SNL-2003


**Department of Energy**
**National Nuclear Security Administration**
Sandia Site Office
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AUG 04 2003

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Ms. Sandra Martin
Acting Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Road
Building E
Santa Fe, NM 87505

Dear Ms. Martin:

On behalf of the Department of Energy (DOE) and Sandia Corporation, DOE is responding to the New Mexico Environment Department (NMED) letter of May 2, 2003, Notice of Deficiency (NOD): Corrective Action Management Unit (CAMU) Class 1 Permit Modification Request for Risk-Based Containment of PCB-Contaminated Soils. The CAMU is authorized under the Hazardous and Solid Waste Amendments Module of the Resource Conservation and Recovery Act Permit for Sandia National Laboratories/ New Mexico (EPA ID No. NM5890110518). On May 30, 2003, DOE requested that the response time for this NOD be extended until August 2, 2003.

The risk-based containment request was submitted as a Class 1 modification to the CAMU Permit on August 23, 2002. A Request for Supplemental Information (RSI), identifying four topics requiring additional information, was transmitted by the NMED on January 28, 2003. DOE provided a response to the RSI on March 12, 2003. Two of the responses to the RSI, regarding comments #1 and #2, were deemed inadequate by the NMED in the NOD issued on May 2, 2003.

Enclosed are the supplemental responses to comments #1 and #2, plus the Risk Assessment Report for CAMU, dated July 2003.

If you have any questions regarding this response, please contact Joe Estrada of my staff at (505) 845-5326.

Sincerely,

Karen L. Boardman

Karen L. Boardman
Manager

Enclosures

AUG 04 2003

cc w/ enclosures:
W. Moats, NMED (Via Certified Mail)
J. Kieling, NMED
L. King, USEPA, Region VI (Via Certified Mail, 2 copies)
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CAMU Site Operating Record, Attn: M. Shain, SNL, MS 1151

cc w/o enclosures:
J. Estrada, NNSA//SSO
F. Nimick, SNL, MS 1087

**RSI Comment 1.** The NOD provided the following clarifying direction in addressing RSI comment #1, which specified that an additional risk assessment for the CAMU (not just the polychlorinated biphenyl (PCB)-contaminated soils) was needed: *The risk assessment shall present the risks associated with the condition where engineered controls (such as the liner and cover) fail and no risk benefit is claimed for these controls. It shall also present the risks associated with the engineered controls when the controls are performing as intended. Evaluation of total cumulative risk posed by all contaminants including PCBs, RCRA constituents (including lead), and radionuclides needs to be included. The PCB and lead risks may be presented separate from other contaminants as has been agreed to in the past. This information will be used to document, in part, the contents of the CAMU containment cell.*

The risk assessment presented in the Class 1 submittal (August 23, 2002) evaluated the containment in the CAMU cell of approximately 2,445 cubic yards of soils excavated from the Chemical Waste Landfill. These soils contained PCBs in concentrations greater than or equal to 50 parts per million and also contained volatile and semi volatile organics above the CAMU treatment levels. The risk assessment demonstrated that the PCB-contaminated soils met the risk-based containment criteria established in Section 3.1.1 of the CAMU permit application and are suitable for CAMU containment under these criteria. In the NMED response, an additional risk assessment of the CAMU was requested, considering all constituents of concerns, under two scenarios (assuming no engineering controls and assuming the intended performance of all existing engineering controls). This total risk assessment, presented in Enclosure 1, has been provided for both scenarios as requested. The risk assessment uses the same format and guidance implemented for risk assessments of SNL environmental restoration sites. We note that, under the no engineering controls scenario, the risk presented by the CAMU is conservatively overestimated and is not representative of actual or expected performance of the CAMU containment cell.

**RSI Comment 2.** The NOD stated that the response to RSI comment #2 was inadequate. RSI comment 2 reads as follows: *It is stated that the maximum concentration for lead is 14,700 mg/kg. However, Section 3.2 (Table 3-1) of the CAMU Permit requires that wastes that exceed the threshold concentrations be treated. Confirm that all soils that exceeded their respective CAMU Permit thresholds were treated before being placed into the CAMU cell.*

The response to RSI comment #2 focused on the treatment of constituents in the PCB-contaminated soils, rather than on the larger question of treatment prior to placement in the CAMU cell. We regret the limited response and submit the following clarification. All soils (with the exception of the 2,445 cubic yards of PCB-contaminated soils that were subject to the risk-based containment request) containing RCRA constituents at levels exceeding their respective CAMU treatment standards were treated prior to containment. The PCB-contaminated soils that were the subject of the risk-based containment request contained organic constituents above CAMU treatment standards; due to concerns associated with thermal treatment of PCBs, thermal desorption was not performed and the risk-based containment option was pursued. All PCB-contaminated soils that contained RCRA metals exceeding the CAMU treatment standards were treated using the stabilization process. In summary, all CAMU soils requiring treatment were treated using thermal desorption and/or stabilization, with the exception of the 2,445 cubic yards of PCB-contaminated soils that were not treated by thermal desorption, but were the subject of the risk-based containment request.

# CERTIFICATION STATEMENT FOR APPROVAL AND FINAL RELEASE OF DOCUMENTS

**Document title: CAMU Risk Assessment NOD Response, July 2003**

**Document author: Tommy Tharp, Dept. 6135**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

Signature: Peter B. Davies — 7/25/03

*Peter B. Davies*
*Director*
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Operator

Date

and

Signature: Karen L. Boardman — 8.4.03

Karen L. Boardman
Manager
U.S. Department of Energy
National Nuclear Security Administration
Sandia Site Office
Owner and Co-Operator

Date

Sandia National Laboratories/New Mexico
Environmental Restoration Project

# RISK ASSESSMENT REPORT FOR CORRECTIVE ACTION MANAGEMENT UNIT

**July 2003**

United States Department of Energy
Sandia Site Office

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# CAMU: RISK ASSESSMENT REPORT

## I. Site Description and History

Sandia National Laboratories/New Mexico (SNL/NM), a U.S. Department of Energy (DOE) facility located on Kirtland Air Force Base immediately southeast of Albuquerque, New Mexico, operates the Corrective Action Management Unit (CAMU). The CAMU is a facility permitted under Resource Conservation and Recovery Act (RCRA) to stage, treat, and contain remediation wastes resulting from SNL/NM environmental restoration (ER) activities. The CAMU is located in a 19-acre area.

A soil investigation conducted adjacent to the CAMU indicated moderately developed soil at the surface underlain by two buried soil types that are dominated by the accumulation of secondary calcium carbonate (SNL/NM October 1995). The surficial deposits are underlain by the Santa Fe Group sediments, which consist of a heterogeneous sequence of unconsolidated to semi-consolidated valley fill deposits (Hawley and Haase 1992, Lozinsky 1988). The sediments are composed primarily of cobbles, gravels, sands, silts, and clays of alluvial and fluvial origin. These sediments are locally cemented by caliche. The Santa Fe Group is overlain in places by Pliocene Ortiz gravel deposits and Rio Grande fluvial deposits. The aquifer in the area of the CAMU is located within the Santa Fe Group at a depth of approximately 485 feet below ground surface (bgs). The aquifer is unconfined to partially confined and is generally composed of interbedded clays, silts, and sands. Based upon water-level data from nearby monitoring wells, groundwater appears to flow toward the northwest at a rate of approximately 2 feet/year (yr) (SNL/NM 1993, SNL/NM 1992).

The area has a semiarid climate characterized by low precipitation, high evapotranspiration, wide temperature extremes, frequent drying winds, occasional heavy rain showers, and erratic, seasonal distribution of precipitation. The average annual precipitation in the area of the CAMU, as measured at Albuquerque International Sunport, is 8.1 inches (NOAA 1990). During operations of the CAMU, all surface water within the facility was collected in one of four collection ponds. Surface water in these ponds were sampled and analyzed prior to disposal to ensure no regulated compounds were released off site. During CAMU closure operations, these ponds have been decommissioned and filled, per CAMU permit criteria, and all surface water at the facility have been redirected to the original natural surface flow pattern. The Rio Grande, which flows from north to south, is located approximately 8 miles west of the CAMU and is the closest perennial surface water to the site. The ground surface in the vicinity of the CAMU has a gentle westward slope of about 2 percent, and surface-water drainage is generally west toward the Rio Grande. Surface water in the vicinity of the CAMU occurs primarily in the form of sheet flow that drains into small arroyos and is carried by natural and artificial flow paths (SNL/NM September 1996) into two playas.

The CAMU is a waste management facility that was used for the staging, treatment, and containment of remediation wastes that were generated as part of the excavation activities at the Chemical Waste Landfill (CWL). Remediation wastes, including contaminated soil, were generated during excavation activities at the CWL. The soil excavated from the CWL contained RCRA-regulated chemicals that were disposed of in unlined pits at the landfill from 1962 through 1981. Although the CWL excavation was initiated because of concerns surrounding the RCRA-regulated compounds disposed of in the landfill, historical disposal records and initial were treated prior to being placed in the contaminant cell with the exception of the PCB contaminated soil, which was only treated for RCRA metals. Both assessments are taking credit for the LTTD treatment for VOC/SVOC contaminants.

The risk assessment presented here considers the potential for adverse health effects from VOCs, SVOCs, RCRA metals, PCBs and H-3 under the industrial land use scenario with and without the engineering controls of the containment cell. The health effects are calculated in terms of excess cancer risk and hazard index (HI).

Under the no engineering controls scenario, the risk presented by the CAMU is conservatively overestimated and is not representative of actual or expected performance of the CAMU containment cell. The information presented does, however, reinforce the legitimacy of the decision to excavate the CWL and construct the highly engineered CAMU containment facility. The CAMU containment cell incorporates the following engineering controls: a 60-millimeter (mil.) high-density polyethylene liner, and geocomposite subliner, an active leachate collection and removal system and a VZMS to ensure the performance of the containment system. The waste is now encapsulated with a five-foot thick vegetative base cover system incorporating a capillary barrier comprised of sand and gravel layers, a native soil layer and a seeded topsoil section that cover the waste. A 60-mil. high-density polyethylene liner positioned at the base of the final cover system provides reinforced hydraulic control. The CAMU containment system is also subject to 30 years of post closure care. Post closure care activities include operation of the leachate collection and removal system, VZMS and maintenance of the final containment cell cover system.

## III. Data Quality Objectives

The Data Quality Objectives (DQOs) present the requirements necessary for producing defensible analytical data suitable for risk assessment purposes. The source of potential constituents of concern (COCs) contained in the soil excavated from the CWL was RCRA-regulated chemicals and PCBs.

Samples were collected from each 100 cubic yard pile of waste soil excavated from the CWL and each batch of soil treated to reduce VOC and SVOC concentrations (Table 1). The sampling conducted during excavation and treatment activities was designed to:

- Characterize the nature and extent of COCs present within the soil matrix.
- Provide sufficient quality of analytical data to support risk assessments.

The soil samples were analyzed for the following COCs: VOCs, SVOCs, RCRA metals, hexavalent chromium, PCBs, radionuclides, and H-3. Most soils were treated prior to containment; the sample analysis for these soils was conducted following treatment. Sample analyses were performed by the URS Corporation On-Site Mobile Laboratory (OSML), the ER Chemistry Laboratory (ERCL), General Engineering Laboratories, Inc. (GEL), Severn Trent Laboratories, Inc. (STL), and the Radioactive and Mixed Waste Management Facility (RMWMF). Table 2 summarizes the analytical requirements and the data quality level for soil pile characterization.

**Table 2**
**Summary of Data Quality Requirements**

| Analytical Requirement[a] | Data Quality Level | Number of Samples Submitted to Each Laboratory[b] | | | | |
|---|---|---|---|---|---|---|
| | | OSML | ERCL | GEL | STL | RMWMF |
| VOCs<br>EPA Method 8260A | Defensible | 0 | 41 | 36 | 4 | 0 |
| VOCs<br>EPA Method 8260B | Defensible | 82 | 0 | 88 | 0 | 0 |
| SVOCs<br>EPA Method 8270C | Defensible | 38 | 83 | 125 | 5 | 0 |
| RCRA Metals<br>EPA Method 6010B/7471A | Defensible | 185 | 0 | 14 | 0 | 0 |
| RCRA Metals<br>EPA Method 6020 | Defensible | 0 | 222 | 0 | 0 | 0 |
| Hexavalent Chromium<br>EPA Method 7196A | Defensible | 407 | 0 | 14 | 0 | 0 |
| PCBs<br>EPA Method 8082 | Defensible | 407 | 0 | 14 | 0 | 0 |
| Gamma Spectroscopy<br>SNL Method RPSD-07-03<br>(based upon EPA Method 90906) | Defensible | 0 | 0 | 5 | 0 | 616 |
| H-3<br>SNL Method RPSD-07-01<br>(based upon EPA Method 600/4-80-032) | Defensible | 0 | 0 | 5 | 0 | 616 |

[a]EPA November 1986.
[b]The number of samples does not include QA/QC samples, such as duplicates, trip blanks, and equipment blanks.

EPA = U.S. Environmental Protection Agency.
ERCL = Environmental Restoration Chemistry Laboratory.
GEL = General Engineering Laboratories, Inc.
H-3 = Tritium.
OSML = On-Site Mobile Laboratory.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
RCRA = Resource Conservation and Recovery Act.
RMWMF = Radioactive and Mixed Waste Management Facility.
SNL = Sandia National Laboratories.
STL = Severn Trent Laboratories, Inc.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.

concentration was selected as the maximum value in the risk assessment. However, if the before-treatment concentration also had an after-treatment concentration, the after-treatment concentration was selected as a true representation of the remaining contaminant concentration. The after-treatment concentration was then compared to the no-treatment soils and the largest value between the two was selected as the maximum concentration for the analyte in the risk assessment.

For metals, no credit was given for treatment, even though ST is a presumptive remedy for metals contamination. ST treatment verification samples were collected and sampled for Toxicity Characteristic Leaching Procedure (TCLP) analysis. However, TCLP analysis is not useful for risk analysis. Therefore, to be conservative, the total metal analyses were used (pretreatment) in the risk assessment calculation.

The SNL/NM maximum background concentrations (Dinwiddie September 1997, Tharp February 1999) were selected to provide the background screening values listed in Tables 3 and 4.

Both radiological and nonradiological COCs were evaluated. Nonradiological inorganic constituents that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment (EPA 1989). The nonradiological COCs evaluated included both inorganic and organic compounds.

Table 3 lists the nonradiological COCs for the human health and ecological risk assessments performed at the CAMU. Table 4 presents the radiological COCs for the human health and ecological risk assessments. All tables show the associated SNL/NM maximum background concentration values (Dinwiddie September 1997, Tharp February 1999).

Sections VII.4, VIII.2, and VIII.3 discuss the results presented in Tables 3 and 4 in more detail.

## VI. Fate and Transport

The containment cell of the CAMU incorporates an engineered liner system and final cover system that was designed to prevent the migration of hazardous constituents to the environment during CAMU waste placement operations and the post-closure care period. The liner system includes both bottom and sidewall liner components that will be chemically resistant to the waste and to potentially generated leachate. The final cover system effectively encapsulates the soil waste in the containment cell and is designed to minimize water infiltration. Construction of the final cover system was completed in July 2003. The cover system design incorporates a capillary barrier and vegetation cover for primary hydraulic control. A high-density polyethylene liner positioned at the base of the final cover system provides reinforced hydraulic control. Provided that these engineered controls remain in place, no transport of COCs could occur from the containment cell to the environment.

Under the hypothetical scenario (CAMU Scenario 2—No Engineering Controls, No Treatment Effectiveness [Section VII.6.2.2]) that the engineered containment system is compromised or removed (specifically, that the soils are exposed to the surface), wind, water, and biota are natural mechanisms of COC transport from site. Because of the openness of the site, and the probability that the treated soils would not have a robust vegetative cover if exposed, wind erosion could be of low to moderate significance as a transport mechanism at this site.

## Table 3 (Continued)
## Nonradiological COCs for Human Health and Ecological Risk Assessment at the CAMU with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log $K_{ow}$

| COC | Maximum Concentration (mg/kg) | SNL/NM Background Concentration (mg/kg)[a] | Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value? | BCF (maximum aquatic) | Log $K_{ow}$ (for organic COCs) | Bioaccumulator?[b] (BCF >40, Log $K_{ow}$ >4) |
|---|---|---|---|---|---|---|
| 2-Butanone | **2.5** | NA | **NA** | 1[g] | 0.29[g] | No |
| n-Butylbenzene | 0.34 | NA | **NA** | 291[f,i] | 4.11[f,i] | **Yes** |
| Butyl benzyl phthalate | 0.99 | NA | **NA** | 663[g] | 4.77[f] | **Yes** |
| Carbazole | 16 | NA | **NA** | 501[f] | – | **Yes** |
| Chlorobenzene | **0.78** | NA | **NA** | 447[h] | 2.51[f] | **Yes** |
| 2-Chlorotoluene | **1.35** | NA | **NA** | 112[f] | 3.42[f] | **Yes** |
| Chrysene | 31 | NA | **NA** | 18,000[f] | 5.91[f] | **Yes** |
| Di-n-butyl phthalate | 8.2 | NA | **NA** | 6,761[h] | 4.61[f] | **Yes** |
| Di-n-octyl phthalate | **0.44** | NA | **NA** | 9,334[f] | 5.22[f] | **Yes** |
| Dibenz(a,h) anthracene | 0.84 | NA | **NA** | 51,000[f] | 6.50[f] | **Yes** |
| Dibenzofuran | 21 | NA | **NA** | 2,800[f] | 4.12[f] | **Yes** |
| 1,2-Dibromo-3-chloropropane | 5.1 | NA | **NA** | 19[f] | 2.96[f] | No |
| 1,2-Dichlorobenzene | 72 | NA | **NA** | 560[h] | 3.38[h] | **Yes** |
| 1,3-Dichlorobenzene | 0.575 | NA | **NA** | 740[h] | 3.53[f] | **Yes** |
| 1,4-Dichlorobenzene | 2.81 | NA | **NA** | 55.6[c] | 3.52[c] | **Yes** |
| 1,2-Dichloroethane | 1.1 | NA | **NA** | 8[g] | 1.48[g] | No |
| Diethylphthalate | 5.4 | NA | **NA** | 117[h] | 2.47[h] | **Yes** |
| 3,3'-Dimethylbenzidine | **3** | NA | **NA** | 83[f] | 2.34[f] | **Yes** |
| Diphenylamine | 2.9 | NA | **NA** | 83[j] | 3.48[j] | **Yes** |
| Ethyl benzene | **8.6** | NA | **NA** | 15.5[h] | 3.15[h] | No |
| Fluoranthene | 114 | NA | **NA** | 12,302[f] | 4.90[f] | **Yes** |
| Fluorene | 49 | NA | **NA** | 2,239[f] | 4.18[f] | **Yes** |
| Hexachlorobutadiene | **2.538** | NA | **NA** | 17,000[f] | 4.78[f] | **Yes** |
| Indeno(1,2,3-c,d)pyrene | 0.97 | NA | **NA** | 59,407[f] | 6.58[f] | **Yes** |
| Iodomethane | **0.65** | NA | **NA** | 2.9[f] | 1.51[f] | No |

Refer to footnotes at end of table.

## Table 3 (Concluded)
## Nonradiological COCs for Human Health and Ecological Risk Assessment at the CAMU with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log $K_{ow}$

| COC | Maximum Concentration (mg/kg) | SNL/NM Background Concentration (mg/kg)[a] | Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value? | BCF (maximum aquatic) | Log $K_{ow}$ (for organic COCs) | Bioaccumulator?[b] (BCF >40, Log $K_{ow}$ >4) |
|---|---|---|---|---|---|---|
| Trichlorofluoromethane | 2.5 | NA | **NA** | 25[g] | 2.53[g] | No |
| 2,4,5-Trichlorophenol | 4.8 | NA | **NA** | 825[f] | 3.72[f] | **Yes** |
| 2,4,6-Trichlorophenol | 3.9 | NA | **NA** | 676[f] | 3.69[f] | **Yes** |
| 1,2,4-Trimethylbenzene | **1.496** | NA | **NA** | 275[f] | 3.78[f] | **Yes** |
| 1,3,5-Trimethylbenzene | 2.1 | NA | **NA** | 342[f] | 3.42[l] | **Yes** |
| m/p-Xylenes | 12.7 | NA | **NA** | 23.4[g] | 1.5[f] | No |
| o-Xylene | 12.7 | NA | **NA** | 23.4[g] | 1.5[f] | No |

Note: **Bold** concentrations indicate pretreatment concentrations of analytes that were treated but lack of analytical information inhibits use of lower expected concentration. **Bold** in other columns indicates the COCs that exceed background screening values and/or are bioaccumulators.

[a]Dinwiddie September 1997.
[b]NMED March 1998.
[c]Yanicak March 1997.
[d]Neumann 1976.
[e]Callahan et al. 1979.
[f]Micromedex 1998a.
[g]Howard 1990.
[h]Howard 1989.
[i]Based upon t-butylbenzene.
[j]EPA 1995.
[k]Howard 1991.
[l]Montgomery 1991.

BCF = Bioconcentration factor.
COC = Constituent of concern.
CAMU = Corrective Action Management Unit.
EPA = U.S. Environmental Protection Agency.
$K_{ow}$ = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
NMED = New Mexico Environmental Department.
PCB = Polychlorinated biphenyl.
SNL/NM = Sandia National Laboratories/New Mexico.
– = Information not available.

The organic COCs at the CAMU may be degraded through photolysis, hydrolysis, and biotransformation. Photolysis requires light, and therefore takes place in the air, at the ground surface, or in surface water. Hydrolysis includes chemical transformations in water, and may occur in the soil solution. Biotransformation (i.e., transformation due to plants, animals, and microorganisms) may occur; however, biological activity may be limited by the aridity of the environment at this site. If the treated soils are exposed to the surface, some organic COCs may be lost through volatilization, with subsequent degradation in the air.

Table 5 summarizes the fate and transport processes that can occur at the CAMU under two scenarios: CAMU Scenario 1—the existence of engineered controls and CAMU Scenario 2—no engineered controls. Under the first scenario, no significant transport to the environment outside of the containment cell is expected to occur. Under the second (specifically assuming exposure of the soil to the surface) wind and surface water could be of moderate significance as transport mechanisms, and food chain uptake could be of low significance as a transport mechanism. Significant leaching in the subsurface soil is unlikely and leaching to the groundwater at this site is highly unlikely. The potential for transformation of inorganic COCs is low. For some organic COCs, loss through volatilization and eventual degradation could be of moderate significance.

**Table 5**
**Summary of Fate and Transport at the CAMU**

| Transport and Fate Mechanism | Existence at Site | Significance Based Upon Engineered Controls (CAMU Scenario 1) | Significance Based Upon No Engineered Controls (CAMU Scenario 2) |
|---|---|---|---|
| Wind | Yes | None | Moderate |
| Surface runoff | Yes | None | Moderate |
| Migration to groundwater | No | None | None |
| Food chain uptake | Yes | None | Low |
| Transformation/degradation | Yes | Moderate to low | Moderate to low |

CAMU = Corrective Action Management Unit.

## VII. Human Health Risk Assessment

### VII.1 Introduction

Human health risk assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include the following:

| | |
|---|---|
| Step 1. | Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site. |
| Step 2. | Potential pathways are identified by which a representative population might be exposed to the COCs. |

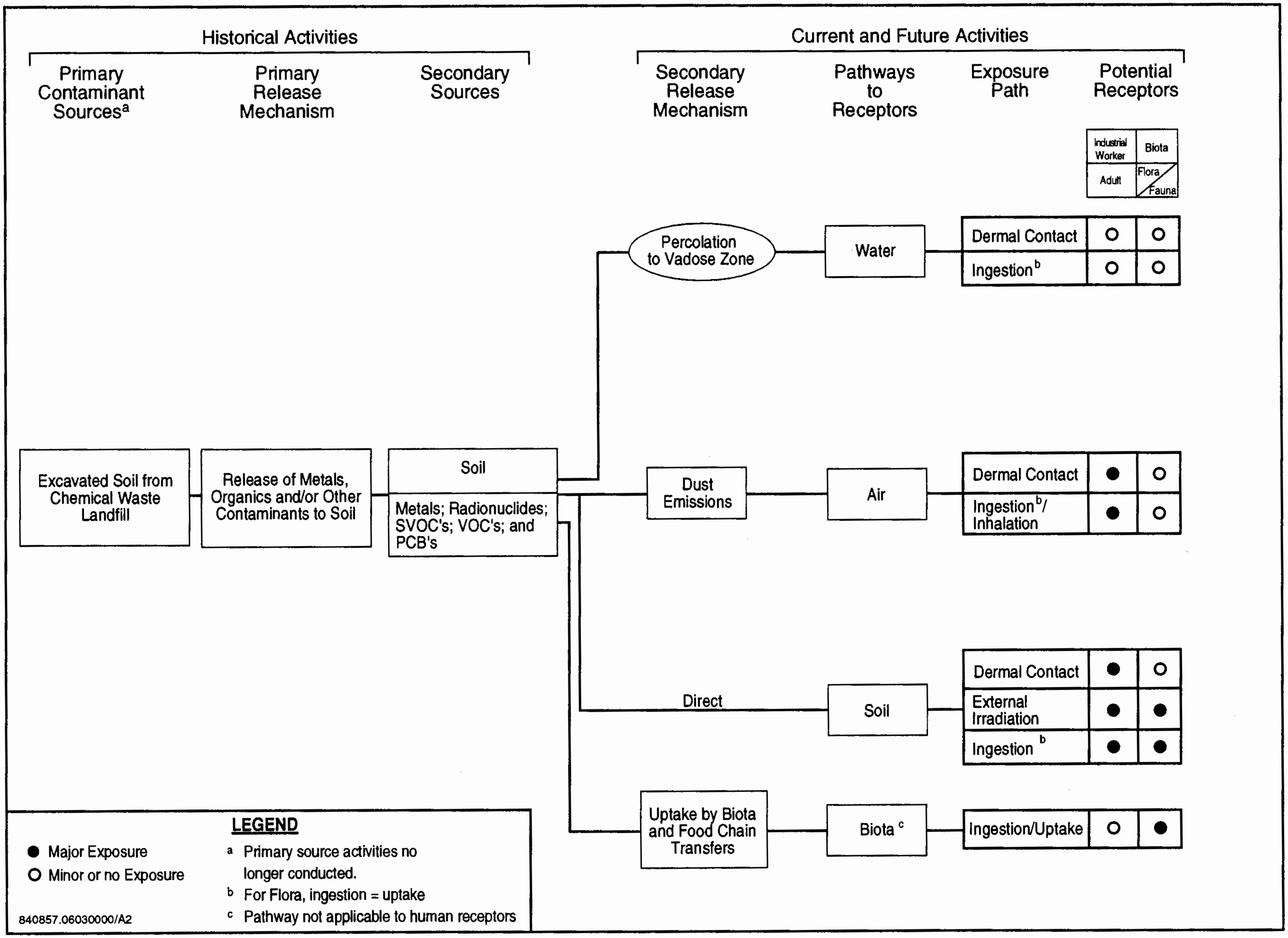


**Figure 1**

**Conceptual Site Model Flow Diagram for the CAMU**