4033 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.020E+00 | 0.1645 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.984E-02 | 0.0064 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.672E-01 | 0.1398 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.981E-03 | 0.0014 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.251E-03 | 0.0004 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.008E-02 | 0.0048 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.204E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.520E-02 | 0.0023 | 7.500E-04 | 0.0001 | 0.000E+00 | 0.0000 | 1.806E-02 | 0.0028 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.831E-04 | 0.0001 |
| Pa-231 | 7.469E-03 | 0.0011 | 4.964E-04 | 0.0001 | 0.000E+00 | 0.0000 | 2.591E-02 | 0.0040 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.496E-04 | 0.0001 |
| Pb-210 | 2.951E-05 | 0.0000 | 6.259E-06 | 0.0000 | 0.000E+00 | 0.0000 | 5.839E-01 | 0.0892 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.556E-04 | 0.0001 |
| Ra-226 | 5.070E-01 | 0.0775 | 5.450E-06 | 0.0000 | 3.809E-01 | 0.0582 | 2.144E-01 | 0.0328 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.662E-04 | 0.0000 |
| Ra-228 | 1.681E+00 | 0.2569 | 2.731E-04 | 0.0000 | 0.000E+00 | 0.0000 | 1.640E-02 | 0.0025 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.231E-04 | 0.0000 |
| Th-228 | 8.482E-02 | 0.0130 | 1.786E-05 | 0.0000 | 0.000E+00 | 0.0000 | 7.806E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.858E-06 | 0.0000 |
| Th-230 | 1.724E-02 | 0.0026 | 1.021E-03 | 0.0002 | 1.291E-02 | 0.0020 | 3.437E-02 | 0.0053 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.919E-04 | 0.0001 |
| Th-232 | 2.717E+00 | 0.4152 | 3.834E-03 | 0.0006 | 0.000E+00 | 0.0000 | 1.364E-01 | 0.0208 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.996E-03 | 0.0003 |
| U-234 | 4.799E-05 | 0.0000 | 4.034E-04 | 0.0001 | 5.782E-07 | 0.0000 | 8.676E-03 | 0.0013 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.840E-04 | 0.0000 |
| U-235 | 2.079E-03 | 0.0003 | 1.933E-05 | 0.0000 | 0.000E+00 | 0.0000 | 4.362E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.253E-06 | 0.0000 |
| U-238 | 2.306E-02 | 0.0035 | 3.723E-04 | 0.0001 | 5.439E-12 | 0.0000 | 8.340E-03 | 0.0013 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.769E-04 | 0.0000 |
| Total | 5.055E+00 | 0.7725 | 7.199E-03 | 0.0011 | 3.938E-01 | 0.0602 | 1.048E+00 | 0.1601 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.745E-03 | 0.0007 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 2.897E-02 | 0.0044 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.670E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.602E-02 | 0.0101 |
| Pa-231 | 3.652E-03 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.365E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.841E-02 | 0.0059 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.844E-01 | 0.0893 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.103E+00 | 0.1686 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.698E+00 | 0.2596 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.563E-02 | 0.0131 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.594E-02 | 0.0101 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.860E+00 | 0.4370 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.312E-03 | 0.0014 |
| U-235 | 1.710E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.575E-08 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.543E-03 | 0.0004 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.195E-02 | 0.0049 |
| Total | 3.262E-02 | 0.0050 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.006E-03 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.545E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : Maywood residences, unit 1 mean resident subsrface, MFMAY1.002, EPA
File : MFMAY1.002

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 9.286E-03 | 0.0012 | 1.036E-03 | 0.0001 | 0.000E+00 | 0.0000 | 8.539E-03 | 0.0011 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.292E-04 | 0.0001 |
| Pa-231 | 1.806E-02 | 0.0023 | 2.376E-03 | 0.0003 | 0.000E+00 | 0.0000 | 3.314E-02 | 0.0042 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.054E-03 | 0.0003 |
| Pb-210 | 2.284E-05 | 0.0000 | 9.809E-06 | 0.0000 | 0.000E+00 | 0.0000 | 3.131E-01 | 0.0398 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.140E-04 | 0.0001 |
| Ra-226 | 5.969E-01 | 0.0760 | 2.394E-05 | 0.0000 | 3.634E-01 | 0.0463 | 4.765E-01 | 0.0607 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.370E-03 | 0.0002 |
| Ra-228 | 1.873E-01 | 0.0238 | 7.792E-05 | 0.0000 | 1.217E-07 | 0.0000 | 1.563E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.778E-05 | 0.0000 |
| Th-228 | 7.147E-05 | 0.0000 | 3.819E-08 | 0.0000 | 6.022E-11 | 0.0000 | 5.712E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.108E-08 | 0.0000 |
| Th-230 | 6.229E-02 | 0.0079 | 3.062E-03 | 0.0004 | 3.788E-02 | 0.0048 | 5.967E-02 | 0.0076 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.251E-03 | 0.0002 |
| Th-232 | 5.166E+00 | 0.6575 | 1.228E-02 | 0.0016 | 2.994E-06 | 0.0000 | 1.558E-01 | 0.0198 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.883E-03 | 0.0009 |
| U-234 | 8.135E-05 | 0.0000 | 1.145E-03 | 0.0001 | 5.035E-06 | 0.0000 | 8.437E-03 | 0.0011 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.226E-04 | 0.0001 |
| U-235 | 3.111E-03 | 0.0004 | 5.570E-05 | 0.0000 | 0.000E+00 | 0.0000 | 4.363E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.704E-05 | 0.0000 |
| U-238 | 2.823E-02 | 0.0036 | 1.057E-03 | 0.0001 | 1.413E-10 | 0.0000 | 8.104E-03 | 0.0010 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.023E-04 | 0.0001 |
| Total | 6.072E+00 | 0.7728 | 2.113E-02 | 0.0027 | 4.013E-01 | 0.0511 | 1.065E+00 | 0.1356 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.394E-02 | 0.0018 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.311E-01 | 0.0167 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.208E-02 | 0.0015 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.625E-01 | 0.0207 |
| Pa-231 | 1.092E-01 | 0.0139 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.006E-02 | 0.0013 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.749E-01 | 0.0223 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.138E-01 | 0.0399 |
| Ra-226 | 2.700E-03 | 0.0003 | 0.000E+00 | 0.0000 | 3.058E-04 | 0.0000 | 2.509E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.442E+00 | 0.1835 |
| Ra-228 | 3.290E-04 | 0.0000 | 0.000E+00 | 0.0000 | 6.380E-13 | 0.0000 | 3.031E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.894E-01 | 0.0241 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.210E-05 | 0.0000 |
| Th-230 | 3.429E-05 | 0.0000 | 0.000E+00 | 0.0000 | 4.318E-06 | 0.0000 | 3.184E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.642E-01 | 0.0209 |
| Th-232 | 1.995E-04 | 0.0000 | 0.000E+00 | 0.0000 | 1.057E-12 | 0.0000 | 1.838E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.341E+00 | 0.6798 |
| U-234 | 7.894E-03 | 0.0010 | 0.000E+00 | 0.0000 | 3.743E-08 | 0.0000 | 7.275E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.881E-02 | 0.0024 |
| U-235 | 4.242E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.909E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.094E-03 | 0.0005 |
| U-238 | 7.591E-03 | 0.0010 | 0.000E+00 | 0.0000 | 1.406E-12 | 0.0000 | 6.996E-04 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.619E-02 | 0.0059 |
| Total | 2.594E-01 | 0.0330 | 0.000E+00 | 0.0000 | 3.102E-04 | 0.0000 | 2.391E-02 | 0.0030 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.857E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.655E-03 | 0.0001 | 2.289E-04 | 0.0000 | 0.000E+00 | 0.0000 | 6.178E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.169E-04 | 0.[illegible]00 |
| Pa-231 | 5.686E-02 | 0.0040 | 8.833E-03 | 0.0006 | 0.000E+00 | 0.0000 | 3.601E-02 | 0.0026 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.816E-03 | 0.[illegible]05 |
| Pb-210 | 9.307E-06 | 0.0000 | 3.369E-06 | 0.0000 | 0.000E+00 | 0.0000 | 3.515E-02 | 0.0025 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.452E-04 | 0.0000 |
| Ra-226 | 1.056E+00 | 0.0749 | 9.249E-05 | 0.0000 | 3.086E-01 | 0.0219 | 7.004E-01 | 0.0497 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.682E-03 | 0.[illegible]04 |
| Ra-228 | 6.734E-05 | 0.0000 | 4.970E-08 | 0.0000 | 5.780E-09 | 0.0000 | 3.263E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.597E-08 | 0.[illegible]00 |
| Th-228 | 1.241E-15 | 0.0000 | 1.231E-18 | 0.0000 | 1.445E-19 | 0.0000 | 6.024E-18 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.793E-19 | 0.0000 |
| Th-230 | 4.005E-01 | 0.0284 | 1.022E-02 | 0.0007 | 1.168E-01 | 0.0083 | 2.205E-01 | 0.0156 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.453E-03 | 0.0004 |
| Th-232 | 1.021E+01 | 0.7238 | 4.120E-02 | 0.0029 | 7.726E-04 | 0.0001 | 1.717E-01 | 0.0122 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.323E-02 | 0.[illegible]16 |
| U-234 | 5.079E-04 | 0.0000 | 3.151E-03 | 0.0002 | 4.990E-05 | 0.0000 | 7.670E-03 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.438E-03 | 0.0001 |
| U-235 | 1.275E-02 | 0.0009 | 1.650E-04 | 0.0000 | 0.000E+00 | 0.0000 | 4.429E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.382E-05 | 0.0000 |
| U-238 | 5.728E-02 | 0.0041 | 2.903E-03 | 0.0002 | 4.583E-09 | 0.0000 | 7.291E-03 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.380E-03 | 0.[illegible]1 |
| Total | 1.179E+01 | 0.8362 | 6.680E-02 | 0.0047 | 4.262E-01 | 0.0302 | 1.180E+00 | 0.0836 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.444E-02 | 0.0032 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 2.436E-02 | 0.0017 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.245E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.923E-02 | 0.0[illegible] |
| Pa-231 | 3.948E-01 | 0.0280 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.638E-02 | 0.0026 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.397E-01 | 0.0383 |
| Pb-210 | 2.958E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.770E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.864E-02 | 0.0027 |
| Ra-226 | 3.377E-02 | 0.0024 | 0.000E+00 | 0.0000 | 2.402E-03 | 0.0002 | 3.147E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.110E+00 | 0.14[illegible] |
| Ra-228 | 1.625E-04 | 0.0000 | 0.000E+00 | 0.0000 | 3.148E-13 | 0.0000 | 1.497E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.452E-04 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.249E-15 | 0.0000 |
| Th-230 | 3.697E-03 | 0.0003 | 0.000E+00 | 0.0000 | 2.839E-04 | 0.0000 | 3.444E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.579E-01 | 0.05[illegible] |
| Th-232 | 1.213E-03 | 0.0001 | 0.000E+00 | 0.0000 | 4.106E-12 | 0.0000 | 1.118E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.045E+01 | 0.74[illegible] |
| U-234 | 3.918E-02 | 0.0028 | 0.000E+00 | 0.0000 | 3.791E-07 | 0.0000 | 3.611E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.561E-02 | 0.0039 |
| U-235 | 2.426E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.236E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.609E-02 | 0.00[illegible] |
| U-238 | 3.768E-02 | 0.0027 | 0.000E+00 | 0.0000 | 4.454E-11 | 0.0000 | 3.473E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.100E-01 | 0.00[illegible] |
| Total | 5.403E-01 | 0.0383 | 0.000E+00 | 0.0000 | 2.686E-03 | 0.0002 | 4.983E-02 | 0.0035 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.410E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+02 years

Water Independent Pathways

| Radio-Nuclide | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 4.830E-04 | 0.0000 | 4.942E-05 | 0.0000 | 0.000E+00 | 0.0000 | 9.425E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.524E-05 | 0.0000 |
| Pa-231 | 1.026E-01 | 0.0048 | 1.175E-02 | 0.0005 | 0.000E+00 | 0.0000 | 3.363E-02 | 0.0016 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.006E-03 | 0.0004 |
| Pb-210 | 4.902E-06 | 0.0000 | 9.965E-07 | 0.0000 | 0.000E+00 | 0.0000 | 7.341E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.253E-05 | 0.0000 |
| Ra-226 | 1.588E+00 | 0.0735 | 1.266E-04 | 0.0000 | 2.746E-01 | 0.0127 | 6.839E-01 | 0.0317 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.817E-03 | 0.0004 |
| Ra-228 | 2.342E-07 | 0.0000 | 1.646E-10 | 0.0000 | 7.109E-10 | 0.0000 | 7.636E-10 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.853E-10 | 0.0000 |
| Th-228 | 2.558E-23 | 0.0000 | 2.504E-26 | 0.0000 | 1.092E-25 | 0.0000 | 8.656E-26 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.382E-26 | 0.0000 |
| Th-230 | 9.629E-01 | 0.0446 | 1.535E-02 | 0.0007 | 1.661E-01 | 0.0077 | 3.533E-01 | 0.0164 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.548E-03 | 0.0004 |
| Th-232 | 1.627E+01 | 0.7532 | 6.179E-02 | 0.0029 | 4.304E-02 | 0.0020 | 1.819E-01 | 0.0084 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.484E-02 | 0.0016 |
| U-234 | 1.604E-03 | 0.0001 | 4.122E-03 | 0.0002 | 1.036E-04 | 0.0000 | 7.203E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.882E-03 | 0.0001 |
| U-235 | 3.481E-02 | 0.0016 | 2.279E-04 | 0.0000 | 0.000E+00 | 0.0000 | 4.442E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.190E-04 | 0.0000 |
| U-238 | 9.495E-02 | 0.0044 | 3.793E-03 | 0.0002 | 1.408E-08 | 0.0000 | 6.731E-03 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.803E-03 | 0.0001 |
| Total | 1.905E+01 | 0.8822 | 9.720E-02 | 0.0045 | 4.838E-01 | 0.0224 | 1.275E+00 | 0.0590 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.511E-02 | 0.0030 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+02 years

Water Dependent Pathways

| Radio-Nuclide | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 3.553E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.275E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.533E-03 | 0.0002 |
| Pa-231 | 3.947E-01 | 0.0183 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.637E-02 | 0.0017 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.880E-01 | 0.0272 |
| Pb-210 | 2.524E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.363E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.018E-02 | 0.0005 |
| Ra-226 | 5.595E-02 | 0.0026 | 0.000E+00 | 0.0000 | 3.721E-03 | 0.0002 | 5.215E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.620E+00 | 0.1213 |
| Ra-228 | 7.262E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.407E-13 | 0.0000 | 6.690E-06 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.954E-05 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.581E-23 | 0.0000 |
| Th-230 | 1.034E-02 | 0.0005 | 0.000E+00 | 0.0000 | 7.291E-04 | 0.0000 | 9.634E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.519E+00 | 0.0703 |
| Th-232 | 9.306E-04 | 0.0000 | 0.000E+00 | 0.0000 | 3.085E-12 | 0.0000 | 8.574E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.659E+01 | 0.7682 |
| U-234 | 4.866E-02 | 0.0023 | 0.000E+00 | 0.0000 | 8.266E-07 | 0.0000 | 4.485E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.806E-02 | 0.0032 |
| U-235 | 3.259E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.004E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.916E-02 | 0.0018 |
| U-238 | 4.681E-02 | 0.0022 | 0.000E+00 | 0.0000 | 1.327E-10 | 0.0000 | 4.314E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.584E-01 | 0.0073 |
| Total | 5.668E-01 | 0.0262 | 0.000E+00 | 0.0000 | 4.451E-03 | 0.0002 | 5.230E-02 | 0.0024 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.160E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.440E-06 | 0.0000 | 1.473E-07 | 0.0000 | 0.000E+00 | 0.0000 | 2.810E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.525E-08 | 0.0000 |
| Pa-231 | 6.785E-02 | 0.0031 | 7.763E-03 | 0.0004 | 0.000E+00 | 0.0000 | 2.219E-02 | 0.0010 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.944E-03 | 0.0003 |
| Pb-210 | 3.761E-08 | 0.0000 | 7.645E-09 | 0.0000 | 0.000E+00 | 0.0000 | 5.632E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.565E-07 | 0.0000 |
| Ra-226 | 1.106E+00 | 0.0511 | 8.888E-05 | 0.0000 | 1.905E-01 | 0.0088 | 4.816E-01 | 0.0222 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.496E-03 | 0.0003 |
| Ra-228 | 2.520E-15 | 0.0000 | 1.771E-18 | 0.0000 | 7.651E-18 | 0.0000 | 8.217E-18 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.995E-18 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 1.630E+00 | 0.0753 | 1.537E-02 | 0.0007 | 2.804E-01 | 0.0129 | 6.432E-01 | 0.0297 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.285E-02 | 0.0006 |
| Th-232 | 1.626E+01 | 0.7506 | 6.177E-02 | 0.0029 | 4.302E-02 | 0.0020 | 1.818E-01 | 0.0084 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.482E-02 | 0.0016 |
| U-234 | 2.539E-03 | 0.0001 | 2.738E-03 | 0.0001 | 3.226E-04 | 0.0000 | 5.326E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.255E-03 | 0.0001 |
| U-235 | 2.321E-02 | 0.0011 | 1.751E-04 | 0.0000 | 0.000E+00 | 0.0000 | 3.638E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.744E-05 | 0.0000 |
| U-238 | 6.271E-02 | 0.0029 | 2.506E-03 | 0.0001 | 8.404E-08 | 0.0000 | 4.448E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.191E-03 | 0.0001 |
| Total | 1.916E+01 | 0.8842 | 9.041E-02 | 0.0042 | 5.142E-01 | 0.0237 | 1.339E+00 | 0.0618 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.166E-02 | 0.0028 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.040E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.587E-07 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.330E-05 | 0.0000 |
| Pa-231 | 2.589E-01 | 0.0119 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.386E-02 | 0.0011 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.865E-01 | 0.0178 |
| Pb-210 | 8.373E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.839E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.726E-04 | 0.0000 |
| Ra-226 | 8.490E-02 | 0.0039 | 0.000E+00 | 0.0000 | 3.633E-03 | 0.0002 | 7.927E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.881E+00 | 0.0868 |
| Ra-228 | 6.301E-11 | 0.0000 | 0.000E+00 | 0.0000 | 1.525E-14 | 0.0000 | 5.806E-12 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.884E-11 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 4.457E-02 | 0.0021 | 0.000E+00 | 0.0000 | 2.507E-03 | 0.0001 | 4.157E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.633E+00 | 0.1216 |
| Th-232 | 1.413E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.302E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.658E+01 | 0.7655 |
| U-234 | 3.247E-02 | 0.0015 | 0.000E+00 | 0.0000 | 3.363E-06 | 0.0000 | 2.992E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.765E-02 | 0.0022 |
| U-235 | 2.982E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.749E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.710E-02 | 0.0013 |
| U-238 | 3.122E-02 | 0.0014 | 0.000E+00 | 0.0000 | 8.681E-10 | 0.0000 | 2.877E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.049E-01 | 0.0048 |
| Total | 4.560E-01 | 0.0210 | 0.000E+00 | 0.0000 | 6.143E-03 | 0.0003 | 4.218E-02 | 0.0019 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.167E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 2.356E-18 | 0.0000 | 2.410E-19 | 0.0000 | 0.000E+00 | 0.0000 | 4.597E-19 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.231E-19 | 0.0000 |
| Pa-231 | 9.646E-03 | 0.0004 | 1.104E-03 | 0.0001 | 0.000E+00 | 0.0000 | 3.155E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.451E-04 | 0.0000 |
| Pb-210 | 5.067E-18 | 0.0000 | 1.030E-18 | 0.0000 | 0.000E+00 | 0.0000 | 7.587E-15 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.497E-17 | 0.0000 |
| Ra-226 | 2.046E-01 | 0.0095 | 1.644E-05 | 0.0000 | 3.137E-02 | 0.0015 | 8.910E-02 | 0.0041 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.017E-03 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 2.864E+00 | 0.1326 | 1.535E-02 | 0.0007 | 4.388E-01 | 0.0203 | 1.181E+00 | 0.0547 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.894E-02 | 0.0009 |
| Th-232 | 1.624E+01 | 0.7515 | 6.167E-02 | 0.0029 | 4.295E-02 | 0.0020 | 1.815E-01 | 0.0084 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.477E-02 | 0.0016 |
| U-234 | 7.565E-03 | 0.0004 | 4.371E-04 | 0.0000 | 1.144E-03 | 0.0001 | 3.717E-03 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.296E-04 | 0.0000 |
| U-235 | 3.492E-03 | 0.0002 | 4.171E-05 | 0.0000 | 0.000E+00 | 0.0000 | 9.952E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.665E-05 | 0.0000 |
| U-238 | 9.054E-03 | 0.0004 | 3.624E-04 | 0.0000 | 7.907E-07 | 0.0000 | 6.451E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.722E-04 | 0.0000 |
| Total | 1.933E+01 | 0.8950 | 7.898E-02 | 0.0037 | 5.143E-01 | 0.0238 | 1.459E+00 | 0.0675 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.600E-02 | 0.0026 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 1.286E-17 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.185E-18 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.722E-17 | 0.0000 |
| Pa-231 | 2.820E-02 | 0.0013 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.599E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.555E-02 | 0.0021 |
| Pb-210 | 1.012E-13 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.477E-15 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.184E-13 | 0.0000 |
| Ra-226 | 1.308E-02 | 0.0006 | 0.000E+00 | 0.0000 | 5.470E-04 | 0.0000 | 1.221E-03 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.410E-01 | 0.0158 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 9.295E-02 | 0.0043 | 0.000E+00 | 0.0000 | 4.269E-03 | 0.0002 | 8.676E-03 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.624E+00 | 0.2141 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.656E+01 | 0.7664 |
| U-234 | 3.989E-03 | 0.0002 | 0.000E+00 | 0.0000 | 1.540E-05 | 0.0000 | 3.680E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.746E-02 | 0.0008 |
| U-235 | 7.568E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.974E-05 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.486E-03 | 0.0002 |
| U-238 | 3.557E-03 | 0.0002 | 0.000E+00 | 0.0000 | 1.046E-08 | 0.0000 | 3.278E-04 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.412E-02 | 0.0007 |
| Total | 1.425E-01 | 0.0066 | 0.000E+00 | 0.0000 | 4.831E-03 | 0.0002 | 1.326E-02 | 0.0006 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.160E+01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+03 years

Water Independent Pathways

| Radio- | Ground | | Dust | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 8.113E-05 | 0.4686 | 0.000E+00 | 0.0000 | 1.991E-05 | 0.1150 | 7.474E-06 | 0.0432 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.085E-04 | 0.6268 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 4.831E-05 | 0.2791 | 0.000E+00 | 0.0000 | 1.183E-05 | 0.0683 | 4.451E-06 | 0.0257 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.459E-05 | 0.3731 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 1.606E-08 | 0.0001 | 0.000E+00 | 0.0000 | 3.933E-09 | 0.0000 | 1.479E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.147E-08 | 0.0001 |
| Total | 1.295E-04 | 0.7477 | 0.000E+00 | 0.0000 | 3.175E-05 | 0.1834 | 1.193E-05 | 0.0689 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.731E-04 | 1.0000 |

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

| Parent (i) | Product (j) | Branch Fraction | DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 1.500E+02 | 3.000E+02 | 1.000E+03 | 3.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ac-227 | Ac-227 | 1.000E+00 | 3.808E-01 | 3.701E-01 | 3.497E-01 | 5.502E-01 | 1.354E+00 | 2.436E-01 | 3.777E-02 | 1.109E-04 | 1.435E-16 | 0.000E+00 |
| Pa-231 | Pa-231 | 1.000E+00 | 1.725E-01 | 1.730E-01 | 1.738E-01 | 1.769E-01 | 3.424E-01 | 9.963E-01 | 1.217E+00 | 8.072E-01 | 9.539E-02 | 0.000E+00 |
| Pa-231 | Ac-227 | | 0.000E+00 | 1.202E-02 | 3.534E-02 | 1.432E-01 | 1.115E+00 | 3.501E+00 | 3.683E+00 | 2.413E+00 | 2.842E-01 | 0.000E+00 |
| Pa-231 | ΣDSR(j) | | 1.725E-01 | 1.850E-01 | 2.092E-01 | 3.201E-01 | 1.457E+00 | 4.498E+00 | 4.900E+00 | 3.221E+00 | 3.795E-01 | 0.000E+00 |
| Pb-210 | Pb-210 | 1.000E+00 | 2.658E+00 | 2.577E+00 | 2.421E+00 | 1.948E+00 | 1.046E+00 | 1.288E-01 | 3.393E-02 | 3.242E-03 | 3.946E-13 | 0.000E+00 |
| Ra-226 | Ra-226 | 1.000E+00 | 2.866E+00 | 2.876E+00 | 2.896E+00 | 2.969E+00 | 3.216E+00 | 4.604E+00 | 6.287E+00 | 4.396E+00 | 7.979E-01 | 0.000E+00 |
| Ra-226 | Pb-210 | | 0.000E+00 | 8.130E-02 | 2.363E-01 | 7.064E-01 | 1.589E+00 | 2.431E+00 | 2.445E+00 | 1.873E+00 | 3.387E-01 | 0.000E+00 |
| Ra-226 | ΣDSR(j) | | 2.866E+00 | 2.957E+00 | 3.132E+00 | 3.675E+00 | 4.805E+00 | 7.035E+00 | 8.732E+00 | 6.268E+00 | 1.137E+00 | 0.000E+00 |
| Ra-228 | Ra-228 | 1.000E+00 | 7.808E-01 | 6.985E-01 | 5.590E-01 | 2.563E-01 | 2.784E-02 | 1.244E-04 | 5.056E-05 | 3.914E-11 | 0.000E+00 | 0.000E+00 |
| Ra-228 | Th-228 | | 0.000E+00 | 5.402E-01 | 1.035E+00 | 8.253E-01 | 9.280E-02 | 3.183E-05 | 1.071E-07 | 4.703E-12 | 0.000E+00 | 0.000E+00 |
| Ra-228 | ΣDSR(j) | | 7.808E-01 | 1.239E+00 | 1.594E+00 | 1.082E+00 | 1.206E-01 | 1.562E-04 | 5.067E-05 | 4.384E-11 | 0.000E+00 | 0.000E+00 |
| Th-228 | Th-228 | 1.000E+00 | 1.879E+00 | 1.319E+00 | 6.499E-01 | 5.454E-02 | 4.592E-05 | 7.957E-16 | 1.644E-23 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Th-230 | Th-230 | 1.000E+00 | 1.300E-02 | 1.308E-02 | 1.324E-02 | 1.379E-02 | 1.536E-02 | 2.102E-02 | 2.561E-02 | 2.556E-02 | 2.536E-02 | 0.000E+00 |
| Th-230 | Ra-226 | | 0.000E+00 | 1.247E-03 | 3.777E-03 | 1.302E-02 | 4.328E-02 | 2.239E-01 | 4.882E-01 | 8.299E-01 | 1.435E+00 | 4.677E-05 |
| Th-230 | Pb-210 | | 0.000E+00 | 1.771E-05 | 1.562E-04 | 1.620E-03 | 1.213E-02 | 8.172E-02 | 1.410E-01 | 2.797E-01 | 5.327E-01 | 0.000E+00 |
| Th-230 | ΣDSR(j) | | 1.300E-02 | 1.435E-02 | 1.717E-02 | 2.842E-02 | 7.077E-02 | 3.267E-01 | 6.548E-01 | 1.135E+00 | 1.993E+00 | 4.677E-05 |
| Th-232 | Th-232 | 1.000E+00 | 6.861E-02 | 6.901E-02 | 6.981E-02 | 7.261E-02 | 8.062E-02 | 1.087E-01 | 1.292E-01 | 1.291E-01 | 1.289E-01 | 0.000E+00 |
| Th-232 | Ra-228 | | 0.000E+00 | 8.941E-02 | 2.438E-01 | 6.046E-01 | 1.039E+00 | 2.290E+00 | 3.957E+00 | 3.955E+00 | 3.949E+00 | 0.000E+00 |
| Th-232 | Th-228 | | 0.000E+00 | 3.525E-02 | 2.387E-01 | 1.144E+00 | 2.283E+00 | 4.255E+00 | 6.481E+00 | 6.479E+00 | 6.468E+00 | 0.000E+00 |
| Th-232 | ΣDSR(j) | | 6.861E-02 | 1.937E-01 | 5.523E-01 | 1.821E+00 | 3.402E+00 | 6.654E+00 | 1.057E+01 | 1.056E+01 | 1.055E+01 | 0.000E+00 |
| U-234 | U-234 | 1.000E+00 | 3.808E-03 | 3.829E-03 | 3.871E-03 | 4.012E-03 | 8.098E-03 | 2.383E-02 | 2.893E-02 | 1.924E-02 | 2.304E-03 | 0.000E+00 |
| U-234 | Th-230 | | 0.000E+00 | 1.176E-07 | 3.560E-07 | 1.224E-06 | 3.982E-06 | 1.654E-05 | 2.832E-05 | 4.697E-05 | 7.757E-05 | 5.927E-08 |
| U-234 | Ra-226 | | 0.000E+00 | 5.612E-09 | 5.092E-08 | 5.829E-07 | 5.839E-06 | 9.625E-05 | 3.054E-04 | 9.561E-04 | 3.752E-03 | 2.778E-05 |
| U-234 | Pb-210 | | 0.000E+00 | 5.327E-11 | 1.416E-09 | 4.965E-08 | 1.236E-06 | 2.910E-05 | 7.636E-05 | 2.965E-04 | 1.394E-03 | 0.000E+00 |
| U-234 | ΣDSR(j) | | 3.808E-03 | 3.829E-03 | 3.871E-03 | 4.014E-03 | 8.109E-03 | 2.397E-02 | 2.934E-02 | 2.054E-02 | 7.528E-03 | 2.784E-05 |
| U-235 | U-235 | 1.000E+00 | 1.781E-02 | 1.812E-02 | 1.875E-02 | 2.114E-02 | 3.361E-02 | 1.282E-01 | 3.152E-01 | 2.083E-01 | 2.960E-02 | 0.000E+00 |
| U-235 | Pa-231 | | 0.000E+00 | 3.655E-06 | 1.102E-05 | 3.738E-05 | 1.932E-04 | 1.447E-03 | 2.740E-03 | 4.378E-03 | 1.951E-03 | 0.000E+00 |
| U-235 | Ac-227 | | 0.000E+00 | 1.278E-07 | 1.140E-06 | 1.388E-05 | 3.154E-04 | 4.449E-03 | 8.440E-03 | 1.317E-02 | 5.832E-03 | 0.000E+00 |
| U-235 | ΣDSR(j) | | 1.781E-02 | 1.812E-02 | 1.876E-02 | 2.120E-02 | 3.411E-02 | 1.341E-01 | 3.263E-01 | 2.258E-01 | 3.739E-02 | 0.000E+00 |
| U-238 | U-238 | 1.000E+00 | 1.263E-02 | 1.274E-02 | 1.297E-02 | 1.377E-02 | 1.991E-02 | 4.741E-02 | 6.827E-02 | 4.522E-02 | 6.076E-03 | 0.000E+00 |
| U-238 | U-234 | | 0.000E+00 | 1.083E-08 | 3.285E-08 | 1.135E-07 | 6.117E-07 | 4.652E-06 | 8.724E-06 | 1.395E-05 | 6.256E-06 | 0.000E+00 |
| U-238 | Th-230 | | 0.000E+00 | 1.663E-13 | 1.509E-12 | 1.724E-11 | 1.666E-10 | 2.232E-09 | 5.597E-09 | 1.722E-08 | 6.477E-08 | 1.637E-11 |
| U-238 | Ra-226 | | 0.000E+00 | 5.290E-15 | 1.440E-13 | 5.483E-12 | 1.648E-10 | 8.863E-09 | 4.156E-08 | 2.490E-07 | 2.592E-06 | 9.238E-09 |
| U-238 | Pb-210 | | 0.000E+00 | 3.674E-17 | 3.015E-15 | 3.557E-13 | 2.779E-11 | 2.285E-09 | 9.124E-09 | 7.107E-08 | 9.404E-07 | 0.000E+00 |
| U-238 | ΣDSR(j) | | 1.263E-02 | 1.274E-02 | 1.297E-02 | 1.377E-02 | 1.991E-02 | 4.742E-02 | 6.828E-02 | 4.524E-02 | 6.086E-03 | 9.255E-09 |

The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Summary : Haywood residences, unit 1 mean resident subsrface, MFMAY1.002, EPA
File : MFMAY1.002

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 100 mrem/yr

| Nuclide (i) | t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 1.500E+02 | 3.000E+02 | 1.000E+03 | 3.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ac-227 | 2.626E+02 | 2.702E+02 | 2.859E+02 | 1.817E+02 | 7.384E+01 | 4.106E+02 | 2.647E+03 | 9.019E+05 | *7.244E+13 | *7.244E+1 |
| Pa-231 | 5.796E+02 | 5.406E+02 | 4.781E+02 | 3.124E+02 | 6.863E+01 | 2.223E+01 | 2.041E+01 | 3.105E+01 | 2.635E+02 | *4.716E+1 |
| Pb-210 | 3.763E+01 | 3.881E+01 | 4.130E+01 | 5.133E+01 | 9.560E+01 | 7.763E+02 | 2.947E+03 | 3.084E+04 | *7.631E+13 | *7.631E+13 |
| Ra-226 | 3.489E+01 | 3.381E+01 | 3.193E+01 | 2.721E+01 | 2.081E+01 | 1.421E+01 | 1.145E+01 | 1.595E+01 | 8.798E+01 | *9.882E+1 |
| Ra-228 | 1.281E+02 | 8.073E+01 | 6.275E+01 | 9.246E+01 | 8.289E+02 | 6.402E+05 | 1.974E+06 | 2.281E+12 | *2.721E+14 | *2.721E+1 |
| Th-228 | 5.321E+01 | 7.580E+01 | 1.539E+02 | 1.834E+03 | 2.178E+06 | *8.192E+14 | *8.192E+14 | *8.192E+14 | *8.192E+14 | *8.192E+14 |
| Th-230 | 7.691E+03 | 6.971E+03 | 5.824E+03 | 3.518E+03 | 1.413E+03 | 3.061E+02 | 1.527E+02 | 8.810E+01 | 5.017E+01 | 2.138E+0 |
| Th-232 | 1.458E+03 | 5.163E+02 | 1.810E+02 | 5.490E+01 | 2.939E+01 | 1.503E+01 | 9.463E+00 | 9.467E+00 | 9.482E+00 | *1.092E+0 |
| U-234 | 2.626E+04 | 2.612E+04 | 2.583E+04 | 2.491E+04 | 1.233E+04 | 4.172E+03 | 3.409E+03 | 4.869E+03 | 1.328E+04 | 3.592E+06 |
| U-235 | 5.615E+03 | 5.519E+03 | 5.331E+03 | 4.718E+03 | 2.931E+03 | 7.458E+02 | 3.064E+02 | 4.428E+02 | 2.675E+03 | *2.160E+0 |
| U-238 | 7.917E+03 | 7.848E+03 | 7.713E+03 | 7.261E+03 | 5.023E+03 | 2.109E+03 | 1.465E+03 | 2.211E+03 | 1.643E+04 | *3.360E+0 |

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 385.3 ± 0.4 years

| Nuclide (i) | Initial pCi/g | tmin (years) | DSR(i,tmin) | G(i,tmin) (pCi/g) | DSR(i,tmax) | G(i,tmax) (pCi/g) |
|---|---|---|---|---|---|---|
| Ac-227 | 1.200E-01 | 49.55 ± 0.05 | 1.639E+00 | 6.102E+01 | 3.977E-06 | 2.515E+07 |
| Pa-231 | 1.200E-01 | 149.9 ± 0.1 | 4.900E+00 | 2.041E+01 | 2.495E+00 | 4.008E+01 |
| Pb-210 | 3.000E-01 | 0.000E+00 | 2.658E+00 | 3.763E+01 | 2.068E-04 | 4.835E+05 |
| Ra-226 | 3.000E-01 | 150.1 ± 0.2 | 8.729E+00 | 1.146E+01 | 5.103E+00 | 1.960E+01 |
| Ra-228 | 1.570E+00 | 3.722 ± 0.004 | 1.612E+00 | 6.202E+01 | 1.393E-12 | 7.179E+13 |
| Th-228 | 1.570E+00 | 0.000E+00 | 1.879E+00 | 5.321E+01 | 0.000E+00 | *8.192E+14 |
| Th-230 | 2.320E+00 | 1057 ± 1 | 2.002E+00 | 4.994E+01 | 1.341E+00 | 7.458E+01 |
| Th-232 | 1.570E+00 | 150.2 ± 0.2 | 1.057E+01 | 9.463E+00 | 1.056E+01 | 9.468E+00 |
| U-234 | 2.320E+00 | 130.6 ± 0.1 | 3.011E-02 | 3.321E+03 | 1.682E-02 | 5.945E+03 |
| U-235 | 1.200E-01 | 150.2 ± 0.2 | 3.262E-01 | 3.065E+02 | 1.824E-01 | 5.482E+02 |
| U-238 | 2.320E+00 | 150.3 ± 0.2 | 6.827E-02 | 1.465E+03 | 3.549E-02 | 2.818E+03 |

*At specific activity limit

# APPENDIX F-3

# SLOPE FACTOR CANCER RISK FROM SURFACE SOILS

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 0.000E+00 years

| | Water Independent Pathways | | | | | Water Dependent Pathways | | | | | Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | Dust pCi/yr | Plant pCi/yr | Meat pCi/yr | Milk pCi/yr | Soil pCi/yr | Water pCi/yr | Fish pCi/yr | Plant pCi/yr | Meat pCi/yr | Milk pCi/yr | Ingestio pCi/yr |
| Ac-227 | 0.351E-02 | 0.507E+00 | 0.000E+00 | 0.000E+00 | 0.800E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.131E+ |
| Pa-231 | 0.351E-02 | 0.507E+00 | 0.000E+00 | 0.000E+00 | 0.800E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.131E+ |
| Pb-210 | 0.107E-01 | 0.413E+02 | 0.000E+00 | 0.000E+00 | 0.245E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.437E+02 |
| Ra-226 | 0.107E-01 | 0.883E+00 | 0.000E+00 | 0.000E+00 | 0.245E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.333E+ |
| Ra-228 | 0.594E-01 | 0.489E+01 | 0.000E+00 | 0.000E+00 | 0.135E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.184E+ |
| Th-228 | 0.594E-01 | 0.143E+02 | 0.000E+00 | 0.000E+00 | 0.135E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.278E+02 |
| Th-230 | 0.699E-01 | 0.168E+02 | 0.000E+00 | 0.000E+00 | 0.159E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.328E+ |
| Th-232 | 0.594E-01 | 0.143E+02 | 0.000E+00 | 0.000E+00 | 0.135E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.278E+ |
| U-234 | 0.699E-01 | 0.101E+02 | 0.000E+00 | 0.000E+00 | 0.159E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.261E+02 |
| U-235 | 0.351E-02 | 0.507E+00 | 0.000E+00 | 0.000E+00 | 0.800E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.131E+01 |
| U-238 | 0.699E-01 | 0.101E+02 | 0.000E+00 | 0.000E+00 | 0.159E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.261E+ |

* Sum of all ingestion pathways, i.e. water indepent plant, meat, milk, soil and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 0.000E+00 years

| | Radionuclides | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Radon Pathway | Rn-222 | Po-218 | Pb-214 | Bi-214 | Rn-220 | Po-216 | Pb-212 | Bi-212 |
| Water-ind. | 0.252E+03 | 0.213E+03 | 0.931E+02 | 0.478E+02 | 0.247E+05 | 0.239E+05 | 0.461E+03 | 0.118E+03 |
| Water-dep. | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Total | 0.252E+03 | 0.213E+03 | 0.931E+02 | 0.478E+02 | 0.247E+05 | 0.239E+05 | 0.461E+03 | 0.118E+03 |

Water-ind. == Water-independent Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Independent Pathways

| Radio-Nuclide | Ground | | Dust | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Ac-227 | 5.474E-07 | 0.0060 | 2.776E-09 | 0.0000 | 1.596E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.519E-09 | 0.0000 |
| Pa-231 | 1.689E-08 | 0.0002 | 1.136E-09 | 0.0000 | 4.196E-10 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.621E-10 | 0.0000 |
| Pb-210 | 3.393E-10 | 0.0000 | 3.860E-10 | 0.0000 | 2.452E-07 | 0.0027 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.453E-08 | 0.0002 |
| Ra-226 | 1.068E-05 | 0.1174 | 2.895E-10 | 0.0000 | 9.535E-10 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.642E-09 | 0.0000 |
| Ra-228 | 2.903E-05 | 0.3191 | 3.688E-10 | 0.0000 | 4.401E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.219E-08 | 0.0001 |
| Th-228 | 4.964E-05 | 0.5456 | 4.169E-08 | 0.0005 | 7.077E-09 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.706E-09 | 0.0001 |
| Th-230 | 7.742E-10 | 0.0000 | 1.824E-08 | 0.0002 | 1.969E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.866E-09 | 0.0000 |
| Th-232 | 3.183E-10 | 0.0000 | 1.496E-08 | 0.0002 | 1.544E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.463E-09 | 0.0000 |
| U-234 | 4.268E-10 | 0.0000 | 1.636E-08 | 0.0002 | 1.455E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.296E-09 | 0.0000 |
| U-235 | 1.699E-07 | 0.0019 | 7.887E-10 | 0.0000 | 7.298E-11 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.152E-10 | 0.0000 |
| U-238 | 4.492E-07 | 0.0049 | 3.271E-08 | 0.0004 | 2.547E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.019E-09 | 0.0000 |
| Total | 9.053E-05 | 0.9951 | 1.297E-07 | 0.0014 | 2.673E-07 | 0.0029 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.901E-08 | 0.0005 |

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water dependent Pathways

| Radio-Nuclide | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.543E-07 | 0.0061 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.910E-08 | 0.0002 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.605E-07 | 0.0029 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.068E-05 | 0.1174 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.905E-05 | 0.3193 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.969E-05 | 0.5462 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.285E-08 | 0.0003 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.829E-08 | 0.0002 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.053E-08 | 0.0002 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.709E-07 | 0.0019 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.884E-07 | 0.0054 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.098E-05 | 1.0000 |

** Sum of water independent ground, dust, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of Radon and its Decay Products at t= 0.000E+00 years

| Radon Pathway | Radionuclides | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Rn-222 | Po-218 | Pb-214 | Bi-214 | Rn-220 | Po-216 | Pb-212 | Bi-212 |
| Water-ind. | 0.165E-08 | 0.111E-08 | 0.243E-08 | 0.904E-09 | 0.267E-07 | 0.103E-09 | 0.178E-06 | 0.700E-08 |
| Water-dep. | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Total | 0.165E-08 | 0.111E-08 | 0.243E-08 | 0.904E-09 | 0.267E-07 | 0.103E-09 | 0.178E-06 | 0.700E-08 |

Water-ind. == Water-independent Water-dep. == Water-dependent

Total Excess Cancer Risk CNRSI(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p) and Fraction of Total Risk at t= 0.000E+00 years

Water Independent Pathways

| Radio-Nuclide | Ground | | Dust | | Plant | | Meat | | Milk | | Soil | | Radon | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Ac-227 | 5.474E-07 | 0.0060 | 2.776E-09 | 0.0000 | 1.596E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.519E-09 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 1.689E-08 | 0.0002 | 1.136E-09 | 0.0000 | 4.196E-10 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.621E-10 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 3.393E-10 | 0.0000 | 3.860E-10 | 0.0000 | 2.452E-07 | 0.0027 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.453E-08 | 0.0002 | 0.000E+00 | 0.0000 |
| Ra-226 | 1.068E-05 | 0.1171 | 2.895E-10 | 0.0000 | 9.535E-10 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.642E-09 | 0.0000 | 6.099E-09 | 0.0001 |
| Ra-228 | 2.903E-05 | 0.3183 | 3.688E-10 | 0.0000 | 4.401E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.219E-08 | 0.0001 | 0.000E+00 | 0.0000 |
| Th-228 | 4.964E-05 | 0.5443 | 4.169E-08 | 0.0005 | 7.077E-09 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.706E-09 | 0.0001 | 2.121E-07 | 0.0010 |
| Th-230 | 7.742E-10 | 0.0000 | 1.824E-08 | 0.0002 | 1.969E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.866E-09 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 3.183E-10 | 0.0000 | 1.496E-08 | 0.0002 | 1.544E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.463E-09 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 4.268E-10 | 0.0000 | 1.636E-08 | 0.0002 | 1.455E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.296E-09 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 1.699E-07 | 0.0019 | 7.887E-10 | 0.0000 | 7.298E-11 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.152E-10 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 4.492E-07 | 0.0049 | 3.271E-08 | 0.0004 | 2.547E-09 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.019E-09 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 9.053E-05 | 0.9927 | 1.297E-07 | 0.0014 | 2.673E-07 | 0.0029 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.901E-08 | 0.0005 | 2.182E-07 | 0.0024 |

Intrisk : Maywood residences, unit 1, mean resident surface, MFMAY1.001, EPA df
File : MFMAY1.001

Total Excess Cancer Risk CNRSI(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | Radon | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.543E-07 | 0.0061 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.910E-08 | 0.0002 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.605E-07 | 0.0029 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.069E-05 | 0.1172 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.905E-05 | 0.3185 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.991E-05 | 0.5472 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.285E-08 | 0.0003 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.829E-08 | 0.0002 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.053E-08 | 0.0002 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.709E-07 | 0.0019 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.884E-07 | 0.0054 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.120E-05 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

# APPENDIX F-4

# SLOPE FACTOR CANCER RISK FROM SUBSURFACE SOILS

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 0.000E+00 years

| | Water Independent Pathways | | | | | Water Dependent Pathways | | | | | Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | Dust | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion |
| | pCi/yr | pCi/yr | pCi/yr | pCi/yr | pCi/yr | pCi/yr | pCi/yr | pCi/yr | pCi/yr | pCi/yr | pCi/yr |
| Ac-227 | 0.000E+00 | 0.175E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.175E+01 |
| Pa-231 | 0.000E+00 | 0.175E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.175E+01 |
| Pb-210 | 0.000E+00 | 0.119E+03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.119E+03 |
| Ra-226 | 0.000E+00 | 0.245E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.245E+01 |
| Ra-228 | 0.000E+00 | 0.128E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.128E+02 |
| Th-228 | 0.000E+00 | 0.385E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.385E+02 |
| Th-230 | 0.000E+00 | 0.568E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.568E+02 |
| Th-232 | 0.000E+00 | 0.385E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.385E+02 |
| U-234 | 0.000E+00 | 0.338E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.338E+02 |
| U-235 | 0.000E+00 | 0.175E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.175E+01 |
| U-238 | 0.000E+00 | 0.338E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.338E+02 |

* Sum of all ingestion pathways, i.e. water indepent plant, meat, milk, soil and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 0.000E+00 years

| Radon Pathway | Radionuclides | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Rn-222 | Po-218 | Pb-214 | Bi-214 | Rn-220 | Po-216 | Pb-212 | Bi-212 |
| Water-ind. | 0.104E+05 | 0.969E+04 | 0.590E+04 | 0.400E+04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Water-dep. | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Total | 0.104E+05 | 0.969E+04 | 0.590E+04 | 0.400E+04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

Water-ind. == Water-independent Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Independent Pathways

| Radio-Nuclide | Ground | | Dust | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Ac-227 | 5.269E-08 | 0.0031 | 0.000E+00 | 0.0000 | 5.512E-09 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 1.511E-09 | 0.0001 | 0.000E+00 | 0.0000 | 1.449E-09 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 1.085E-11 | 0.0000 | 0.000E+00 | 0.0000 | 7.069E-07 | 0.0415 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 1.588E-06 | 0.0933 | 0.000E+00 | 0.0000 | 2.646E-09 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-228 | 3.773E-06 | 0.2215 | 0.000E+00 | 0.0000 | 1.154E-08 | 0.0007 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 1.079E-05 | 0.6334 | 0.000E+00 | 0.0000 | 1.904E-08 | 0.0011 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 9.437E-12 | 0.0000 | 0.000E+00 | 0.0000 | 6.650E-09 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 2.196E-12 | 0.0000 | 0.000E+00 | 0.0000 | 4.154E-09 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 7.490E-12 | 0.0000 | 0.000E+00 | 0.0000 | 4.872E-09 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 4.029E-09 | 0.0002 | 0.000E+00 | 0.0000 | 2.520E-10 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 5.213E-08 | 0.0031 | 0.000E+00 | 0.0000 | 8.526E-09 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 1.626E-05 | 0.9547 | 0.000E+00 | 0.0000 | 7.715E-07 | 0.0453 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water dependent Pathways

| Radio-Nuclide | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.820E-08 | 0.0034 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.960E-09 | 0.0002 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.069E-07 | 0.0415 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.591E-06 | 0.0934 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.784E-06 | 0.2222 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.081E-05 | 0.6345 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.660E-09 | 0.0004 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.156E-09 | 0.0002 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.879E-09 | 0.0003 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.281E-09 | 0.0003 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.066E-08 | 0.0036 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.703E-05 | 1.0000 |

** Sum of water independent ground, dust, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of Radon and its Decay Products at t= 0.000E+00 years

| Radon Pathway | Radionuclides | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Rn-222 | Po-218 | Pb-214 | Bi-214 | Rn-220 | Po-216 | Pb-212 | Bi-212 |
| Water-ind. | 0.685E-07 | 0.506E-07 | 0.154E-06 | 0.756E-07 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Water-dep. | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Total | 0.685E-07 | 0.506E-07 | 0.154E-06 | 0.756E-07 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

Water-ind. == Water-independent Water-dep. == Water-dependent

Total Excess Cancer Risk CNRSI(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p) and Fraction of Total Risk at t= 0.000E+00 years

Water Independent Pathways

| Radio-Nuclide | Ground | | Dust | | Plant | | Meat | | Milk | | Soil | | Radon | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Ac-227 | 5.269E-08 | 0.0030 | 0.000E+00 | 0.0000 | 5.512E-09 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pa-231 | 1.511E-09 | 0.0001 | 0.000E+00 | 0.0000 | 1.449E-09 | 0.0001 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Pb-210 | 1.085E-11 | 0.0000 | 0.000E+00 | 0.0000 | 7.069E-07 | 0.0407 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Ra-226 | 1.588E-06 | 0.0914 | 0.000E+00 | 0.0000 | 2.646E-09 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.486E-07 | 0.0201 |
| Ra-228 | 3.773E-06 | 0.2171 | 0.000E+00 | 0.0000 | 1.154E-08 | 0.0007 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-228 | 1.079E-05 | 0.6207 | 0.000E+00 | 0.0000 | 1.904E-08 | 0.0011 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-230 | 9.437E-12 | 0.0000 | 0.000E+00 | 0.0000 | 6.650E-09 | 0.0004 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Th-232 | 2.196E-12 | 0.0000 | 0.000E+00 | 0.0000 | 4.154E-09 | 0.0002 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-234 | 7.490E-12 | 0.0000 | 0.000E+00 | 0.0000 | 4.872E-09 | 0.0003 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-235 | 4.029E-09 | 0.0002 | 0.000E+00 | 0.0000 | 2.520E-10 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| U-238 | 5.213E-08 | 0.0030 | 0.000E+00 | 0.0000 | 8.526E-09 | 0.0005 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Total | 1.626E-05 | 0.9355 | 0.000E+00 | 0.0000 | 7.715E-07 | 0.0444 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.486E-07 | 0.0201 |

Total Excess Cancer Risk CNRSI(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water dependent Pathways

| Radio-Nuclide | Water | | Fish | | Plant | | Meat | | Milk | | Radon | | All pathway | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Ac-227 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.820E-08 | 0.0[illegible]3 |
| Pa-231 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.960E-09 | 0.0002 |
| Pb-210 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.069E-07 | 0.04[illegible]7 |
| Ra-226 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.940E-06 | 0.1[illegible]6 |
| Ra-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.784E-06 | 0.2178 |
| Th-228 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.081E-05 | 0.6218 |
| Th-230 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.660E-09 | 0.0[illegible]4 |
| Th-232 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.156E-09 | 0.0[illegible]2 |
| U-234 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.879E-09 | 0.0003 |
| U-235 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.281E-09 | 0.0[illegible]2 |
| U-238 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.066E-08 | 0.0[illegible] |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.738E-05 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

# APPENDIX G

# RADIOLOGICAL SLOPE FACTOR RISKS

# APPENDIX G

## RADIOLOGICAL SLOPE FACTOR RISKS

Appendix G contains information supporting the comparison of slope factor risk to the dose/risk results. RESRAD risks were corrected to account for the use of measured data, this process is described.


| | |
|---|---|
| Table G-1 | Slope Factor Risk - Current Employee |
| Table G-2 | Slope Factor Risk - Current Resident (Child) |
| Table G-3 | Slope Factor Risk - Current Resident (Adult) |
| Table G-4 | Slope Factor Risk - Current Resident (Adult and Child) |
| Table G-5 | Slope Factor Risk - Current Transient |
| Table G-6 | Slope Factor Risk - Future Employee |
| Table G-7 | Slope Factor Risk - Future Resident (Child) |
| Table G-8 | Slope Factor Risk - Future Resident (Adult) |
| Table G-9 | Slope Factor Risk - Future Resident (Adult and Child) |
| Table G-10 | Slope Factor Risk - Future Transient |
| Table G-11 | Dose Factor Vs. FS Risk Comparison |
| Table G-12 | Slope Factor Risk Incorporating Actual Measured Data |

# Table G-1. Slope Factor Risk - Current Employee

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | TOTAL w/o Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | | | | | | | | | | | | | | |
| | UNIT 2 | | | | | | | | | | | | | | |
| STEPAN | UNIT 3 | 8E-09 | 7E-08 | NP | NP | 1E-07 | 2E-06 | 1E-05 | 3E-05 | 1E-05 | 3E-05 | 5E-05 | 1E-04 | 6E-05 | 1E-04 |
| | UNIT 3H | 4E-08 | 3E-07 | NP | NP | 5E-07 | 6E-06 | 3E-05 | 9E-05 | 3E-05 | 1E-04 | 1E-04 | 2E-04 | 1E-04 | 3E-04 |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 5E-09 | 4E-08 | NP | NP | 1E-07 | 1E-06 | 2E-05 | 1E-04 | 2E-05 | 1E-04 | 0E+00 | 0E+00 | 2E-05 | 1E-04 |
| | UNIT 6 (MISS) | 2E-08 | 2E-07 | NP | NP | 5E-07 | 6E-06 | 2E-04 | 8E-04 | 2E-04 | 8E-04 | 1E-04 | 1E-04 | 3E-04 | 9E-04 |
| | UNIT 6H | 0E+00 | 0E+00 | 0E+00 | 0E+00 | 0E+00 | 0E+00 | 4E-04 | 1E-03 | 4E-04 | 1E-03 | 7E-05 | 6E-04 | 4E-04 | 2E-03 |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | |
| | UNIT 7 | 4E-08 | 3E-07 | NP | NP | 1E-06 | 1E-05 | 2E-05 | 8E-05 | 2E-05 | 9E-05 | 0E+00 | 4E-05 | 2E-05 | 1E-04 |
| | UNIT 7H | 9E-08 | 7E-07 | NP | NP | 2E-06 | 2E-05 | 3E-04 | 2E-03 | 3E-04 | 2E-03 | 8E-05 | 1E-04 | 3E-04 | 2E-03 |
| | UNIT 8 | | | | | | | | | | | | | | |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

ND = No Data

## Table G-2. Slope Factor Risk - Current Resident (Child)

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 5E-08 | 1E-07 | 0E+00 | 0E+00 | 9E-08 | 3E-07 | 6E-05 | 1E-04 | 7E-07 | 1E-06 | 6E-05 | 1E-04 | 7E-05 | 5E-04 | 1E-04 | 6E-04 |
| | UNIT 2 | 1E-07 | 3E-07 | 0E+00 | 0E+00 | 3E-07 | 9E-07 | 2E-06 | 8E-06 | 2E-06 | 3E-06 | 4E-06 | 1E-05 | 0E+00 | 0E+00 | 4E-06 | 1E-05 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | | | |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

# Table G-3. Slope Factor Risk - Current Resident (Adult)

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 5E-08 | 3E-07 | 0E+00 | 0E+00 | 1E-07 | 1E-06 | 9E-05 | 7E-04 | 2E-06 | 6E-06 | 9E-05 | 7E-04 | 7E-05 | 5E-04 | 2E-04 | 1E-03 |
| | UNIT 2 | 1E-07 | 9E-07 | 0E+00 | 0E+00 | 4E-07 | 4E-06 | 3E-06 | 4E-05 | 4E-06 | 1E-05 | 8E-06 | 5E-05 | 0E+00 | 0E+00 | 8E-06 | 5E-05 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | | | |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

## Table G-4. Slope Factor Risk - Current Resident (Adult and Child)

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 5E-08 | 3E-07 | 0E+00 | 0E+00 | 1E-07 | 1E-06 | 7E-05 | 6E-04 | 1E-06 | 5E-06 | 7E-05 | 6E-04 | 7E-05 | 5E-04 | 1E-04 | 1E-03 |
| | UNIT 2 | 1E-07 | 8E-07 | 0E+00 | 0E+00 | 3E-07 | 3E-06 | 2E-06 | 3E-05 | 2E-06 | 1E-05 | 5E-06 | 5E-05 | 0E+00 | 0E+00 | 5E-06 | 5E-05 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | | | |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

# Table G-5. Slope Factor Risk - Current Transient

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | TOTAL w/o Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | | | | | | | | | | | | | | |
| | UNIT 2 | | | | | | | | | | | | | | |
| STEPAN | UNIT 3 | 1E-11 | 1E-09 | NP | NP | 4E-09 | 5E-08 | 0E+00 | 1E-05 | 4E-09 | 1E-05 | 1E-07 | 1E-05 | 1E-07 | 3E-05 |
| | UNIT 3H | | | | | | | | | | | | | | |
| MUNICIPAL PA | UNIT4 | 5E-12 | 4E-10 | NP | NP | 2E-09 | 2E-08 | 1E-06 | 6E-05 | 1E-06 | 6E-05 | 0E+00 | 0E+00 | 1E-06 | 6E-05 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | 4E-11 | 3E-09 | NP | NP | 2E-08 | 2E-07 | 7E-06 | 2E-04 | 7E-06 | 2E-04 | 4E-06 | 5E-06 | 1E-05 | 2E-04 |
| | UNIT 6H | 0E+00 | 0E+00 | NP | NP | 0E+00 | 0E+00 | 5E-05 | 2E-03 | 5E-05 | 2E-03 | 3E-06 | 3E-05 | 5E-05 | 2E-03 |
| | UNIT 6B (BALLOD) | 0E+00 | 0E+00 | NP | NP | 0E+00 | 0E+00 | 8E-06 | 7E-05 | 8E-06 | 7E-05 | 1E-05 | 2E-04 | 2E-05 | 3E-04 |
| | UNIT 7 | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | |
| | UNIT 8 | 6E-11 | 1E-09 | NP | NP | 2E-08 | 3E-07 | 1E-05 | 4E-05 | 1E-05 | 4E-05 | 3E-07 | 5E-05 | 1E-05 | 9E-05 |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

# Table G-6. Slope Factor Risk - Future Employee

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | TOTAL w/o Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | | | | | | | | | | | | | | |
| | UNIT 2 | | | | | | | | | | | | | | |
| STEPAN | UNIT 3 | 8E-09 | 7E-08 | 0E+00 | 0E+00 | 1E-07 | 2E-06 | 1E-05 | 3E-05 | 1E-05 | 3E-05 | 5E-05 | 1E-04 | 6E-05 | 1E-04 |
| | UNIT 3H | 7E-08 | 6E-07 | 5E-07 | 4E-06 | 9E-07 | 1E-05 | 3E-05 | 1E-04 | 3E-05 | 1E-04 | 1E-04 | 2E-04 | 1E-04 | 3E-04 |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | 4E-08 | 3E-07 | 5E-07 | 3E-06 | 7E-07 | 8E-06 | 2E-04 | 8E-04 | 2E-04 | 8E-04 | 1E-04 | 1E-04 | 3E-04 | 9E-04 |
| | UNIT 6H | 7E-07 | 7E-06 | 5E-06 | 4E-05 | 1E-05 | 1E-04 | 4E-04 | 1E-03 | 4E-04 | 2E-03 | 1E-04 | 1E-03 | 5E-04 | 3E-03 |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | |
| | UNIT 8 | 6E-08 | 8E-07 | 3E-07 | 3E-06 | 1E-06 | 2E-05 | 5E-04 | 4E-03 | 5E-04 | 4E-03 | 3E-05 | 6E-05 | 5E-04 | 4E-03 |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

ND = No Data

## Table G-7. Slope Factor Risk - Future Resident (Child)

| | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 5E-08 | 1E-07 | 0E+00 | 0E+00 | 9E-08 | 3E-07 | 6E-05 | 1E-04 | 7E-07 | 1E-06 | 6E-05 | 1E-04 | 7E-05 | 5E-04 | 1E-04 | 6E-04 |
| | UNIT 2 | 1E-07 | 3E-07 | 0E+00 | 0E+00 | 3E-07 | 9E-07 | 2E-06 | 8E-06 | 2E-06 | 3E-06 | 4E-06 | 1E-05 | 0E+00 | 0E+00 | 4E-06 | 1E-05 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | 3E-08 | 8E-08 | 2E-08 | 4E-08 | 4E-08 | 2E-07 | 7E-05 | 1E-04 | 4E-07 | 8E-07 | 7E-05 | 1E-04 | 0E+00 | 0E+00 | 7E-05 | 1E-04 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 4E-08 | 1E-07 | 0E+00 | 0E+00 | 7E-08 | 2E-07 | 6E-05 | 9E-05 | 5E-07 | 1E-06 | 6E-05 | 9E-05 | 0E+00 | 0E+00 | 6E-05 | 9E-05 |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | 1E-06 | 7E-06 | 9E-07 | 4E-06 | 2E-06 | 1E-05 | 2E-03 | 6E-03 | 5E-05 | 1E-04 | 2E-03 | 6E-03 | 4E-05 | 9E-05 | 2E-03 | 6E-03 |
| | UNIT 7 | 5E-07 | 1E-06 | 8E-07 | 2E-06 | 6E-07 | 2E-06 | 3E-05 | 3E-05 | 1E-05 | 3E-05 | 4E-05 | 6E-05 | 0E+00 | 1E-04 | 4E-05 | 2E-04 |
| | UNIT 7H | 8E-07 | 2E-06 | 0E+00 | 0E+00 | 1E-06 | 4E-06 | 7E-04 | 2E-03 | 1E-05 | 3E-05 | 7E-04 | 2E-03 | 5E-04 | 7E-04 | 1E-03 | 3E-03 |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

## Table G-8. Slope Factor Risk - Future Resident (Adult)

| | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 5E-08 | 3E-07 | 0E+00 | 0E+00 | 1E-07 | 1E-06 | 9E-05 | 7E-04 | 2E-06 | 6E-06 | 9E-05 | 7E-04 | 7E-05 | 5E-04 | 2E-04 | 1E-03 |
| | UNIT 2 | 1E-07 | 9E-07 | 0E+00 | 0E+00 | 4E-07 | 4E-06 | 3E-06 | 3E-05 | 4E-06 | 1E-05 | 8E-06 | 4E-05 | 0E+00 | 0E+00 | 8E-06 | 4E-05 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | 3E-08 | 4E-07 | 8E-08 | 5E-07 | 6E-08 | 1E-06 | 1E-04 | 7E-04 | 8E-07 | 4E-06 | 1E-04 | 7E-04 | 0E+00 | 0E+00 | 1E-04 | 7E-04 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 4E-08 | 3E-07 | 0E+00 | 0E+00 | 9E-08 | 9E-07 | 1E-04 | 4E-04 | 1E-06 | 5E-06 | 1E-04 | 4E-04 | 0E+00 | 0E+00 | 1E-04 | 4E-04 |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | 1E-06 | 2E-05 | 5E-06 | 4E-05 | 3E-06 | 5E-05 | 3E-03 | 3E-02 | 5E-05 | 6E-04 | 3E-03 | 3E-02 | 4E-05 | 9E-05 | 3E-03 | 3E-02 |
| | UNIT 7 | 4E-07 | 4E-06 | 3E-06 | 2E-05 | 8E-07 | 1E-05 | 4E-05 | 1E-04 | 3E-05 | 1E-04 | 7E-05 | 3E-04 | 0E+00 | 1E-04 | 7E-05 | 4E-04 |
| | UNIT 7H | 7E-07 | 5E-06 | 0E+00 | 0E+00 | 2E-06 | 2E-05 | 1E-03 | 8E-03 | 2E-05 | 1E-04 | 1E-03 | 9E-03 | 5E-04 | 7E-04 | 2E-03 | 9E-03 |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

## Table G-9. Slope Factor Risk - Future Resident (Adult and Child)

| | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | PLANT ING. | | TOTAL W/O Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | 5E-08 | 3E-07 | 0E+00 | 0E+00 | 1E-07 | 1E-06 | 7E-05 | 6E-04 | 1E-06 | 5E-06 | 7E-05 | 6E-04 | 7E-05 | 5E-04 | 1E-04 | 1E-03 |
| | UNIT 2 | 1E-07 | 8E-07 | 0E+00 | 0E+00 | 3E-07 | 3E-06 | 2E-06 | 2E-05 | 2E-06 | 1E-05 | 5E-06 | 4E-05 | 0E+00 | 0E+00 | 5E-06 | 4E-05 |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | 3E-08 | 3E-07 | 4E-08 | 4E-07 | 5E-08 | 1E-06 | 8E-05 | 6E-04 | 5E-07 | 3E-06 | 8E-05 | 6E-04 | 0E+00 | 0E+00 | 8E-05 | 6E-04 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 4E-08 | 2E-07 | 0E+00 | 0E+00 | 7E-08 | 8E-07 | 7E-05 | 4E-04 | 8E-07 | 4E-06 | 7E-05 | 4E-04 | 0E+00 | 0E+00 | 7E-05 | 4E-04 |
| | UNIT 6 (MISS) | | | | | | | | | | | | | | | | |
| | UNIT 6H | | | | | | | | | | | | | | | | |
| | UNIT 6B (BALLOD) | 1E-06 | 2E-05 | 2E-06 | 4E-05 | 2E-06 | 4E-05 | 2E-03 | 2E-02 | 5E-05 | 5E-04 | 3E-03 | 2E-02 | 4E-05 | 9E-05 | 3E-03 | 2E-02 |
| | UNIT 7 | 4E-07 | 3E-06 | 1E-06 | 2E-05 | 6E-07 | 9E-06 | 3E-05 | 1E-04 | 2E-05 | 1E-04 | 5E-05 | 3E-04 | 0E+00 | 1E-04 | 5E-05 | 4E-04 |
| | UNIT 7H | 8E-07 | 5E-06 | 0E+00 | 0E+00 | 1E-06 | 2E-05 | 1E-03 | 7E-03 | 1E-05 | 1E-04 | 1E-03 | 7E-03 | 5E-04 | 7E-04 | 1E-03 | 8E-03 |
| | UNIT 8 | | | | | | | | | | | | | | | | |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

# Table G-10. Slope Factor Risk - Future Transient

| LOCATION | PROPERTY UNIT | SOIL INGESTION | | WATER INGESTION | | INHALATION | | DIRECT RAD. | | TOTAL w/o Rn | | RADON | | TOTAL DOSE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME | X | RME |
| RESIDENTIAL | UNIT 1 | | | | | | | | | | | | | | |
| | UNIT 2 | | | | | | | | | | | | | | |
| STEPAN | UNIT 3 | | | | | | | | | | | | | | |
| | UNIT 3H | | | | | | | | | | | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | | | | | | | | | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | | | | | | | | | | | | |
| | UNIT 6 (MISS) | 6E-11 | 5E-09 | 0E+00 | 0E+00 | 2E-08 | 2E-07 | 7E-06 | 2E-04 | 7E-06 | 2E-04 | 3E-07 | 1E-06 | 7E-06 | 2E-04 |
| | UNIT 6H | 1E-09 | 3E-08 | NP | NP | 3E-07 | 4E-06 | 6E-05 | 2E-03 | 6E-05 | 2E-03 | 3E-06 | 3E-05 | 6E-05 | 2E-03 |
| | UNIT 6B (BALLOD) | | | | | | | | | | | | | | |
| | UNIT 7 | | | | | | | | | | | | | | |
| | UNIT 7H | | | | | | | | | | | | | | |
| | UNIT 8 | | | | | | | | | | | | | | |

Bold cells indicate risk from actual measured values

X = Mean

RME = Reasonable Maximum Exposure

NP = No Pathway

ND = No Data

## Table G-11. Dose Factor vs. Slope Factor Risk Comparison*

| CURRENT USE SCENARIO | | | | | | | |
|---|---|---|---|---|---|---|---|
| LOCATION | PROPERTY UNIT | Employee Mean | Employee RME | Resident Mean | Resident RME | Transient Mean | Transient RME |
| RESIDENTIAL | UNIT 1 | | | 2.0 | 4.1 | | |
| | UNIT 2 | | | 6.4 | 4.6 | | |
| STEPAN | UNIT 3 | 1.5 | 4.8 | | | 1.85 | 3.6 |
| | UNIT 3H | 1.7 | 4.0 | | | | |
| MUNICIPAL PARKS | UNIT4 | | | | | 1.6 | 1.4 |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | 1.7 | 1.7 | | | | |
| | UNIT 6 (MISS) | 1.8 | 2.4 | | | 1.5 | 1.9 |
| | UNIT 6H | 1.8 | 1.5 | | | 1.7 | 1.8 |
| | UNIT 6B (BALLOD) | | | | | 0.7 | 0.6 |
| | UNIT 7 | 2.1 | 3.3 | | | | |
| | UNIT 7H | 1.7 | 2.1 | | | | |
| | UNIT 8 | | | | | 1.6 | 3.7 |
| FUTURE USE SCENARIO | | | | | | | |
| LOCATION | PROPERTY UNIT | Employee Mean | Employee RME | Resident Mean | Resident RME | Transient Mean | Transient RME |
| RESIDENTIAL | UNIT 1 | | | 2.0 | 4.1 | | |
| | UNIT 2 | | | 6.4 | 5.6 | | |
| STEPAN | UNIT 3 | 1.5 | 4.8 | | | | |
| | UNIT 3H | 1.8 | 4.0 | | | | |
| MUNICIPAL PARKS | UNIT4 | | | 2.1 | 1.7 | | |
| COMMERCIAL/ GOVERNMENT | UNIT 5 | | | 2.2 | 2.1 | | |
| | UNIT 6 (MISS) | 1.6 | 2.4 | | | 1.5 | 1.9 |
| | UNIT 6H | 2.3 | 1.7 | | | 1.4 | 1.6 |
| | UNIT 6B (BALLOD) | | | 2.2 | 2.0 | | |
| | UNIT 7 | | | 4.9 | 6.3 | | |
| | UNIT 7H | | | 1.8 | 1.9 | | |
| | UNIT 8 | 1.6 | 1.7 | | | | |

* Dose factor risk/slope factor risk

## G-12. Correction of Slope Factor Risk Using Measured Data

The RESRAD v4.6 computer code estimates excess cancer risk using the slope factor approach. The RESRAD risk estimates must be corrected to account for dose from measured data. If not corrected, the risks would be based on the calculated radiation doses and would not incorporate the available radiation survey data. The risks for the direct gamma irradiation and the radon pathways were corrected using the following formula.

$$A_{SF} = \frac{A_{DOSE}}{R_{DOSE}} (R_{SF})$$

where:

$A_{SF}$ = Actual data slope factor risk;
$A_{DOSE}$ = Actual data dose;
$R_{DOSE}$ = RESRAD dose; and
$R_{SF}$ = RESRAD slope factor risk.