DRAFT FINAL

ENGINEERING EVALUATION / COST ANALYSIS (EE/CA)

FOR

PESTICIDE STORAGE FACILITY

FORT RILEY, KANSAS

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PREPARED BY

FORT RILEY
DIRECTORATE OF ENGINEERING AND HOUSING
ENVIRONMENTAL AND NATURAL RESOURCES DIVISION

UTILIZING MATERIALS
DEVELOPED BY

LAW ENVIRONMENTAL
GOVERNMENT SERVICES DIVISION

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LIST OF ACRONYMS

ACL	Alternate Concentration Limits
A-E	Architect-Engineer
ARAR	Applicable or Relevant and Appropriate Requirement
ASTDR	Agency for Toxic Substances and Disease Registry
BGS	Below Ground Surface
CAL	Corrective Action Level (RCRA)
CAS	Chemical Abstract Service
CEMRD	Corps of Engineers - Missouri River Division
CEMRK	Corps of Engineers - Missouri River Division, Kansas City District
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
cm^2	Centimeter Squared
cm/sec	Centimeters Per Second
COE-PM	Corps of Engineers - Project Manager
CSF	Carcinogenic Slope Factor
CWA	Clean Water Act
DCF	Dry Cleaning Facility
DEH	Directorate of Engineering and Housing
DFAE	Directorate of Facilities Engineering (now DEH)
DOD	Department of Defense
DOT	Department of Transportation
DPDO	Defense Property Disposal Office (now DRMO)
DQCR	Daily Quality Control Report
DQO	Data Quality Objectives
DRMO	Defense Reutilization and Marketing Office
ECD	Electron Capture Detector
ENR	Environment and Natural Resources Division (Fort Riley DEH)
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ESE	Environmental Science and Engineering, Inc.
FEMA	Federal Emergency Management Agency
FFA	Federal Facilities Agreement
FID	Flame Ionization Detector
FS	Feasibility Study
FSP	Field Sampling Plan
GC/MS	Gas Chromatograph/Mass Spectrometer
GPC	Gel Permeation Clean-up
gpm	Gallons Per Minute
GWPS	Ground Water Protection Strategy

LIST OF ACRONYMS (Continued)

HAN	Heavy Aromatic Naphtha
HRS	Hazard Ranking Score
IAG	Inter-Agency Agreement
ID	Inside Diameter
IRP	Installation Restoration Program
K	Character Representing Ground-Water Velocity
KDHE	Kansas Department of Health and Environment
kg	Kilogram
KGS	Kansas Geological Survey
l	Liter
LAN	Local Area Network
LDR	Land Disposal Restrictions (Land Ban)
LEGS	Law Environmental, Inc., Government Services Division
LENL	Law Environmental National Laboratory
m	Meter
MCL	Maximum Contamination Level
MCLG	Maximum Contaminant Level Goal
MDL	Method Detection Limit
mg	Milligram
mg/l	Milligram per Liter
MSL	Mean Sea Level
MTV	Mobility, Toxicity, Volume
NAAQS	National Ambient Air Quality Standard
NCP	National Contingency Plan
ND	Not Detected (Above Method Detection Limits)
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List (Superfund List)
NTU	Nephelometric Turbidity Units
OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene, also Perchloroethylene
PID	Photoionization Detector
ppb	Part Per Billion
PPE	Personal Protective Equipment
ppm	Part Per Million
PSCS	Preliminary Site Characterization Summary
PSF	Pesticide Storage Facility
PSF "___"	Pesticide Storage Facility "Sample Designation Number"
PVC	Poly Vinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QCSR	Quality Control Summary Report

LIST OF ACRONYMS (Continued)

RA	Risk Assessment
RCRA	Resource Conservation and Recovery Act
RFCs	Reference Concentrations
RFDs	Reference Doses
RG	Remedial Goals
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SFL	Southwest Funston Landfill
SOC	Site(s) Operation Center
SOW	Scope of Work
SPHEM	Superfund Public Health Evaluation Manual
SWLO	Southwest Laboratory of Oklahoma
TBC	To Be Considered
2,3,7,8-TCDD	Tetrachlorodibenzo-p-dioxin
TCL	Target Compound Lists
TEF	Toxicity Equivalency Factor
TLV	Threshold Limit Value
TM	Technical Memorandum
TOC	Top of Casing (Monitoring Well Casing)
μg/kg	Microgram Per Kilogram
μg/L	Microgram Per Liter
USAEHA	United States Army Environmental Hygiene Agency
USAETL	United States Army Engineer Topographic Laboratories
USDASCS	United States Department of Agriculture - Soil Conservation Service
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WQC	Water Quality Criteria
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

The Fort Riley Directorate of Engineering and Housing (DEH), Environment and Natural Resources Division, has prepared this Engineering Evaluation/Cost Analysis (EE/CA) for a Removal Action addressing contaminated soils at the Pesticide Storage Facility (PSF) located in the DEH maintenance and storage yard. The objectives of the Removal Action are to quickly develop, evaluate, select, and implement a removal action for the site contamination. The EE/CA is the process used to develop and evaluate feasible and cost-effective removal actions.

The PSF is located in Building 348 of the Main Post cantonment area. The "site" is an of area of contamination around the building of about 2/3 of an acre in size. Building 348 was constructed in 1941 as a warehouse facility and has since stored pesticides and herbicides and other products used at the Base. Fort Riley records do not state when pesticides were first stored in Building 348. However, discussions with Fort Riley personnel indicate that Building 348 has been used for pesticide storage since at least 1973.

Prior to the late 1970s, the maintenance yard area east of and adjacent to Building 348 was used to wash down vehicles and spray equipment used for pesticide applications. Spills of pesticides and dumping of excess formulations may have also occurred. Furthermore, electrical transformers containing polycholorinated biphenyls (PCBs) were once stored outside the Southeast corner of Building 348. Environmental sampling and analyses of shallow soils at the site in the 1970s and 1980s indicated chlordane, methoxychlor, malathion, diazinon, dieldrin, and DDT (and its metabolites) were present in the soil east of the building.

Ground water, surface water, soil and sediment samples were analyzed for volatile and semi-volatile organics, pesticides, PCBs, metals, organophosphorus pesticides, and herbicides. PCBs, acid herbicides, and dioxin were not detected in samples analyzed for these constituents. Results of the Remedial Investigation field activities indicate that ground water and surface water within the study area have not been significantly impacted by the PSF contaminant releases. Consequently, only soil media is addressed in this EE/CA.

The Draft Final Remedial Investigation (RI) report, including the Baseline Risk Assessment, has recently been completed and is undergoing final review by the Environmental Protection Agency, Region VII (EPA) and the Kansas Department of Health and Environment (KDHE).

The pesticides detected in soil samples consisted of DDT and its metabolites (DDD and DDE), alpha- and gamma-chlordane, heptachlor, dieldrin, methoxychlor, endrin, ronnel (fenchlorphos) and malathion. Constituents were indicated in three major areas. Pesticides were found around the north end of the PSF and extending to the east. Another area of pesticide detections is near the southeast corner of the PSF and extending to the east. A third area of pesticide detections in soils is the area of formerly stressed vegetation near the drainage ditch east of the PSF.

PAHs detected in the soil samples included acenaphthlene, anthracenes, chrysene, fluoranthenes, naphthalene, phenanthrene and pyrenes. The analytical results indicate that PAH concentrations are present in the soil along the existing fence boundary to the east of the PSF and extending to the east. Another area of PAHs is located at the bottom of the culvert leading away (to the east) from the southeastern corner of the fence. In both areas the pattern of PAH concentrations tends to follow the pathways of surface water runoff. A third area of PAH constituents is located near the southeastern corner of the PSF. The presence of PAHs in these areas may be the result of pesticide formulation, mixing, application or spills. However, both treated lumber and asphalt contain PAHs and these may also be the source of PAH contamination.

Of the metals analyzed in soil samples, arsenic, barium, chromium and lead were routinely found in detectable concentrations.

The risk assessment performed indicated that an unacceptable risk was noted with pesticides and arsenic in soil. However for arsenic it should be noted that the exposure point concentration used to determine risk (both carcinogenic and noncarcinogenic) due to arsenic for site receptors (4.6 mg/kg) is greater than the site-specific background concentration of 3.4 mg/kg, but it is within the range of naturally occurring arsenic levels in Missourian uncultivated, unglaciated prairie soils (3.4 - 38 mg/kg; USGS, 1975). Therefore, since the arsenic concentration used to determine risk for all site receptors is within the range of background in regional soils, the unacceptable risk associated with that level of arsenic may or may not be attributable to site-related activities.

Cleanup levels are determined by Applicable or Relevant and Appropriate Requirements (ARARs) and other To-Be-Considered (TBC) information or criteria. The Resource Conservation and Recovery Act (RCRA) corrective action levels (CAL) have been determined to be ARARs for this action. TBCs include site-specific remediation goals which were calculated based on the exposure scenarios used in the Baseline Risk Assessment. In the absence of ARARs, RGs are used to determine appropriate clean-up levels. RCRA CALs are available for the chemicals of concern at the PSF.

The CAL for arsenic is 80 mg/kg and the maximum detected concentration was 120 mg/kg. However, the 95% Upper Confidence Limit (UCL) site concentration for arsenic is 16 mg/kg, which is much less than the RCRA CAL and is also in the range of expected background levels for the region (3.4 - 38 mg/kg). All of the calculated site-specific remediation goals (RGs) for arsenic are either at or below the expected background levels for arsenic. In addition, the analytical results for near-surface (0.0 to 24 inches) and sub-surface (24 inches and below) soils indicate that only one metal (arsenic) presents a calculated unacceptable risk. The unacceptable arsenic risk in soils is due to a "hot spot" (120 mg/kg) that is 3.5 to 4.5 feet underground. There are no utility lines within 60 feet of the "hot spot" so the chance of exposure to the arsenic contaminated soil is minimal.

Although other constituents were detected in sediment, soils, surface water and ground water samples, no unacceptable risk above background was noted with those constituents and media. The risk assessment information resulted in five areas of concern at the PSF. The volume of soil was estimated at approximately 450 cubic yards. The depth of the area of concern ranges from 1.5 to 4.5 feet. In most cases the potential for exposure from these areas is limited unless excavation is completed.

Based upon the baseline risk assessment, facility data and available technologies and process options for remediation, the following alternatives were considered for the site:

Alternative 1 - No Action
Alternative 2 - Institutional Action
Alternative 3 - Institutional Action/Grading
Alternative 4 - Institutional Action/Grading/Capping (Asphalt Cap Contaminated Area)
Alternative 5 - Institutional Action/Grading/Capping (Asphalt/Concrete Cap Contaminated Area)
Alternative 6 - Excavation and (Off-site) Disposal

Alternative 6 is presented for a range of potential clean-up levels.

Of these six alternatives, based upon the detailed analysis performed which considers: short and long term effectiveness, implementability, cost, reduction of mobility, toxicity, and volume, and compliance with ARARs, Alternatives 3 and 4 are considered the most appropriate for the site. However, due to future land use considerations at the site, Alternative 5 is the remedial action favored by Fort Riley.

1.0 INTRODUCTION

1.1 PURPOSE OF THE REPORT

The purpose of this report is to assess the appropriateness of performing Removal Action activities in the vicinity of the Pesticide Storage Facility (Bldg 348), Main Post, Ft. Riley, Kansas, prior to the Record of Decision/Remedial Design/Remedial Action (ROD/RD/RA) activities. A removal action is a response performed to eliminate or reduce human health or environmental threats from the release, or threat of release, of hazardous substances, pollutants, or contaminants. The term "removal action" is broad and may include institutional controls, containment, stabilization, treatment, or removal. An immediate threat to human health, necessitating an immediate removal action, has not been identified. However, implementation of early action may be appropriate.

Upon determination that a removal action is appropriate, removal action options are identified as alternatives and screened based on effectiveness, implementability and cost. This report summarizes the results of site investigations and recent baseline risk assessment activities to allow their consideration in the removal action decision.

The project objectives are to:

- Determine if removal action is appropriate to protect human health and the environment; and

- Identify and evaluate alternative conceptual options, and recommend options for removal action which are consistent with the needs for removal action, which can be incorporated into the permanent solution to remediate the site, and can meet the time schedule for construction; and

- Develop an alternative that meets all safety and health requirements and that allows for the continuing use of the site.

1.2 APPLICABILITY AND STEPS IN THE EE/CA PROCESS

The Engineering Evaluation/Cost Analysis (EE/CA) regulatory process can be used to accomplish Early Response Actions at Fort Riley National Priority Listing (NPL) sites which are determined to require non-time-critical removal actions. Non-time-critical removal actions are defined as on-site activities which do not need to be initiated within six months after the determination that removal actions are appropriate at the site. Estimated existing threats to human health and the environment, based on the results of site assessment, must indicate that there is at least a six month lead-time available before any on-site response actions must begin, to allow the EE/CA regulatory process option.

The steps in the EE/CA process are as follows:

A. Site Evaluation and Interagency Agreement (IAG)

Initial site investigation/evaluation at the PSF were completed prior to the finalization of the Federal Facilities Agreement (FFA) or IAG between the Department of the Army Fort Riley (DA), the Kansas Department of Health and the Environment (KDHE), and the U.S. Environmental Protection Agency Region VII (EPA) and additional (RI/FS) activities required by that agreement. Interim removal actions are allowed under the terms of the IAG, which includes the EE/CA regulatory process option, if potential non-time-critical threats are determined to exist at the PSF. Site remedial investigation (RI) activities are near completion at the PSF, characterizing the extent of contamination and estimating the baseline risk.

B. EE/CA Study and Report Preparation

The EE/CA report is prepared to characterize the site, identify removal action objectives and alternatives, analyze removal alternatives and propose a removal action.

C. Public Comment Period

The EE/CA report is added to the Administrative Record, a public notice is published by Fort Riley, and the public comment period is granted in accordance with the IAG. A presentation will also be made to the Technical Review Committee.

D. Action Memorandum Document and Responsiveness Summary

The action memo or decision document describes the proposed PSF interim response actions and secures approval by the DA and concurrence by the EPA and KDHE to implement these actions. The responsiveness summary provides Fort Riley's responses to significant public comments.

E. Implementation of Removal Action

Implementation entails construction of the removal action. The $2 million/12 month statutory limits for removal actions do not apply to the PSF as they apply only to actions financed through the EPA "Superfund" trust fund.

2.0 SITE CHARACTERIZATION

2.1 SITE DESCRIPTION

2.1.1 Site Location and Description

The Pesticide Storage Facility (PSF) is located in the Directorate of Engineering and Housing (DEH) equipment and supply storage yard located in the Main Post cantonment area of Fort Riley, Kansas, as depicted in Figure 2-1. The DEH yard extends south of Dickman Avenue to the south central edge of the Main Post cantonment area and is a fenced, secured storage and maintenance area that supports services necessary to maintain the buildings, grounds and utility systems at Fort Riley. The area of investigation (Figure 2-2) is approximately two-thirds of an acre in the southeast portion of the DEH yard. Included in the area of investigation is Building 348 (formerly Building 292), property adjacent to and adjoining Building 348 (within the eastern and southern fence) and paved areas to the south and west of Building 348. The paved area to the south is used to store electrical equipment. In addition, the area of investigation includes the limestone-lined drainage ditch located to the east and outside of the fenced portion of the PSF, and the soils between the limestone-lined drainage and the eastern fence. An area of stressed or no vegetation measuring approximately 20' x 20' has, in the past, been observed downslope of the PSF outside of the perimeter fence (Figure 2-2). This area is now vegetated with various weeds and grasses. An early 1900's map indicates that there was once a barn/hay storage shed located in the vicinity of the PSF. The structure (probably a wood-framed building without a foundation) disappears from Fort Riley maps in the 1920's prior to the construction of a livestock dipping facility.

Building 348 is a wood frame, slab-on-grade structure that measures approximately 110 by 30 feet. The northern portion of the building (approximately 30' x 30') is used to store herbicides and preformulated pesticides (Senior Pesticide and Herbicide Program Manager, 1992). The remainder of Building 348 is used to store general improvement materials and paint. The indoor configuration of the PSF portion of Building 348 is shown in Figure 2-3. The PSF portion is about 1/3 of the total building area.

2.1.2 Surface Features

The PSF is situated on an escarpment on the north side of the Kansas River Valley approximately 2,000 feet west of the Kansas River, on the southeast edge of the Main Post cantonment area (USGS, 1992). The ground surface slopes downward towards the east-southeast with a gradient of approximately one foot fall for every 13 feet of run (1:13) or a slope of approximately 11%. There is an abrupt drop or slope change just east of the PSF fence line. Topographic elevations at the PSF are about 25 feet higher than the Kansas River. The easterly flowing Kansas River is formed by the confluence of the Smoky Hill and Republican Rivers, approximately 1.5 miles west of the PSF.

In general, the relative positions of the alluvium and terrace areas are described as follows. Geologically, recent alluvium extends from the Kansas River to the first distinguishable escarpment. Older alluvial deposits underlie the Newman terrace that extends from the first escarpment to the next escarpment (or change in soil texture) towards the valley wall. Finally, still older alluvium underlies the second Buck Creek terrace, which extends to the valley wall. The alluvium beneath these two terraces are referred to as terrace deposits.

Surface water impoundments at or near Fort Riley include a man-made reservoir, several oxbow lakes (crescent shaped lake formed in an abandoned river meander which has become separated from the main stream by a change in the course of the river), and numerous large and smaller ponds. Milford Reservoir is located west of Fort Riley and is fed by the Republican River. There are no surface water impoundments within the PSF drainage basin or immediately downstream on the Kansas River.

Based on the draft wetlands report from the United States Fish and Wildlife Service and Section 404 of the Clean Water Act (CWA), there are no wetlands within the immediate vicinity of the PSF that meet jurisdictional requirements (Fish and Wildlife Administrator, 1992). A review of the National Wetlands inventory conducted by the U.S. Fish and Wildlife Service did not identify wetlands within the immediate vicinity of the PSF. The CEMRK conducted a wetland survey of the PSF area. The survey concluded that the PSF is not located in a potential wetlands area and there are no wetlands immediately downstream of the PSF drainage ditch.

2.1.3 Surface Water Hydrology

Surface water features at Fort Riley can be characterized into three distinct categories: rivers, streams/drainages and impoundments. Refer to Figure 2-4 for the locations of these features. The major rivers in the vicinity of the PSF are the Republican, Smoky Hill and Kansas Rivers. There is no levee between the PSF and the Kansas River (USGS, 1982).

The Kansas River flows at a mean annual discharge rate of 2,750 cubic feet per second (cfs), calculated as the combined flow from the Republican and Smoky Hill Rivers (USGS, 1992) at the USGS gaging station on Henry Drive off Interstate 70. The Kansas River depth fluctuates between 1.5 feet to 12 feet. The Republican River flows at a mean annual discharge rate of 1,007 cfs. The lowest flow recorded was 50 cfs, and the highest flow recorded was 13,500 cfs (USGS, 1992). The Smoky Hill River discharges approximately 1,760 cfs (USGS, 1992). General surface water quality is considered moderate to poor especially during periods of lower flow (USGS, 1992). The waters are characterized as turbid, alkaline, moderately mineralized, buffered, with high dissolved oxygen content, low organic load, high nutrient levels, and high bacterial levels.

The report, Flood Insurance Study (FEMA, 1988), lists the following flood elevations above mean sea level for the Kansas River: 10 year - 1,059 feet; 50 year = 1,067 feet; 100 year - 1,070.5 feet; and 500 year = 1,078 feet. Therefore, based on this data and the ground surface (1,088 feet to 1,062 feet MSL) for the PSF study area, the southern portion of the area of investigation lies within the 50 year flood plain.

Surface run-off flows easterly, following the general topography of the site. Direct observation during a thunderstorm confirms that surface run-off follows the general topographic trends as seen in Figure 2-5 (IRP Manager, 1992). Surface run-off behaves as sheet flow in the unobstructed areas of the DEH yard. As the run-off follows the general slope it is, to a degree, interrupted by Buildings 345, 346, 347 and 348. Once the flow has "navigated" these obstacles, it then enters a 12-inch corrugated metal pipe culvert discharging overland into a rock-lined drainage channel east of the yard area. The lined drainage ditch runs from Dickman Avenue to the railroad tracks southeast of the site. The sides of the drainage ditch are constructed of cemented limestone blocks. This channel proceeds southward under the railroad tracks and then flows into an unnamed tributary leading to the Kansas River.

2.1.4 Geology

This section presents a summary of site-specific geology as related to the PSF evaluation. The PSF is located in the Buck Creek Terrace deposits north of the Kansas River alluvium. These terrace deposits are part of the valley-fill deposits of the Kansas River valley and contain water-bearing sand and gravel (KGS, 1974). They are described as grading upward from brownish-yellow sand, sandy silt and fine gravel in the lower part to reddish-brown and reddish-tan silt in the upper part. The soils formed in this material are described as reddish-brown or reddish-tan slit and clay. Surface elevations of the investigation area range from approximately 1093 feet to 1063 feet MSL. A general stratigraphic sequence-rock column diagram is located in figure 2-6.

Field investigations revealed depths to the competent shale and limestone bedrock in the study area to range from approximately 28 to 29.5 feet below ground surface, or elevations 1049.09 to 1049.8 feet MSL. The materials were generally found to be yellow-orange to brown, coarse to fine sand, silty sand and clayey sand to brown and black silt and clayey silt. This corresponds to an elevation of approximately 1,034 MSL. The unconsolidated materials alternate between brown and black silt or clayey silt and brown to yellow-brown fine to coarse sand or clayey sand. Refer to Figure 2-7 and Figure 2-7a for graphical representations of the site-specific geological conditions. The bedrock encountered beneath the alluvial and terrace deposits is Lower Permian in age and believed to be of the Council Grove Group, Gearyan Stage.

2.1.5 Soils

Geotechnical analysis from the five borings completed during the RI has classified the soil as clayey sands (SC) and clayey silts (ML) under the Unified Soil Classification System. Table 2-1 shows the classification of the soil at each boring together with parameters analyzed and the Unified Soil Classification System identification.

The Soil Survey of Riley County and Part of Geary County, Kansas by the United States Department of Agriculture Soil Conservation Service (USDASCS, June 1975) has classified the native soil at the PSF and its vicinity to be of the Kennesaw Series silt loam, with six to ten percent slopes. The surface layer is about 12 inches thick consisting of dark gray to dark grayish-brown silt loam. The subsoil which extends to 36 inches deep is made up of brown to light brown silt loam. The Kennesaw soils are well drained and moderately permeable. Surface run-off is medium to rapid in some cultivated areas, and erosion is a severe hazard. The area within the fence is covered with approximately 12 inches of firmly compacted limestone gravel.

2.1.6 Hydrogeology

This section summarizes the site-specific hydrogeologic conditions. The primary source of drinking water for Fort Riley, Junction City and Ogden is the valley fill alluvium (alluvial aquifer) of the Republican and Kansas Rivers (KGS, 1974). Junction City and Fort Riley water supply wells are within the Republican River floodplain. The alluvial deposits are capable of yielding more than 14,000 gpm from a single well (KGS, 1974). This aquifer is recharged through direct infiltration of rain and from seepage from limestone and shales. The Kansas and Republican Rivers are also primary sources of recharge to the alluvial aquifer. The regional direction of ground-water flow generally follows the Kansas River and is influenced by river stage. Water levels in the Fort Riley water supply wells generally range from 15 to 25 feet below land surface.

Five ground-water monitoring wells were installed at the PSF. Analysis and reduction of the well slug test data according to Bouwer and Rice, 1976, resulted in calculated hydraulic conductivity (K) values for the PSF wells ranging from 1.171×10^{-4} ft/min (5.9×10^{-5} cm/sec) to 1.03×10^{-3} ft/min (5.21×10^{-4} cm/sec).

The calculated direction of flow is east southeast with a gradient of approximately 0.07 ft/ft. This is toward the Kansas River and appears to follow the approximate dip of the bedrock surface and the general topographic trends. Figure 2-9 shows ground water potentiometric surface.

2.1.7 Ecological Survey

Land use in the undeveloped portions of Fort Riley consists primarily of grasslands or woodlands, with very little acreage devoted to crop production. Cropland on the reservation is planted primarily as wildlife food plots or as a firebreak between private and federal lands. Grasslands may be comprised either or native prairie species, of cool-season tame grasses, or of naturally invaded grasses and forbs on old field or "go-back" acres where crops once grew (U.S. Department of Interior, 1992).

A site survey was conducted with the Fish and Wildlife Administrator at Fort Riley with LEGS personnel on August 5, 1992. The purpose of this survey was to determine if PSF activities impact any habitats suitable for threatened and endangered species. Due to the close proximity of the PSF to the floodplain of the Kansas River, the wooded area to the east of the PSF can be categorized as a riparian woodland; however, there are no documented sightings of wintering bald eagles in this area. The Fish and Wildlife Coordinator did mention that the confluence of the drainage ditch to the east of the PSF and the Kansas River provides a suitable habitat for the Sturgeon Chub, which is a federal category 2 species. However, the State of Kansas Fish and Wildlife Report (February 1992) on threatened and endangered species at the Fort Riley Military Reservation states that the occurrence of the Sturgeon Chub at Fort Riley is very unlikely. Category 2 candidate species are those for which the Fish and Wildlife Service is seeking additional information regarding their biological status, in order to determine if listing of these species is warranted (U.S. Department of Interior, 1992). The survey determined that the impacts of the PSF contamination on the local wildlife and plantlife is minimal.

2.1.8 Climate

The Fort Riley area experiences four distinct seasons; summer, fall, winter, and spring. During the summer months (June, July, and August), the average daily high temperature is 89°F while the average daily low temperature is 65°F. The summer daily mean temperature is 77°F. During the winter months (December, January, and February), the average daily high and low temperatures are 47°F and 27°F, respectively. The winter daily mean temperature is 30°F.

The average amount of precipitation is approximately 34 inches per year. However, during the 1992 calendar year, the Fort Riley Marshall Airfield Weather Station recorded nearly 45 inches of precipitation. Equally unusual is that nearly one-half of this amount was recorded in the summer months. However, during a "typical" year 70 percent of the precipitation occurs between April and September.

2.2 SITE BACKGROUND

The PSF building was constructed in May, 1941, to serve as a general purpose warehouse facility. Fort Riley records do not state what was initially stored in this building. Personal interviews with the current Fort Riley Senior Pesticide and Herbicide Program Manager and the current Exterior Works Branch Chief, indicates that Building 348 has been used for the storage of pesticides since at least 1973. The building is currently planned to be demolished and replaced by a new building located elsewhere in the DEH yard (not in the area of contamination).

Pesticides (including insecticides and rodenticides), herbicides, fungicides, insect repellents, and soil fumigant have been used at Fort Riley for a variety of domestic or facility applications, and are referred to herein collectively as "pesticides and herbicides". Historically, the types of pesticides and herbicides used can be expected to have paralleled those that were generally available to the public at the time of use. Prior to about 1975, pesticide and herbicide wastewaters, rinse water and concentrated spills were allowed to run onto the ground surface east of the PSF in the area where the tanks were filled. Currently, tanks are filled with water at the PSF but mixing occurs at the site of application. After the water is mixed to the appropriate application concentration it is either sprayed over the day's task area or saved for future herbicide application (ie. no chemically-mixed water is released at the PSF). The exteriors of trucks may be or may have been rinsed off at the PSF using the PSF fill hose. Since at least 1976, the majority of insecticide application has been performed by outside contractors to Fort Riley (Senior Pesticide and Herbicide Program Manager, 1992). Contractors are not allowed to use the PSF for formulation or mixing of pesticides.

A listing of pesticides and herbicides commonly available to Fort Riley during the time when formulation and mixing occurred (1971) is in Table 2-2. This table includes formulations which were available for tactical as well as domestic (facility) use. Only base-type domestic-use chemicals were stored at the PSF (ie. tactical agents, s.a. Agent Orange would not have been stored in the PSF). Tables 2-3 and 2-4 are inventories of pesticides stored at the PSF during 1979 and 1983, respectively. A current inventory is tabulated on Table 2-5.

Pesticide contamination was identified in sampling performed in 1976 and 1984. Subsequent to the 1986 sampling Fort Riley placed an additional six inches of gravel over the area within the DEH yard to eliminate exposure of workers to the contamination.

A "Closure Plan for Hazardous Waste Storage Facilities, Building 292 (now Building 348) and Two CONEXs" was written in 1987 by the U.S. Army Environmental Hygiene Agency (USAEHA) for a portion of Building 348 and for two CONEX containers. The CONEX's were located outside, at the southeast corner of building 348. These were considered hazardous waste storage facilities and closed under the provisions of 40 CFR 265 on December 3, 1990. The hazardous waste and materials stored in the CONEXs included PCB-containing electrical transformers (PCB Program Manager, DEH, 1992).

DEH personnel have indicated during personal interviews that numerous heavy thunderstorms occurred between 1981 and 1983 (Chief, DEH, ENR Div., et al., 1992). The resulting storm water run-off followed natural topography and eroded sizeable channels, ruts, and "wash-outs" along and underneath the east and south PSF fence lines. Some of these erosional features were large enough for a man to crawl through (Chief, DEH, ENR Div., 1992). Estimates indicate that between three and five feet of material eroded from underneath the train tracks adjacent to the PSF at one time. In each case new "fill" material was placed, returning the site to existing grade. The Chief, DEH, ENR Div., also pointed out that the blacktop area southeast of the site was built up anywhere from 1 to 1.5 feet, based on original fence height and surface of blacktop. This work was done in late 1991.

In December of 1991, a natural gas line leak developed in gas service piping south of the tracks below building 348. Repairs required the excavation of a portion of the gas line east of the PSF within the fenced area to access valves and connections. The exposed subsurface material was consistent with material commonly used for fill. In addition, several horseshoes were found in the fill. The excavated material was returned to the trench(es) when repairs were finished. Since that time, less than one foot of settlement has occurred where the excavations were performed.

2.3 SUMMARY OF NATURE AND EXTENT OF CONTAMINATION

2.3.1 Field Sampling Program

Samples were collected from soil, surface water/sediment, and ground water for laboratory analysis. Detailed sampling procedures are presented in the RI planning documents and report.

Field samples which were collected for chemical analysis are summarized below by matrix.

Location Description	Matrix	No. of Locations	Samples per Location	Total Samples
Surface	Soil	4	1	4
Shallow Borings	Soil	20	2	40
Pilot Hole	Soil	1	2	2
Monitoring	Soil	4	2	8
Chemical Profile[a]	Soil	1	5	5
Monitoring Well	Ground Water	5	1	5
Ditch	Surface Water	8	1	6*
Ditch	Sediment	8	2	14*

[a]MONITORING WELL PSF92-02 SERVED AS A CHEMICAL PROFILE BORING.
*SURFACE WATER/SEDIMENT NOT PRESENT AT ALL LOCATIONS.

Samples were collected in accordance with the Work Plans (Law, 1992). Two of the four "surface" samples were taken below 12 inches of gravel and the other two samples were taken at depths up to 12 inches. Monitoring well and soil sampling locations are shown on Figures 2-9 through 2-12. The methods chosen were appropriate to identify contaminants of concern.

2.3.2 Analytical Data / Nature and Extent of Contamination

Ground water, surface water, soil and sediment samples have been analyzed for volatile and semi-volatile organics, pesticides, PCBs, metals, organophosphorus pesticides, and herbicides. PCBs, acid herbicides, and dioxin were not detected in samples analyzed for these constituents. Results of the RI field activities indicate that ground water and surface water within the study area have not been significantly impacted by the PSF contaminant releases. Consequently, only soil media is addressed in this EE/CA. All other medias will be presented in the Remedial Investigation Report.

The analytical results and initial risk assessment activities for near-surface (0.0 to 24 inches) and sub-surface (24 inches and below) soils indicate the metal arsenic as a contaminant of concern. The pesticides of concern detected in the soil samples consist of DDT and its metabolites (DDD and DDE), alpha- and gamma-chlordane, heptachlor, dieldrin, methoxychlor, endrin, ronnel (fenchlorphos) and malathion. Areas of slightly elevated pesticide concentrations in soil were found in three areas at the PSF. (See Figure 2-13) Table 2-6 includes the contaminants found that exceed the RCRA CALs for soils based on maximum concentrations found. Table 2-7 contains the contaminants found that exceed RCRA CALs based on the 95% Upper Confidence Limit for exposure point concentrations. Tables 2-8 through 2-10 show the sampling results for chemicals in the soil at the site. A complete listing of positive hits for soils is included in Appendix A. Figures 2-14 through 2-26 depict areas of contamination for all pesticides found at various depths.

Polynuclear Aromatic Hydrocarbons (PAHs) detected in the soil samples include acenaphthlene, anthracenes, chrysene, fluoranthenes, naphthalene, phenanthrene and pyrenes. The analytical results indicate that PAH concentrations are present in the soil along the existing fence boundary to the east of the PSF and extending to the east. The pattern of PAH concentrations tends to follow the pathways of surface water runoff. The presence of PAHs in these areas may be the result of pesticide formulation, mixing, application or spills. Both creosote and asphalt contain PAHs and may also be a source of PAH contamination. The carcinogenic PAHs were included in the risk assessment data set, even though the risk associated with benzo[a]pyrene was less than one percent, because of the uncertainty associated with estimating the toxicity equivalency factors.

Of the metals analyzed in soil samples, arsenic, barium, chromium and lead were routinely found in detectable concentrations. Two samples contained concentrations of lead which exceeded the proposed To-be-Considered requirements (TBCs). However, since RCRA standards weren't exceeded, lead is not considered a constituent of concern. The RCRA corrective action level for arsenic was exceeded significantly in one sample. The results of this sample lead us to consider arsenic may be a constituent of concern even though the 95% Upper Confidence Limit (UCL) for arsenic did not exceed the RCRA corrective action level for soils at the site. The 95% UCL is used in risk assessment to determine if a constituent is of concern (ie. if it exceeds corrective action levels or remediation goals). The estimated area of lateral extent of arsenic exceeding the corrective action level was less than 250 square feet.

Analytical results indicate that volatile organic compounds (VOC's), pesticides, PAHs, and metals detected exist in the sediment within the drainage ditch to the east of the PSF. VOCs detected in the sediment samples included toluene, carbon disulfide, 1,2-dichloropropane and 1,1,2,2,-tetrachloroethane. Concentrations of carbon disulfide, 1,2-dichloropropane and 1,1,2,2,-tetrachloroethane were only found in one sample each. PAHs did not always decrease with depth and the lateral extent of PAH contamination in the sediments downstream of the PSF. None of the constituents detected in sediment are great enough to be of concern.

Of the metals analyzed in the sediment samples, arsenic, barium, cadmium, chromium and lead were often found in the sediment samples. While concentrations of lead increased immediately downstream of the PSF, concentrations of arsenic, barium cadmium and chromium show no significant increases above background conditions. Based upon historical documentation and facility operation, the detection of arsenic, barium, cadmium, chromium and lead are not directly linked to the PSF due to the similarity in concentration levels with background samples.

2.4 SUMMARY OF FATE AND TRANSPORT

The pesticide and other semi-volatiles (PAHs) detected in site soils have low water solubilities and high K_{oc} values, indicating that these constituents have a high affinity for binding to soil particles, and a low potential for transfer to ground water or surface water (ATSDR, 1987-1991: Howard, 1991). Secondary transport pathways for PAHs and pesticides include the transportation of these sediments to points downstream. Soil particles containing sorbed contaminants may also be dispersed as airborne particulates.

The primary and secondary transport pathways for metals detected in site soils are similar to the pathways discussed above, with the addition of water soluble species leaching to ground and surface water. The volatile organic compounds (VOCs) detected in site soils are also water soluble, so they may also leach to ground water or surface water, or, if they are present in the upper surface soils, these constituents may volatilize out into the atmosphere.

Constituents that dissolve the transfer to the ground water, can be expected to travel within the aquifer in the direction of ground-water flow. Metals constituents dissolved in surface water will continue to flow downstream, but VOCs will tend to volatilize out of surface water to the atmosphere. Nonionic metals species and organic compounds with lower water solubility and high K_{oc} values may also precipitate out of surface water and settle into or become bound to sediments. Constituents present in the sediments may act as a future source of surface water contamination, if conditions favor their reentry into the water column.

The low levels of VOCs detected in site soils are unlikely to affect the ground water column to a great extent. In addition, the pesticides and PAHs detected in site soils tend to remain strongly bound to soil particles, also resisting transfer to the water column.

2.5 SUMMARY OF BASELINE RISK ASSESSMENT

A baseline risk assessment was conducted for the site, which includes a human health evaluation and an ecological risk assessment. The human health evaluation identified 26 potential exposure pathways, including 12 current and 14 future pathways. The BRA indicates that there may be a concern for potential risk to human health, based on the exposure pathways developed for the site.

Please note that this summary is taken from the Draft Final Remedial Investigation Report which is currently undergoing final review by the EPA and KDHE. The RI report, including the Baseline Risk Assessment (BRA), has not been finalized.

This EE/CA addresses only the soil media, however, the results of the risk assessment for all media is presented for information. Site-specific remediation goals (RGs), which are To-Be-Considered (TBC) cleanup criteria, calculated for pathways yielding unacceptable risks under the BRA are presented hereinafter.

The following is only a summary. Many aspects of the BRA's development are not presented or described. Summaries of the calculated Non-carcinogenic and Carcinogenic risks are presented followed by a description of some of the uncertainties associated with the BRA results.

2.5.1 Non-carcinogenic (Systemic) Risk- Hazard Indices

The risk assessment identified several receptor exposure pathways that have the potential to cause noncarcinogenic health effects. A calculated hazard index (HI) greater than 1.0 indicates that the "threshold" for noncarcinogenic (systemic) health effects for a particular pathway has been exceeded.

A hazard index (HI) greater than 1.0 was calculated for the following receptors and exposure pathways:

Receptor	Exposure Pathway - Media	HI	HI*
• **Occupational**			
current on-site worker	dermal - surface soil	9.2	6.7
future on-site worker	dermal - surface soil	33	29.8
future construction worker	dermal - surface soil	16	14.5
future construction worker	dermal - subsurface soil	7.3	6.3
• **Recreational**			
future child	dermal - surface soil	1.9	1.7
• **Residential (offsite)**			
future adult	ingestion - groundwater	2.2	1.9
future child	ingestion - groundwater	10	8.9

HI* - Adjusted HI; accounts for risk due to background

Estimations of dermal exposure are likely to be overestimated, due to the conservative assumptions used in calculating the risks. This is especially true for the occupational receptors listed above.

For instance, the dermal exposure experienced by the on-site worker is due mainly to dust exposure, rather than gross surface soil exposure (that is, actual direct skin contact with site soils). The amount of contaminated dust present in ambient air and subsequently contacting the exposed skin of the on-site worker should be less than the contaminant concentrations detected in the soil itself. In addition, the risks estimates are calculated using the conservative assumption that exposure to soils indoors equals that of outdoors, resulting in overestimation of risk.

In the case of the construction worker, risks are estimated using an exposure duration of 120 total days. According to the individuals interviewed (DEH, 1993l; DEH, 1993m), a construction crew would not be expected to be on the site for the entire duration of the project. Therefore, the dermal risks estimated for the construction worker are likely to be overestimated. (The planned new PSF will not be placed in the same location as the existing PSF, i.e. not in the area of contamination (DEH 1993q). A future construction activity is included in the BRA because represents a future "reasonable" action.)

A layer of gravel not impacted by practices causing the contamination, has been placed over the surface within the fenced DEH yard. Therefore, surface area should be relatively free of pesticide contamination. However, in absence of analytical data illustrating this, the BRA was calculated using a surface sample (SS-04) obtained from outside the fence in an area of stressed vegetation. This results in a "worst case" overestimation of risk due to surface soil exposures.

The risks estimated for future consumption of site groundwater may also be overestimated, since there are no current plans to develop the site as a well field. Such development is unlikely, given the aquifer characteristics at the site and because there is an adequate supply of drinking water available from the Fort Riley Main Post well field, located 1.8 miles upgradient from the PSF site.

Note that adjustments are made to the HI (see HI*) to account for background levels of metals. Non-carcinogenic risk still exists when site-specific background levels are accounted for.

2.5.2 Cancer Risk Estimates

Cancer risk estimates that exceed the acceptable risk range (as defined by the NCP) of 1×10^{-6} to 1×10^{-4} were calculated for three receptors as follows:

Receptor	Exposure Pathway- Media	Cancer Risk	Cancer Risk*
• **Occupational**			
current on-site worker	dermal - surface soil	8×10^{-4}	5×10^{-4}
future on-site worker	dermal - surface soil	4×10^{-3}	4×10^{-3}

Receptor	Exposure Pathway- Media	Cancer Risk	Cancer Risk*
Residential (off-site)			
future adult	ingestion - groundwater	5×10^{-4}	4×10^{-4}

* Cancer risk due to background is accounted for.

In addition, fifteen cancer risk estimates were calculated that exceed the standard point of departure, but are within the acceptable risk range identified by the NCP. These are as follows:

Receptor	Exposure Pathway- Media	Cancer Risk
Occupational		
current on-site worker	incidental ingestion - surface soil	1×10^{-6}
current landscaper	dermal - surface soil	1×10^{-6}
current landscaper	dermal - subsurface soil	2×10^{-6}
current utility worker	dermal - surface soil	4×10^{-6}
current utility worker	dermal - subsurface soil	2×10^{-6}
future on-site worker	incidental ingestion - surface soil	6×10^{-4}
future on-site worker	inhalation fugitive dust - surface soil	1×10^{-6}
future on-site worker	dermal - sediment	2×10^{-6}
future landscaper	dermal - surface soil	2×10^{-5}
future landscaper	dermal - subsurface soil	7×10^{-6}
future utility worker	dermal - surface soil	2×10^{-5}
future utility worker	dermal - surface soil	8×10^{-6}
future construction worker	incidental ingestion - surface soil	1×10^{-6}
future construction worker	dermal - surface soil	7×10^{-5}
future construction worker	dermal - subsurface soil	4×10^{-5}

The unacceptable carcinogenic risks determined for the three pathways and those for the fifteen within the acceptable range are overestimated for the same reasons explained in the noncarcinogenic risk summary and in 2.3.3.3 Uncertainties, below.

2.5.3 Uncertainties

Several caveats need to be noted while evaluating this risk assessment. These caveats, based on assumptions made and data gaps identified, increase the uncertainties associated with the risk assessment results.

- Chemical-specific absorbtion factors are not currently available to convert dermal intakes into dermal absorbed doses for constituents detected in soil and sediment media. Use of these factors, if they were available, in calculating risks due to dermal exposures to soil and sediment may have resulted in reduced risk estimations via these pathways.

- In accordance with USEPA Region VII guidance (EPA, 1992d), when calculating risks due to dermal exposures, oral toxicity values were not adjusted by oral absorbtion rates. The default dermal absorption factor used in Region VII is 100 percent; the constituents are assumed to be completely absorbed through the skin. Thus, the bioavailability of a constituent via dermal exposure is assumed to be equal to that received from an oral dose. This assessment process tends to overestimate risks associated with dermal exposures and may, in particular, overestimate dermal risks due to constituents that are non-lipid soluble (i.e., metals).

- Toxicity values are not available for several constituents of concern, and the risk due to these constituents was unable to be quantified. Thus, the total noncarcinogenic risks calculated for the pathways of interest at the site may be underestimated, because they do not account for constituents without toxicity values.

- The assumption of the exclusive use of the groundwater beneath the site as a potable water source is conservative. Currently, a public supply of potable water is readily available nearby. A well placed in the aquifer beneath the PSF site is capable of yielding approximately one to two gpm, compared to a well capable of yielding up to 14,000 gpm located in river alluvial deposits nearby. It is reasonable to assume that if a drinking water well is needed in the vicinity of the site, it would probably be placed in the alluvium, located just 2,000 feet away. However, because the aquifer at the site is classified as a useable aquifer by the State of Kansas, the potential risk associated with the site groundwater is assessed. Evaluating risk based on using site groundwater as a source of future potable water results in an overestimation of risk.

- The assumption that exposure to constituents in soils indoors (e.g., for the future on-site worker pathways) equals that of outdoors is conservative and results in overestimation of risks due to exposure to surface soils.

- In evaluating future risks to receptors contacting site sediments, the assumption that the constituents present at the time of sampling will be present at the same concentrations in the future. The sediment-contact scenarios do not account for the removal and cleaning of sediment residue from the channel during routine clearing activities. The assumption that the same constituents will be present at the same concentrations may over or underestimate the risk associated with this route.

- The assumption that exposure to constituents in surface soils for the current recreational child, landscaper, utility worker, and on-site worker equals that which was detected in surface sample SS-04 (collected in the area of [previously] stressed vegetation and thus the worst case) results in overestimation of risks from exposure to surface soils. A layer of gravel six to eight inches thick was applied to the site in 1988 (DEH 1993r), after pesticide formulation and mixing practices were discontinued at the site. Therefore, the layer of gravel currently covering the site should be relatively free of pesticide contamination when compared to soils.

- In evaluating risks from future exposures to site media, the assumption was made that future constituent concentrations will remain the same as current concentrations. Dilution, decay, degradation, and attenuation of constituents occurs naturally over time and site contaminants would thus actually be expected to present a reduced risk in future scenarios.

- In evaluating risks due to chromium exposure, all chromium detected on site was assumed to be hexavalent chromium (the more toxic species) when in truth, only a portion of the total chromium detected in hexavalent. Hexavalent chromium is considered by USEPA to be a Group A (known human) carcinogen by the inhalation route. Therefore the use of hexavalent chromium toxicity values may have overestimated carcinogenic risks due to the inhalation of fugitive dust containing chromium.

The risk assessment indicates that there may be concern for potential risks to current or future occupational receptors, based on conservative exposure scenarios. Additionally, a borderline risk to possible future off-site residential receptors' drinking water from the site was also identified.

This risk assessment should not be viewed as an absolute quantitative measure of the risk to public health presented by site-specific contaminants. The assumptions and inherent uncertainties in the risk assessment process do not allow this level of confidence. This risk assessment provides a conservative indication of the potential for risk due to exposure to site-specific chemicals and should help guide the management of the site to reduce that potential risk to acceptable levels.

2.6 SITE CONDITIONS THAT JUSTIFY A REMOVAL ACTION

The present site conditions may pose a threat to public health or welfare, and meet or pertain to the criteria for removal actions under 40 Code of Federal Regulations (CFR) 300.415 (b)(2) of the National Contingency Plan as follows:

- Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants
- High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate
- Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released

Remedial Investigation field investigations reveal that the soil media is contaminated by various constituents (See Section 2.3). Although other constituents were detected in sediment, soils, surface water and ground water samples, only arsenic, chlordane, 4,4'-DDT, heptachlor and dieldrin exceed RCRA corrective action levels (Table 2.6). The risk assessment activities performed to date also indicate that these constituents are the primary contributors to risk. Arsenic poses the greatest non-carcinogenic risk due to exposure to soils at PSF. The primary constituents contributing to carcinogenic risk from soils are chlordane, 4,4'-DDT and dieldrin.

Five small areas of concern have been identified at the PSF (see Fig. 4-1). The volume of soil exceeding RCRA CALs is estimated at 450 cubic yards. One "hot spot" has been identified in surface soils which has in the past been evidenced by an area of stressed or limited vegetation (See Fig. 2-2). Analytical data confirms this. The depth of the largest portion of the soils of concern is 3.5 to 4.5 feet, therefore, the potential for exposure from this area is limited unless excavation is performed or erosion occurs. Two areas of elevated levels of PAHs exist at the site as well.

The following situations relate to the removal criteria cited above and justify early remedial or removal actions.

- The current use of the portion of the site within the DEH yard is limited due to the imposition of work practice restrictions (an institutional control). However, the DEH would like to regain the use of this area for material storage.

- Access to the areas of concern outside the fenced area has not been restricted although land use patterns and generally heavy vegetation result in infrequent traffic in this area by workers or others. However, exposure may occur not only to humans but animals (wildlife) which have been observed in the vicinity of the site.

- Excavations for the purpose of utility inspection or repair could expose workers to contaminated soils.

- Although soils of concern at the site are primarily subsurface, some areas are susceptible to erosion and therefore have the potential to migrate to surface waters and sediments.

- High intensity precipitation and associated heavy runoff events which could result in soil erosion are not uncommon.

3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

3.1 STATUTORY LIMITS ON REMOVAL ACTIONS

Under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Section 104, the federal government is empowered to respond to releases of hazardous substances and pollutants or contaminants. The Superfund Amendment and Reauthorization Act (SARA) amended Section 104 to increase the maximum funding and time limits on removal actions. However, on Department of Defense sites such as Fort Riley, statutory limits for funding and time to complete removal actions do not apply (Executive Order 12580, October 22, 1991).

3.2 REMOVAL ACTION SCOPE

The broad scope of this removal action is to prevent or minimize the actual or potential exposure of site receptors to hazardous contaminants at the PSF.

Specifically, the scope of the removal actions for the PSF and adjacent soils is focused on reducing or eliminating the current and future exposure paths present at the site. The scope addresses soil contamination only. (Data for contaminants found in surface water, sediments, and ground water media will be presented in the Remedial Investigation and will be addressed further in the full site Feasibility Study.) Soil remediation may be accomplished by establishing a protective barrier on the site, removing the contaminants from the site, destroying the contaminants at the site, or any combination of these.

Specific objectives are:

- Minimize Potential Exposure to Soils for all Site Receptors
- Minimize Potential for Contamination Migration through Erosion and Leaching
- Consistency with Final Remedy
- Attainment of ARARs

3.3 REMOVAL ACTION SCHEDULE

Pending approval of this document and signature of the decision documents, the removal action is anticipated to be implemented expeditiously. The schedule will depend on the action selected. Containment alternatives are generally more readily implemented than excavation and disposal because local contracting mechanisms may be utilized. Funds are programmed for first quarter of the 1994 fiscal year.

3.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

CERCLA remedial response actions must address the requirements of the environmental laws which are determined to be "applicable" or "relevant and appropriate". The identification of ARARs involves the comparison of a number of factors, including the type of hazardous substances present (chemical-specific), the types of remedial actions considered (action-specific), and the physical nature of the site (location-specific), to the statutory or regulatory requirements of the relevant environmental laws. Three types of ARARs are addressed in the following sections; chemical-specific, location-specific and action-specific.

According to the CERCLA Compliance with Other Laws Manual: Interim Final (USEPA, 1988), a requirement under other environmental laws may be either "applicable" or "relevant and appropriate," but not both. Identification of ARARs must be done on a site-specific basis and involves a two-part analysis. First, a determination whether a given requirement is applicable. If it is not directly applicable, a determination is made whether it is both relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

The determination that a requirement is relevant and appropriate is a two-step process: 1) determination if a requirement is relevant and (2) determination if a requirement is appropriate. As stated earlier, this involves a comparison of a number of site-specific factors, including the characteristics of the remedial action, the hazardous substances present at the site, or the physical circumstances of the site, with those addressed in the statutory or regulatory requirement. In some cases, a requirement may be relevant, but not appropriate, given site-specific circumstances; such a requirement would not be ARAR for the site. In addition, there is more discretion in the determination of relevant and appropriate; it is possible for only part of a requirement to be considered relevant and appropriate in a given case. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

In addition to the ARARs, TBCs (To Be Considered) are also identified during the process of determining remedial response objectives. The TBCs are non-promulgated advisories or guidance issued by the state or federal government that are not legally binding and thus do not have the status of potential ARARs. TBCs are used, however, in conjunction with ARARs to aid in the determination of cleanup levels necessary to protect human health and the environment. Examples of TBCs include health advisories, reference doses (RfDs), guidance policy documents developed to implement regulations, and calculated risk-based levels such as contaminant-specific remediation goals.

3.4.1 Determination of Chemical-Specific ARARs and TBC Requirements

Several constituents that have the potential for causing adverse human health and environmental effects have been detected at the site. This section briefly summarizes the available guidelines and standards which have been established by EPA and the State of Kansas for these constituents. Chemical-specific ARAR and TBC information is presented here for all media for information, however, this EE/CA only addresses soil contamination.

Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

3.4.1.1 Drinking Water

In accordance with the Safe Drinking Water Act, the EPA has established Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) for a number of constituents. By definition, MCLGs equal to zero are non-enforceable health goals while the MCLs are the enforceable standards which must be set as close to the MCLGs as feasible. Non-zero federal MCLGs are also considered ARARs for groundwater.

The receptor population's total environmental exposure to a specific chemical is considered in developing the MCL, which attempts to set lifetime limits at the lowest practicable level to minimize the amount of toxicants contributed by drinking water. An intake of two liters of water per day is assumed in developing MCLs. The MCLs are relevant for constituents in the ground water at the site because the aquifer beneath the site is considered a potential potable water supply by the State of Kansas.

Relevant State Water Regulations which set State MCLs for constituents detected on the site may be more stringent than the federal MCLs. However, discussions with the Kansas Department of Health and Environment, Bureau of Water Protection, indicated that the State of Kansas is required to enforce the federally established MCLs. In the case where the current state MCL is more stringent than the federal MCL, the state MCL is considered a MCL goal (MCLG) rather than a MCL and is not an enforceable standard.

In addition to MCLs, the State of Kansas has developed Kansas Action Levels (KALs), Kansas Notification Levels (KNLs), Alternate Kansas Action Levels (AKALs), and Alternate Kansas Notification Levels (AKNLs). The KNL or AKNL is used to constitute administrative confirmation that ground-water contamination exists. The KAL or AKAL is applied to represent the level at which long-term exposure to contaminant concentrations is considered unacceptable. The KNL/KAL apply to fresh water and usable water aquifers in the state, whereas the AKNL/AKAL apply to alluvial aquifers and/or specific aquifers which surface through springs or seeps to become contributors to the surface waters of the state (KDHE, 1988). The KALs, KNLs, AKALs, and AKNLs for constituents detected in the ground-water samples collected from the site are considered TBC requirements.

A list of the contaminants detected in the groundwater at the PSF, and the ground-water ARARs and To Be Considered (TBC) criteria associated with these constituents, is presented in Table 3-1. Beryllium exceeded its Kansas Action Level but the maximum detected concentration of beryllium was less than the federal MCL of 0.004 mg/L (effective date January 17, 1994).

The maximum detected concentrations for aluminum, manganese, and inorganic chloride exceeded the secondary MCLs established by the federal government. Secondary MCLs are used to define the aesthetic quality of drinking water, and are not enforceable standards. The detected concentrations of arsenic, barium, chromium, and sulfate were below proposed or current MCLs (see Table 3-1). There are currently no criteria values for bicarbonate and vanadium.

3.4.1.2 <u>Surface Water</u>

The USEPA has developed Ambient Water Quality Criteria (AWQC) for constituents in surface waters for the protection of aquatic life and for the protection of human health from the ingestion of contaminated water and/or organisms. The AWQC for the protection of aquatic organisms are based on two criteria: (1) acute criterion representing the maximum concentrations permissible at any time, and (2) chronic criterion representing the maximum permissible concentration averaged over a 24-hour time period. The AWQC for the protection of human health are based on the ingestion of contaminated water and/or the ingestion of contaminated organisms from surface waters (USEPA, 1987). The AWQC assumes a daily water intake of two liters and a daily fish intake of 6.5 grams.

Relevant State Surface Water standards include the State of Kansas Surface Water Standards which set water quality criteria for constituents which may be more stringent than the federal criteria. The State of Kansas incorporates the federal AWQC by reference.

The chemical-specific surface water guidance criteria for the PSF are shown in Table 3-2. Manganese and arsenic concentrations in the surface water samples collected near the site exceed the AWQC for the protection of human health. Cadmium and inorganic chloride concentrations exceed AWQC for the protection of aquatic life. The exposure point concentration of total chromium exceeds the AWQC for the protection of aquatic life for hexavalent chromium, but not for trivalent chromium (chromium valence was not specified in the analysis). Finally, the concentrations of copper and lead exceed the chronic AWQC for the protection of aquatic life. There are no current regulatory criteria for aluminum, barium, bicarbonate, manganese, sulfate, or vanadium in surface waters.

These criteria are not strictly applicable to near surface water (i.e., the lined channel east of the site) because flow in the channel is intermittent. Therefore, the use of on-site water for the support of aquatic life, recreational activities, or a domestic water supply is not considered at the PSF. For these reasons, the AWQC criteria are included here as TBCs because the lined channel on-site ultimately discharges to the Kansas River.

3.4.1.3 Soils

Currently, there are no chemical-specific federal regulations governing the levels of contaminants in soils, therefore, there are no "applicable" requirements. However, in the proposed RCRA Subpart S regulations (55 FR 30798-30884), Corrective Action Levels (CALs) have been developed but are not yet in effect. The CALs are health-based criteria that are meant to serve as an indication of whether corrective actions are required at RCRA treatment, storage or disposal facilities. The CALs are recognized as being "relevant and appropriate" requirements for this site.

The RCRA CALs for carcinogens are calculated based on Carcinogenic Slope Factors (CSFs). The calculation of lifetime (carcinogenic) soil criteria assumes that an adult weighing 70 kilograms ingest 0.1 grams of soil daily throughout a 70-year lifetime (Federal Register, 1990a). The CALs for systemic (noncarcinogenic) toxicants are calculated based on Reference Doses (RfDs) and are an estimate of the daily exposure that an individual can experience without appreciable risk of health effects during a lifetime. The calculation of the noncarcinogenic criteria assume a soil ingestion rate of 0.2 grams daily, by a child weighing 15 kilograms, over a period of five years.

The RCRA soil CALs for the constituents detected in PSF site soils are presented as ARARs in Table 2-6. The maximum detected concentrations of alpha- and gamma-chlordane and dieldrin exceed the RCRA soil action levels in both surface and subsurface soils, while the maximum detected concentration of 4,4′-DDT exceeds the RCRA CALs in subsurface soil only. All metals were present in concentrations below available CALs in subsurface and surface soils, except for arsenic, which was present at a maximum concentration of 120 mg/kg (RCRA CAL = 80 mg/kg) in a subsurface soil sample collected at a depth of 3.5 to 4.5 feet. There are no RCRA action levels for the polynuclear aromatic hydrocarbons (PAHs) or 2-methylnaphthalene.

The USEPA (Region VII) provided a risk based concentration table (generated by EPA Region III) for all of the contaminants of concern at the PSF site. The table contains maximum contaminant concentration goals based on reasonably conservative carcinogenic risks for all contaminants. The table includes maximum concentration goals for both commercial/occupational and residential scenarios.

Contaminant-specific Remediation Goals (RGs) are concentration goals for individual constituents of concern for specific medium and land use combinations at the PSF site. These concentrations are based on risk assessment or risk-based calculations that set the concentration limits for the constituents using carcinogenic and/or toxicity values under specific exposure conditions (ie., the exposure scenarios included in the RI report's baseline risk assessment). Contaminant-specific remediation goals are considered TBC criteria for remediation of site media, in the absence of chemical-specific ARARs. Contaminant-specific RGs are derived to protect human health; no consideration is given to ecological effects when developing RGs. A comparison of these concentration goals to the RCRA CALs is located in Table 2-7a.

Tables 1 through 4 in Appendix B are summary tables that compare the calculated RGs for each medium (and each receptor of concern) to the maximum constituent concentrations detected in that particular medium. In addition, available regulatory criteria or guidance values are listed in these tables for comparison. The procedures and methodology used to develop the RGs at the PSF site are depicted in tables A-1 through A-27 (Appendix B). The spreadsheets used to calculate the constituent- and receptor-specific RGs are also located in Attachment A of Appendix B.

For all exposure scenarios, standard default body weights of 70 kg for an adult and 15 kg for a child are used. Standard default exposure values were taken from the"Supplemental Guidance to the Human Health Evaluation Manual" (USEPA, 1991a).

Except for arsenic, the EPA, Region III maximum concentration goals are less conservative than the RCRA CALs.

3.4.1.4 Sediments

Currently, there are no chemical-specific federal regulations (ARARs) governing the levels of contaminants in sediments. However, the National Oceanic and Atmospheric Administration (NOAA) has developed Effects Range Concentrations which are non-enforceable sediment guidance criteria for environmental (non-human) receptors. These concentrations were derived from data on the potential of certain chemicals to cause adverse biological effects in the coastal marine and estuarine environments. These values are used as an general indication of the environmental health of the ecosystem.

Two effects-based values, the Effects Range-Low (ER-L) and the Effects Range-Median (ER-M), are generally determined for a given constituent of concern. These values are developed using a method (Klapow and Lewis, 1979 - as cited in NOAA, 1990) that is similar to that used in establishing marine quality standards for the State of California (NOAA, 1990). First, currently available information (studies and reports) which contain estimates of chemical sediment concentrations associated with adverse biological effects are assembled and reviewed. Next, a range is established for the constituent, based upon a preponderance of evidence, which reflects the concentrations at which the biological effects are noted. Lastly, this range is evaluated relative to the sediment chemical data available from the National Status and Trends Program. The ER-L and ER-M values are generated as a result of this process. The Effects Range - Low (ER-L) is the lower 10th percentile of concentrations with detectable adverse effects while the Effects Range - Median (ER-M) is the corresponding median concentration. Effects threshold range concentrations are defined as those concentrations at which effects may be perceived in an organism due to exposure to the constituent of concern.

A description of the relative degree of confidence associated with the ER-L and ER-M values is also provided by NOAA. The ER-L and ER-M values associated with a high degree of confidence were supported by clusters of data with similar concentrations, by data sets from multiple geographic locations, by data sets that included more than results from an approach, and for chemicals for which the overall apparent effects threshold was similar to or within the range of the ER-L and ER-M values (NOAA, 1990).

The NOAA criteria are not strictly applicable to the site because they were developed for estuarine and marine (saltwater) environments. However, they are used as an indication of the general health of the ecosystem in the environmental risk assessment portion of the Baseline Risk Assessment. Therefore, the NOAA values for the chemicals detected in site sediment samples are presented in Table 3-3 as TBCs for site sediments.

The sediment concentrations of chlordane, DDT, and dieldrin exceed available NOAA low effects and median effects threshold values. One metal, lead, is present in sediments in concentrations which exceed both the low and median NOAA Effects Threshold Range Concentrations, while the concentration of mercury exceeds the available low NOAA effects threshold value. All PAHs are present in concentrations below the effects threshold range. As the support of aquatic life in the lined channel adjacent to the site is limited by intermittent stream flow, the impact of pesticides and metals in the sediments on aquatic life is expected to be minimal. Riparian species utilizing this habitat may potentially be affected by the site constituents. The RI will access this further.

3.4.2 Determination of Location-Specific ARARs and TBC Requirements

Location-specific ARARs are restrictions placed on the concentration of constituents or the activities to be performed at a site because the site occurs in a special location such as a floodplain, wetland area, historic places, and fragile ecosystems or habitats. Potentially applicable federal requirements that have been evaluated are listed below:

- Endangered Species Act of 1973
- Fish and Wildlife Coordination Act Requirements
- Stormwater Discharge Requirements National Pollutant Discharge Elimination System Requirements
- Protection of Wetlands (Executive Order 11990)
- Floodplain Management Requirements (Executive Order 11988)
- Historic Site Building and Antiquities Act

Additional State of Kansas requirements that apply are:

- Kansas Surface Water Use Designations
- State of Kansas Historic Preservation Act

Currently, there are no location-specific To Be Considered (TBC) requirements under examination for this site. The ARARs are summarized with the appropriate citations in Table 3-4. Descriptions of reasons for the applicability of a given location-specific ARAR to this site are provided in the following paragraphs.

3.4.2.1 **Endangered Species Act of 1973**

These regulations protect or conserve endangered or threatened species. Fort Riley falls within an area that eight federally endangered species and thirteen additional candidate species for the federal endangerment listing are likely to inhabit. Of these 21 total species, two federally endangered species and eight candidate species are known to occur on Fort Riley; it is assumed that these species are also present on the Pesticide Storage Facility (PSF) site. Examples of these species include the bald eagle, the peregrine falcon, the prairie mole cricket, and Henslow's sparrow.

3.4.2.2 **The Fish and Wildlife Protection Act**

This Act conserves fish and wildlife when remedial actions result in the modification of a body of water; it is potentially applicable to this site because several different species of animals have been identified at Fort Riley, including the American Burying Beetle, the Texas Horned lizard, the Loggerhead Shrike, and the Regal Fritillary butterfly.

3.4.2.3 **Stormwater Discharge Requirements National Pollutant Discharge Elimination System**

The PSF is located approximately one-half mile north of the Kansas River; an ephemeral drainage way, draining toward the Kansas River, is located east of the PSF. The federal Stormwater Discharge Requirements and National Pollution Discharge Elimination System (NPDES) requirements therefore apply to this site, because of the potential for stormwater to drain off the site, acquiring chemical contaminants by contact with contaminated surface soils (left exposed under certain remedial alternatives), into the Kansas River. This drainage would constitute a surface water discharge.

3.4.2.4 **Protection of Wetlands (Executive Order 11990)**

Federal requirements for protection of wetlands (Executive Order 11990) regulate action involving management of property in wetland areas to avoid adverse effects, minimize potential harm, and preserve and protect wetlands to the extent possible; these requirements may apply because although no formally delineated wetlands appear to exist at the site, the Kansas River and its associated biota could constitute a wetlands region. Currently, the Corps of Engineers is conducting a wetlands delineation survey. Pending the results generated from this survey, this ARAR may be removed from consideration, if no wetlands are identified which could be impacted by the site.

3.4.2.5 **Flood Plain Management (Executive Order 11988)**

Federal requirements for floodplain management (Executive Order 11988) regulate action that will occur within a floodplain to avoid adverse effects due to flooding. This ARAR applies because part of the PSF area of investigation is located within the 50 year floodplain. The 50-year flood peak in this region has been set at 1067 feet above mean sea level and the PSF area of investigation ranges from 1062 to 1088 feet above mean sea level.

3.4.2.6 **Historic Site Building and Antiquities Act**

This act provides the protection, enhancement, and preservation of sites of archaeological or historic significance. It is a potential ARAR because the Main Post area at Fort Riley has been designated as an Historic District and is listed on the National Register of Historic Places. The Historic District encompasses an area of approximately 670 acres and the PSF lies within the Historic District Boundaries.

3.4.2.7 **State of Kansas Surface Water Use Designations**

These regulations provide criteria for approved uses of certain types of waters. Surface water located within the confines of the PSF exists principally in the drainage ditch located east of the site that drains to the Kansas River. Surface water in the drainage ditch has not been classified by the State of Kansas. Provisions of this ARAR may apply to water contained in the drainage ditch, depending on the classification of its use. The Kansas River is classified for "noncontact recreational use" and "consumptive recreational use" in this area. Furthermore, the Kansas River is also designated as an expected aquatic life region.

3.4.2.8 **State of Kansas Historic Preservation Act**

This Act provides for the protection and preservation of site and buildings listed on state or federal historic registries. The Main Post Area at Fort Riley has been designated as an Historic District and is listed on the National Register of Historic Places. The Historic District encompasses an area of approximately 670 acres and the PSF lies within the Historic District Boundaries. This ARAR will apply if actions requiring permitting are required at the site.

3.4.3 Determination of Action-Specific ARARs and TBC Requirements

Action-specific ARARs are technology-based or activity-based requirements or limitations on proposed remedial actions at the site. By definition, action-specific ARARs are dependent on the proposed remedial actions at the site. Currently, there are five remedial alternatives under consideration for this site. These alternatives are developed and discussed in great detail in section 4.0 of this document. (The action-specific ARARs are presented here, prior to the development of the remedial alternatives, to maintain consistency in the document.) The alternatives are listed below:

- No-Action
- Institutional Controls
- Institutional Controls and Grading
- Asphalt Cap and Grading
- Asphalt/Concrete Cap and Grading
- Removal and Disposal

Federal and State of Kansas ARARs that apply to each alternative are summarized in Table 3-4. A discussion of ARARs applicable to each remedial alternative under consideration is provided in the following paragraphs. Also provided is a discussion of specific reasons why each ARAR or TBC requirement applies to a specific remedial alternative.

3.4.3.1 **No-Action**

There have been no ARARs or TBCs identified for this remedial alternative.

3.4.3.2 **Institutional Controls**

There have been no ARARs or TBCs identified for this remedial alternative.

3.4.3.3 **General**

The following general ARAR applies to any type of remedial activities. These activities include grading, capping, and any other miscellaneous construction work.

> Hazardous Waste Operations and Emergency Response (OSHA) - These regulations define the training, health and safety, and monitoring requirements for workers involved in on-site activities on hazardous waste sites. It is applicable to all remedial alternatives under which worker exposure to hazardous constituents may occur, and is applicable to this site because of the constituents detected in the soils.

3.4.3.4 **Institutional Controls and Grading**

The following federal ARARs apply to this activity for the reasons described herein:

> National Ambient Air Quality Standards (CAA) - These regulations define the levels of air quality necessary to protect public health. As grading will generate the emissions of contaminated dust (from surficial soils), this ARAR is applicable to this alternative.

> National Emission Standards for Hazardous Air Pollutants (NESHAPs - CAA) - These regulations provide national emission standards for listed hazardous air pollutants. Because both listed hazardous air pollutants (e.g - arsenic and mercury) and other constituents that are under consideration to be added to the list of hazardous air pollutants (e.g. - chromium, various polycyclic organics) were detected in the surficial soils, the potential for airborne emissions of these contaminants caused by grading activities make this ARAR applicable to this remedial alternative.

> Occupational Safety and Health Standards for Air Contaminants (OSHA) -These regulations provide national standards of worker exposure to listed air contaminants, and because workers will be involved in on-site grading activities, this ARAR is applicable.

The following State of Kansas ARAR also applies to this remedial alternative for the reasons listed below:

Ambient Air Quality Standards and Air Pollution Control Regulations - These regulations provide state emission standards for listed hazardous air pollutants and state air quality standards to protect public health. Listed compounds that were detected in surficial soils include arsenic, chlordane (alpha and gamma), chromium, 4,4′-DDT, and dieldrin. As there is the potential to volatilize some listed air pollutants present in the surficial soil from this site, these regulations are applicable.

3.4.3.5 **Asphalt Cap and Grading**

The following federal ARARs apply to this activity for the reasons described herein:

National Ambient Air Quality Standards (CAA) - These regulations define the levels of air quality necessary to protect public health. As grading will generate the emissions of contaminated dust (from surficial soils), this ARAR is applicable to this alternative.

National Emission Standards for Hazardous Air Pollutants (NESHAPs - CAA) - These regulations provide national emission standards for listed hazardous air pollutants. Because both listed hazardous air pollutants (e.g - arsenic and mercury) and other constituents that are under consideration to be added to the list of hazardous air pollutants (e.g. - chromium, various polycyclic organics) were detected in the surficial soils, the potential for airborne emissions of these contaminants caused by grading activities make this ARAR applicable to this remedial alternative.

Occupational Safety and Health Standards for Air Contaminants (OSHA) -These regulations provide national standards of worker exposure to listed air contaminants, and because workers will be involved in on-site grading activities, this ARAR is applicable.

The following State of Kansas ARAR also applies to this remedial alternative for the reasons listed below:

Ambient Air Quality Standards and Air Pollution Control Regulations - These regulations provide state emission standards for listed hazardous air pollutants and state air quality standards to protect public health. Listed compounds that were detected in surficial soils include arsenic, chlordane (alpha and gamma), chromium, 4,4'-DDT, and dieldrin. As there is the potential to volatilize some listed air pollutants present in the surficial soil from this site, these regulations are applicable.

3.4.3.6 **Asphalt/Concrete Cap and Grading**

The following federal ARARs apply to this activity for the reasons described herein:

National Ambient Air Quality Standards (CAA) - These regulations define the levels of air quality necessary to protect public health. As grading will generate the emissions of contaminated dust (from surficial soils), this ARAR is applicable to this alternative.

National Emission Standards for Hazardous Air Pollutants (NESHAPs - CAA) - These regulations provide national emission standards for listed hazardous air pollutants. Because both listed hazardous air pollutants (e.g - arsenic and mercury) and other constituents that are under consideration to be added to the list of hazardous air pollutants (e.g. - chromium, various polycyclic organics) were detected in the surficial soils, the potential for airborne emissions of these contaminants caused by grading activities make this ARAR applicable to this remedial alternative.

Occupational Safety and Health Standards for Air Contaminants (OSHA) -These regulations provide national standards of worker exposure to listed air contaminants, and because workers will be involved in on-site grading activities, this ARAR is applicable.

The following State of Kansas ARAR also applies to this remedial alternative for the reasons listed below:

> Ambient Air Quality Standards and Air Pollution Control Regulations - These regulations provide state emission standards for listed hazardous air pollutants and state air quality standards to protect public health. Listed compounds that were detected in surficial soils include arsenic, chlordane (alpha and gamma), chromium, 4,4'-DDT, and dieldrin. As there is the potential to volatilize some listed air pollutants present in the surficial soil from this site, these regulations are applicable.

There were no state TBC requirements noted for this alternative.

3.4.3.7 **Removal and Disposal**

The following federal ARARs apply to this activity for the reasons described herein:

> DOT Rules for Transportation of Hazardous Materials (DOT) - These regulations provide for transport of hazardous waste on the highway system, rail system, by water or by air. These regulations are applicable because the alternative in question involves transportation of potentially hazardous waste (presumably by ground) to an off-site disposal facility.
>
> National Ambient Air Quality Standards (CAA) - These regulations define the levels of air quality necessary to protect public health. As excavation will generate the emissions of contaminated dust (from surficial soils), this ARAR is applicable to this alternative.
>
> National Emission Standards for Hazardous Air Pollutants (NESHAPs - CAA) - These regulations provide national emission standards for listed hazardous air pollutants. Because both listed hazardous air pollutants (e.g - arsenic and mercury) and other constituents that are under consideration to be added to the list of hazardous air pollutants (e.g. - chromium, various polycyclic organics) were detected in the surficial soils, the potential for airborne emissions of these contaminants caused by excavation activities make this ARAR applicable to this remedial alternative.

Occupational Safety and Health Standards for Air Contaminants (OSHA) -These regulations provide national standards of worker exposure to listed air contaminants, and because workers will be involved in on-site grading activities, this ARAR is applicable.

The following federal TBC requirements also apply:

Standards Applicable to Generators of Hazardous Waste (RCRA) - These regulations apply to owners or operators of facilities that generate hazardous waste. Since the soil has the potential to be a characteristic waste, and since, by removing the waste, it is effectively being managed, these regulations will apply, if TCLP testing indicates that these soils are characteristically hazardous.

Standards Applicable to Transporters of Hazardous Waste (RCRA) - These regulations establish the standards which apply to persons transporting hazardous waste within the United States if the waste requires a manifest under RCRA and will be applicable if the waste is transported off-site for disposal. These regulations are applicable because the alternative in question involves transportation of potentially hazardous waste (presumably by ground) to an off-site disposal facility.

Standards of Identification and Listing of Hazardous Waste (RCRA) - These regulations provide criteria to distinguish hazardous waste from solid waste; it also lists the characteristics of hazardous waste. These regulations will be applicable when identifying hazardous waste. Since classification of the waste as hazardous or nonhazardous will be required for off-site disposal and for manifesting and transportation under this alternative, these regulations will apply.

Manifesting, Recordkeeping, and Reporting Requirements (RCRA) - These standards apply to the owners and operators of facilities that treat, store, or dispose of hazardous waste and will apply if the waste is shipped off-site for disposal as hazardous waste. Since this alternative involves transportation of potentially hazardous waste to an off-site disposal facility, these regulations may apply.

Land Disposal Restrictions (RCRA) - These regulations identify hazardous wastes that are restricted from land disposal and define the limited circumstances under which an otherwise prohibited waste may continue to be land disposed. These restrictions are applicable for on or offsite disposal and include requirements based on the constituents in the waste. Because this alternative involves the disposal of the soil in a landfill (RCRA Subtitle C or D, depending on whether the soils are hazardous wastes under RCRA), these disposal restrictions apply, depending on specific constituents and their concentrations in the soil.

The following State of Kansas ARAR also applies to this remedial alternative for the reasons listed below:

Ambient Air Quality Standards and Air Pollution Control Regulations - These regulations provide state emission standards for listed hazardous air pollutants and state air quality standards to protect public health. Listed compounds that were detected in surficial soils include arsenic, chlordane (alpha and gamma), chromium, 4,4'-DDT, and dieldrin. As there is the potential to volatilize some listed air pollutants present in the surficial soil from this site during excavation and transport, these regulations are applicable.

The following State of Kansas TBC requirements apply to this alternative for the reasons described below:

Solid Waste Management Regulations - These describe state requirements for solid waste management, including all aspects of storage, treatment, and transport. Because solid waste is being handled at, and will be transported from this facility under this alternative, these regulations apply to this alternative.

Hazardous Waste Management Regulations - These describe state requirements for hazardous waste management, including all aspects of storage, treatment, and transport. Because hazardous waste may be handled at and transported from this facility under this alternative, these regulations are applicable to this alternative.

4.0 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

This section identifies and screens potential technologies for remediating the site and provides specific removal action alternatives based on the results of the technology screening. The major factors considered in the screening process are timeliness, and overall effectiveness.

4.1 GENERAL RESPONSE ACTIONS

Five general response actions have been identified to categorize the potential remedial actions for the PSF considering the constituents (arsenic, chlordane, 4',4-DDT, heptachlor and dieldrin) to be addressed: (1) No-Action; (2) Institutional; (3) Containment; (4) Treatment; and (5) Removal/Disposal. These general response actions were developed based upon the potential media, (i.e. soils) with constituents above chemical-specific ARARs and TBCs. The various remedial technologies associated with the general response actions are discussed in this section. Although each of the response actions are presented individually, it is possible and likely due to the site characteristics that the recommended remedial action will require a combination of response actions. The potential combination of technologies into site wide alternatives is discussed in Section 5.0.

4.1.1 No-Action

This response action will allow the site to remain as is, without implementation of remedial technologies. This type of action would not directly address the soil at the PSF. This response action would not reduce the potential risk associated with exposure to contaminants in soils.

4.1.2 Institutional Actions

This response action includes controls which prevent or limit access to the site as well as long-term usages of the area. Examples of institutional controls would include fencing, warning signs, deed restrictions (if applicable), on-site work procedures and monitoring. At the PSF site, with institutional actions, utility services in the area could be isolated. These utility services include gas, fire, water and sewer lines. Either a long-term or short-term monitoring plan could be developed depending upon what remedial action is selected.

4.1.3 **Containment Actions**

Containment is the use of physical barriers to control the migration of contaminants from the PSF and potential on-site exposure. Containment response actions do not treat or reduce toxicity or volume of contaminations. Containment actions can be implemented both in-situ and above ground on soil and sediment. In-situ generally refers to the utilization of a cap (clay or asphalt), or a slurry wall. Above grade containment typically refers to removing the media of potential concern and placing the media in drums, disposal containers, or containment structures. Containment actions do not provide permanent remedies for the site.

4.1.4 **Treatment Actions**

Treatment actions refer to the use of either chemical, physical, thermal, or biological treatment methods to reduce or eliminate the toxicity, mobility, or volume of potential contamination. Treatment technologies typically alter the characteristics of the contaminants by changing the chemical structure or isolating or destroying the contaminant. Typically, a single treatment methodology is not capable of treating all potential constituents of concern, i.e. volatile organics, semi-volatile, and metals, and combinations of the technologies are utilized to achieve clean-up standards. However, with limited constituents of concern, it may be feasible that only a few treatment technologies could be utilized.

Treatment of soil can be performed either on-site or off-site. The utilization of either on-site or off-site treatment is dependent upon the volume of waste, type of constituents, feasibility of the technology and economics required to perform the treatment. Potential treatment options for the media of concern are discussed in Section 4.2.

4.1.5 **Removal/Disposal Action**

The removal/disposal action involves the collection of contaminated soil from the site and placing these waste in a secure location. The storage of the waste can be either on-site or off-site depending upon the contaminant levels and the quantities of wastes. Treatment of the contaminated soils may be required before it can be disposed of.

4.2 IDENTIFICATION AND SCREENING OF POTENTIAL TECHNOLOGY TYPES

Technologies are screened for potential use for the PSF remediation in the following discussion.

4.2.1 No-Action Technologies

Since under the no-action response the site remains in it's current state, no remedial treatment technologies are utilized. Therefore, no remedial treatment technologies or process options are applicable for remediation of the contaminated soils.

4.2.2 Institutional Action Technologies

Table 4-1 includes institutional controls that could be used at the site to address the contaminated soils. Institutional action technologies do not directly address contamination at the site. Long or short-term ground water, surface water, sediment and/or soil monitoring are potential technologies that may be implemented to confirm that these media are not being impacted by on-site soils. Soils could be collected and analyzed for the constituents of concern to determine changes of constituents with time. Fencing, and utility relocation (shut off and abandonment in-place) in the PSF area may be used. Long-term use restrictions at the site may be appropriate here also. No-action, usually involving no controls, is typically used as a baseline for comparison. Since some of the institutional actions are already existing at the PSF (fencing), for non-remedial purposes, the existing status is utilized as the baseline technology for comparison to other alternatives and technologies.

4.2.3 Containment Action Technologies

Table 4-1 includes the potential remedial technologies and process options that could be utilized at the site for the containment response action. In addition, Table 4-1 also provides screening comments for each technology type and process option. Options which are potentially feasible are also identified. The containment remedial technologies which passed the initial screening remediation include:

- Clay cap
- Hard cap
- Grading / Vegetation enhancement
- Diversion / Collection

A multi-layer cap was screened out because of its higher cost. (An asphalt cap is as effective and costs less.)

4.2.4 **Treatment Action Technologies**

Table 4-2 includes the treatment technologies that could potentially be utilized at the site for treatment in soil remediation. The remedial technologies include chemical/physical treatment technologies. Table 4-2 also provides screening comments and identifies which technologies and process options should be considered further. In order to utilize treatment technologies, some institutional and removal and disposal process options would also be required. The treatment technologies being considered further for soil remediation include: stabilization/solidification.

4.2.5 **Removal/Disposal Action Technologies**

Table 4-3 includes the removal and disposal technologies that could potentially be utilized at the site for soil and sediment remediation. The remedial technologies include only off-site disposal. On-site disposal is not being considered since there is no place on-site (PSF) to dispose of the soil. Table 4-3 also provides screening comments and identifies which technologies and process options should be considered further. The removal and disposal technologies for soil being considered are: excavation off-site and off-site disposal-landfilling.

4.3 ACCEPTABLE PROCESS TYPES AND TECHNOLOGIES

Based upon the screening information, the following remedial technology types and process options are considered for further evaluation for soil remediation:

General Response Action	
Institutional Actions	Access Restrictions Utility Service Isolation Land Use Restrictions

Soil:

General Response Action	Technology Type	Process Option
• Containment	Capping	Clay Cap
	Capping	Hard Cap
	Surface Controls	Grading
	Surface Controls	Diversion/ Collection

General Response Action	Technology Type	Process Option
• Treatment	Chemical/Physical	Stabilization/ Solidification
• Removal and Disposal	Collection Disposal	Excavation Treatment/ Landfill

Table 4-4 summarizes the general response actions, technology types and process options for the constituents of concern in the soil media.

4.4 REMOVAL ACTION ALTERNATIVES

Based on the results of the technology screenings, six remedial action alternatives were developed to achieve site remedial action objectives and the clean-up criteria. Ground water, sediments and surface water media are not addressed in this EE/CA. In this section of the EE/CA, process options developed from the technology screening in Section 4.3 are combined into remedial alternatives. These alternatives are developed and initially evaluated based on effectiveness, implementability and, to a lesser extent, cost. The potential process options were combined into six alternatives considered to be effective and implementable at the PSF site.

Alternative 1 - No-Action
Alternative 2 - Institutional Controls
Alternative 3 - Institutional Controls/Grading
Alternative 4 - Institutional Controls/Grading/Capping (Asphalt Cap)
Alternative 5 - Institutional Controls/Grading/Capping (Asphalt/Concrete Cap)
Alternative 6 - Removal and Disposal

Although other alternatives could have been developed based upon the process options and technology types, only these alternatives are considered feasible and practical for the site considering the level of constituents in the soil, the size of the site, and the volume and depth of contaminated soil.

Of the process options summarized in Section 4.3, only treatment (Chemical/Physical-Stabilization/Solidification) was not considered for an alternative. Solidification/Stabilization was not considered since significant migration of the constituents of concern have not been noted. Additionally, this technology would result in increased exposure and generate a larger quantity of material to be disposed compared to the other options utilized in the alternatives.

Based upon the identification of ARARs (RCRA CALs), baseline risk assessment indications, the clean-up criteria, and the process options identified in Section 4.3, the following process options were not considered for alternatives: Multi-layer cap and stabilization/solidification.

4.4.1 Development of Alternatives

A set of remedial alternatives for the PSF were assembled from the technologies and representative process options that passed the screening criteria in Section 4.3. These alternatives are meant to address a range of remedial approaches and levels of treatment, from no-action to one which would eliminate the contaminants in the soil. Since the constituents of concern (arsenic, chlordane, 4,4'-DDT, heptachlor and dieldren) have not been noted to migrate from the site, installation of monitoring wells and an extended monitoring program to evaluate migration into the ground water is not being considered. Therefore, monitoring of ground water at the PSF is not included in the EE/CA. (Monitoring wells do not constitute a removal action, rather they augment removal actions and will be further evaluated in the full site FS.) The developed remedial alternatives are described in the following sections.

4.4.1.1 Alternative 1 - No-Action

The no-action alternative requires no on-site remediation for soil clean-up or institution controls be implemented. The PSF site would remain in its current state and the contaminates of concern would remain in their present state. With this alternative, no risk reduction is noted. The no-action alternative, usually involving no controls, is typically a baseline remedial action for the site, and serves as a comparison for the other alternatives. However, for this site, since some of the institutional actions (fencing, access restriction measures) are already in place for non-remedial purposes, the existing status is utilized as the baseline technology for comparison to other alternatives and technologies. Alternative 2 (Institutional Controls) will be used as the baseline case for comparison.

4.4.1.2 Alternative 2 - Institutional Controls

This alternative involves limiting the access to the PSF area and restricting future land use. The installation of a perimeter fence and on-site security will prevent access to the potential areas of contamination from facility personnel. This alternative assumes that the installation already has an action in place to prevent public access to the site. A boundary fence already exist at the PSF which limits the accessibility to the area. With this alternative, the east side of the boundary fence is relocated as shown in Figure 4-2 approximately 30 feet closer to the lined drainage ditch. Movement of the fence will encompass Area 5 in the restricted access area. With the relocation of the fence, no areas of potential contamination will be disturbed. Typically, deed restrictions are used to restrict future land use. However, with this site as an active military installation, deed restrictions as such are not applicable. Alternatively, Fort Riley real property records and land use planning documents can record site conditions and be used similar to deed restrictions to record and specify controls and land use restrictions. Additionally, with the implementation of institutional actions, utility lines would be isolated from the area (water supply, sewer and gas line) which would eliminate utility service as a potential exposure route, if applicable. Isolation just involves closing valves or capping lines to discontinue service. It is not the intent of this alternative to excavate the utility lines from the site, but rather abandon them in place. Electrical lines will not be addressed since electrical service connections are provided on poles above grade. On-site work procedures can be established to limit landscaping activities in the area of concern. The current state of the PSF site remains relatively unchanged with the implementation of the institutional action alternative.

4.4.1.3 Alternative 3 - Institutional Controls/Grading

Due to the limited mobility of the constituents of concern (arsenic, chlordane, 4,4'-DDT, heptachlor and dieldrin) to the ground water, this alternative considers regrading of the area as shown in Figure 4-2 and implementation of the institutional actions presented in Alternative 2. The primary focus of this alternative is erosion control at the site. The site can be regraded just outside the existing perimeter fence from the east of Building 348 to the existing drainage channel. The area around the PSF Building 348 will be graded for erosion control. Due to the topography of the area on the east side of the building to the channel, approximately 350 yards of clean backfill will be required for grading.

Also under this alternative, drainage from the north will be collected in a proposed drainage channel placed near the northeast end of Building 348 and draining to the existing lined channel. Drainage from the south will be collected in a proposed drainage channel (as shown in Figure 4-2) initiated southeast of Building 348 and also draining to the existing lined channel. This alternative does not directly address Areas 1, 2, and 3 but is intended to control soil erosion in Areas 4 and 5. The extent of contamination in Areas 1, 2, and 3 are subsurface (2 to 4.5 feet deep) and are presently covered by asphalt or gravel. Due to the topography near Building 348, these areas are not likely to be affected by surface water erosion. The proposed center drainage channel roughly follows the topography at the PSF site. Proper grading and revegetation of the area are also included to reduce/minimize the mobility of constituents in contaminated soil.

4.4.1.4 Alternative 4 - Institutional Controls/Grading/Capping (Asphalt)

This alternative involves all of the institutional actions described in Alternative 2 and regrading as presented in Alternative 3 except for the middle section of the proposed drainage ditch in Alternative 3. This alternative includes asphalt capping of Areas 1, 2, 3, 4 and a portion of Area 5. As shown in Figure 4-3, an asphalt cover is used to cover these areas east/northeast of the PSF. Due to the change in grade (12% slope) outside the existing perimeter fence, Area 5 will be regraded as described in Alternative 3. Furthermore, clean backfill will be required for regrading of Area 5. The purpose of the asphalt cover is to control erosion, eliminate exposure during landscaping and on-site work, and control the infiltration of rainfall into potentially contaminated areas. Waterway channels and curbing will be used on the sides of the asphalt cover to direct water away from the areas of contamination to the existing limestone channel.

4.4.1.5 Alternative 5 - Institutional Controls/Grading/Capping (Asphalt/Concrete)

This alternative involves the institutional actions described in Alternative 2 and containment at the site using a hard (asphalt) cap in the area around Building 348 covering the Area of 1, 2, 3 and 4 as described in Alternative 4. In addition, concrete will be utilized in the area (elevations 1076 to 1070) sloping toward the limestone lined channel. The concrete will be used as a cap for Area 5. Concrete is used as a cap in this area, as the steep slope (25% grade) will not support paving. Backfill and regrading, as described in Alternative 3, will also be required prior to the use of concrete. The primary intent of the asphalt and concrete is for surface water diversion from the contaminated area. The asphalt and concrete covers extend over the area as shown in Figure 4-4. The covers reduce percolation/infiltration of surface water into the contaminated soil and also prevents erosion due to surface water.

4.4.1.6 Alternative 6 - Removal and Disposal

This alternative involves the institutional actions described in Alternative 2 with excavation of the estimated area of concern. These areas include Areas 1, 2, 3, 4 and 5 as delineated in Figure 4-1. With this alternative, soil volumes requiring removal and disposal depend greatly on the clean-up level chosen. Several clean-up standards are considered including RCRA CALs, site specific remediation goals for two future scenarios and standard maximum risk based concentrations provided by the EPA. (RCRA CALs are ARARs; the others are TBCs.) The future On-Site Worker scenario represents the most stringent calculated RGs, while the future Utility Worker is presented to illustrate a future scenario developed using fewer conservative assumptions. Table 2-7a compares various potential clean-up levels for the contaminants of concern at the site.

The soil volumes estimated for removal/treatment/disposal under each clean-up level scenario are outlined below. The volumes were calculated by interpolating the area around each "hot spot" that exceeded the clean-up criteria and then multiplying by the corresponding maximum soil depth. This method of calculation assumes disposal of all soils above the deepest contaminated soils although RI data shows that some shallower soils are less contaminated than those at depth. Confirmation sampling is used to ensure that all the contaminated soil was removed.

Alternative	ARAR/TBC	Scenario	Soil Volume Requiring Removal
6A	RCRA CAL	N/A	42 cy (Arsenic) 407 cy (Pesticides)
6B	Site RG	Future Utility Worker	265 cy (Arsenic) 0 cy (Pesticides)
6C	Site RG	Future Site Worker	231 cy (Arsenic) 610 cy (Pesticides)

Alternative	ARAR/TBC	Scenario	Soil Volume Requiring Removal
6D	EPA Maximum Risk Based Concentration	Occupational	277 cy (Arsenic) 71 cy (Pesticides)

In general, the areas excavated due to arsenic are separate from the areas excavated due to pesticides. Excavation of soil will not be done under the north end of the Building 348 floor slab. The north end of Building 348 may require structural support during excavation of adjacent soils. (Excavation of contamination in the portion of Area 2 under existing asphalt pavement could be preformed or not; the soil is effectively capped and residual risk due to this small area would be low.)

Clean backfill will be brought in and placed in the excavated area. Additional backfill is utilized to regrade the area to provide proper drainage from the site as discussed in Alternative 3.

With this alternative it is assumed that hauling boxes holding approximately 20 cubic yards each, would be used for containerization and off-site transportation. Additional testing (TCLP) is included to meet RCRA TSD requirements prior to landfilling.

Landfilling is the ultimate disposal method for the soils as metals (arsenic) are present and cannot be treated by incineration, the LDR pretreatment technology standard for pesticides. Stabilization would likely be used by the disposal facility prior to landfilling to treat the metals.

4.5 SUMMARY OF SCREENING RESULTS

Due to the small area of concern, depth of contamination and the low potential for exposure, all remedial alternatives are retained for detailed analysis. At this time all alternatives are potentially feasible as remedial alternatives for the site.

Alternatives 3, 4 and 5 are designed to prevent surface water contact with contaminated soil and to provide erosion control. Alternative 6 addresses the complete removal of the contaminated area as well as regrading the site.

5.0 ANALYSIS OF REMOVAL ALTERNATIVES

5.1 CRITERIA OF THE ANALYSIS

The purpose of the detailed analysis is to present a comparative evaluation of selected remedial alternatives to facilitate the selection of a removal action for the PSF. The detailed analysis is performed for the selected alternatives that represent distinct, viable options while also preserving a range of treatment and/or containment.

5.2 EVALUATION OF THE CRITERIA

The process options potentially applicable to PSF were combined into alternatives in Section 4.0. This section presents a brief description and detailed evaluation of the alternatives developed based upon the nine point criteria. The evaluation criteria are:

- Overall Protection of Human Health and the Environment - Addresses whether or not a remedy will result exposures within the risk range, result in any unacceptable impacts, and control the inherent hazards associated with the site.

- Compliance with ARARs - Addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements of other environmental statutes.

- Long-Term Effectiveness and Permanence - Refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

- Short-Term Effectiveness - Refers to the period of time needed to achieve protection, and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

- Reduction in Toxicity, Mobility or Volume of Waste - Refers to the anticipated performance of the treatment technologies that may be employed in a remedy.

- Implementability - Describes the feasibility of a remedy, including the availability of materials and services needed to implement the chosen actions, and the ability to obtain regulatory approval.

- Cost - Includes the capital cost for materials, equipment and related items, and the operation and maintenance costs. (The cost projections included herein are estimations of cost used for evaluation/ranking and do not represent a detailed engineering evaluation)

- Support Agency Acceptance - Refers to EPA's and the State of Kansas anticipated response to and acceptance of a remedy.

- Community Acceptance - Refers to the public's anticipated response to and acceptance of a remedy.

The last two criteria are not directly evaluated in the EE/CA report. The agency acceptance and community acceptance criteria are evaluated, and the final decision is presented in the Removal Action/Decision Document. These final two criteria are extremely significant, however.

5.3 ALTERNATIVE DESCRIPTION AND INDIVIDUAL ANALYSIS

This section presents a brief description and a detailed re-evaluation of the six remedial action alternatives based upon seven of the nine point criteria above. Each alternative is described in Section 4.0. Individual components are presented in this section and discussed as appropriate.

5.3.1 Alternative 1 - No-Action

5.3.1.1 **Description of Alternative 1**

The no-action alternative, as its name implies, requires no on-site remediation or institution of constraints. The PSF would remain in its present condition. The risk to human health and the environment will remain unchanged.

5.3.1.2 **Evaluation of Alternative 1**

Overall Protection

Since no remedial actions are taken, the human health and environment risks for the site are not eliminated or reduced The No-Action Alternative does not reduce sources or control migration of constituents.

Compliance with ARARs

Chemical-specific ARARs and TBCs include RCRA CALs for the constituent of concern in the soils. No action-specific ARARs or TBCs apply to the site since no-action is taken under this alternative.

Long-Term Effectiveness and Permanence

Estimated health risks for current and future exposures remain unchanged. Effectiveness and permanence do not apply to this alternative since no actions are taken.

Short-Term Effectiveness

There is no short-term risk to the community or to site workers due to remediation since no action is taken. Exposure and risk to the community from the PSF is expected to be minimal due to the limited and controlled access to the site already in place.

Reduction of Toxicity, Mobility and Volume

Wastes are not remediated with this alternative, therefore toxicity, volume and mobility are not reduced except through natural degradation processes.

Implementability

There are no implementation concerns since no action would be taken.

Cost

There is no cost associated with this alternative.

5.3.2 Alternative 2 - Institutional Controls

5.3.2.1 **Description of Alternative 2**

The PSF is located within a material and equipment storage area. A security fence currently exists at the site limiting access to authorized personnel only. Warning signs will be posted around the PSF. With this alternative, utility service lines will be isolated (ie. left in place and new lines re-routed outside the contaminated area). To confine the potential contamination in Area 5, this alternative involves the relocation of the perimeter fence 30 feet closer to the existing lined drainage ditch. This fence extension will encompass the chlordane contamination of area 5 (SB-19/SS-4). With this alternative, the relocation of the perimeter fence should neither involve large areas of digging nor expose site workers to the potential contaminated areas. The possibility of exposure with this scenario is if persons enter area 5, however warning signs will be posted to deter them. Isolation of utilities does not include subsurface excavation in the contaminated area.

5.3.2.2 **Evaluation of Alternative 2**

Overall Protection

This alternative is primarily aimed at reducing or eliminating human contact and may be effective at preventing the inappropriate future usage of the site contaminated soil. This alternative does not directly prevent or mitigate potential environmental degradation caused by migration of contaminants from the soil to the ground water beneath the site. However, considering the existing data, the constituents of concern at the site are not migrating into ground water. Migration of contamination due to erosion is also not addressed.

Compliance with ARARs

The chemical-specific ARARs identified for the soils are the RCRA CALs. Removal action objectives would be met by eliminating exposure pathways. Exposure is restricted to the areas exceeding the RCRA CALs and/or site remediation goals.

Long-Term Effectiveness and Permanence

Exposure hazards would exist both during and after implementation of this alternative. With this alternative, the contaminated media at the site is not remediated. Effectiveness and permanence is based on preventing exposure only. Long-term maintenance and controls would effectively minimize exposure to contaminated soil. Exposure to the contaminated areas, except for area 5, is not anticipated at the site unless subsurface soil excavation is performed. The soil sample (SB-2) was taken below the asphalt cover in this area. As a result, the soil tested does not present a complete exposure pathway since the asphalt cover in this area is not to be removed. The chlordane contaminated area (area 5) near soil boring 7 is near the surface (0.1 to 1 feet) at concentrations (1.3 mg/kg) slightly above the RCRA corrective action level (0.5 mg/kg).

Short-Term Effectiveness

Little or no disturbance of the potentially contaminated areas at the site will occur during implementation of this alternative. Therefore, no additional risks to human health or the environment due to remedial activities will be caused by this alternative.

Reduction of Toxicity, Mobility and Volume

Mobility, toxicity, and volume of contaminants and contaminated media at the site remain at their current levels since no actions are done as part of this alternative to address the soil contamination. However, natural degradation would continue.

Implementability

This alternative is straight forward to implement since most of the primary institutional controls currently exist and are enforced at the PSF.

Cost

This cost primarily involves the administrative, fence installation, and other expenses for installing signs and instituting potential land use restrictions and other procedural mechanisms. Capital costs are estimated at approximately $12,300 (Table 5-1). Present worth costs for this alternative over thirty years is estimated at approximately $49,000. The annual operation and maintenance costs are based upon one 5 hour man-day a week in the area for fence inspection and vegetation control.

5.3.3 Alternative 3 - Institutional Controls/Grading

5.3.3.1 **Description of Alternative 3**

This alternative involves all of the institutional actions described in Alternative 2 and the control of surface water runoff at the site through surface grading. The site is regraded providing a stable slope from the PSF Building 348 to the existing lined drainage channel as shown in Figure 4-2. Proper grading and revegetation will reduce/minimize the chance of contact of surface water runoff and the contaminated soil at the site. Proper grading and revegetation will also minimize soil erosion on the bank which leads to the discharge channel and the area northeast of PSF Building 348. Furthermore, revegetation will help minimize the possibility of dermal contact with the contaminated soils.

5.3.3.2 **Evaluation of Alternative 3**

Overall Protection

Changing the present grading of the PSF site is used to help control surface water run-off and soil erosion. Institutional controls combined with grading will reduce the risk to human health and the environment at the PSF site. While capable of protecting human health and the environment, contaminant concentrations are not reduced. Regrading of the areas around the PSF Building 348 will not disturb the subsurface areas of potential contamination. Only Area 5 may be slightly disturbed during grading, however, based upon topography, fill will be required to establish grade. Minimal disturbance of Area 5 is expected during grading. Regrading and revegetation will minimize the potential migration of surface soil and control surface water run-off. Adding soil and revegetating the area of concern will also eliminate potential exposure to landscape workers since subsurface excavation is not anticipated by landscape workers. Furthermore, revegetation will help limit the exposure do to dermal contact of soils for site workers.

Compliance with ARARs

The chemical-specific ARARs identified for soils are the RCRA CALs. Soil removal action objectives would be met by controlling exposure to and erosion of the soils exceeding the RCRA CALs and/or site remediation goals.

Long-Term Effectiveness and Permanence

Regrading and revegetation and lawn care maintenance at the site would significantly limit infiltration of surface water into as well as erosion of the contaminated soil. Regrading would require maintenance to assure its long-term effectiveness.

Short-Term Effectiveness

The eastern bank of the pesticide storage building is regraded for this alternative. The risk of temporary exposure to the workers and public should be minimal since the areas of contamination (except for Area 5) are subsurface and fill will be brought in to cover this area. Fugitive dust from grading may need to be suppressed and appropriate personal protective equipment should be provided. Personal protective equipment should be worn to protect workers from potential respirable contaminants and external contact. Dust suppression and soil erosion control measures would be instituted to reduce and control exposure.

Reduction in Toxicity, Mobility and Volume of Waste

Mobility of contamination (soil erosion during construction) and surface exposure are the potential parameters affected by grading. This alternative would not physically alter the contaminants. By regrading the surface soil over contaminant areas 3,4 and 5, and surface water flow diversion, infiltration and percolation of rain water through the potentially contaminated soil is reduced. The reduction of infiltration will subsequently reduce the potential for contaminant mobility (no significant mobility currently noted) due to leaching from the soil matrix. In addition to reducing soil erosion, regrading and revegetation will prevent exposure to contaminants that would occur by direct contact. Toxicity and volume of the contaminants and soil medium would remain at present levels except as affected by natural degradation.

Implementability

Although implementability is straight forward, coordination of grading activities and waterway channels is critical before the perimeter fence is relocated. Dust control and respiratory dust protection would be required. It is anticipated that construction would require no significant disturbance (ie. no intrusive excavation) of the potentially contaminated areas at the site. Materials for construction are easily obtained and the remedial technology is straight forward.

Cost

This cost includes mobilization, site preparation, cover materials, erosion controls, revegetation, monitoring, and labor. Capital costs are estimated at approximately $38,500 and operational and maintenance costs at $7,800 per year. Present worth cost over 30 years is estimated to be approximately $111,600. Individual costs are summarized in Table 5-2.

5.3.4 Alternative 4 - Institutional Controls/Grading/Capping (Asphalt Cover over Contaminated Areas)

5.3.4.1 **Description of Alternative 4**

This alternative involves all of the institutional actions described in Alternative 2 and regrading as presented in Alternative 3 except for the middle section of the proposed drainage ditch in Alternative 3. A berm is provided instead of a drainage ditch for surface water flow divergence. This alternative provides containment of the contaminant areas 1, 2, 3, 4, and 5. As shown in Figure 4-3, asphalt is used to cover the areas east/northeast of the PSF to control erosion, eliminate exposure during landscaping and on-site work as well as control the infiltration of rainfall into potentially contaminated areas. Waterway channels are used on the sides of the asphalt cover to direct water away from the areas of contamination to the limestone channel. Areas 4 and 5 are graded to divert water flow from the areas of potential contamination.

5.3.4.2 **Evaluation of Alternative 4**

Overall Protection

This alternative is capable of meeting the removal objectives by preventing or minimizing both human contact and potential erosion. This alternative would provide some protection of the ground water from further degradation (no significant degradation presently noted) due to potential leaching of contaminants from the soil. While capable of protecting human health and the environment, contaminant concentrations are not reduced.

Compliance with ARARs

The chemical-specific ARARs identified for soils are the RCRA CALs. Soils will not be "cleaned-up" to levels derived from ARARs/TBCs with this alternative. Soil removal action objectives would be met by controlling exposure to and erosion of the soils exceeding the RCRA CALs and/or site remediation goals.

Long-Term Effectiveness and Permanence

The asphalt cover would significantly limit infiltration of surface water into the potentially contaminated soil. This would reduce the potential for contaminant migration, caused by leaching and erosion of site constituents. The asphalt cover would require maintenance to assure its long-term effectiveness. The area from the asphalt cap to the lined channel will also need to be maintained to prevent soil erosion. The vegetation layer on this area will also need to be maintained.

Short-Term Effectiveness

The slope east of the pesticide storage building will need to be regraded as shown in Figure 4-3. The risk of temporary exposure to the workers and public should be minimal since the areas of contamination (except for Area 5) are subsurface and fill will be utilized for developing a stable slope. Fugitive dust from grading may need to be suppressed and appropriate personal protective equipment should be provided. Personal protective equipment should be worn to protect workers from respirable contaminants and external contact. Dust suppression and soil erosion control measures could be instituted to reduce or control exposure.

Reduction of Mobility, Toxicity, and Volume

Mobility and surface exposure are the main parameters affected by capping. Nothing is done to chemically or physically alter the contaminants. By covering the surface over the contaminated soil, infiltration and percolation of rain water through the contaminated soil is reduced as is migration of contaminants by erosion. The asphalt cover prevents exposure to contaminants that would occur by direct contact. Toxicity and volume of the contaminants and soil medium would remain at present levels except as affected by natural degradation.

Implementability

As with Alternative 3, the implementation of Alternative 4 is straight forward. Few special procedures are required to protect worker and public safety. Construction should require no significant disturbance (excavation) of the potentially contaminated areas at the site. Materials for the asphalt cover and the fill for grading are easily obtained.

Cost

The total cost of this alternative includes mobilization, site preparation, cover materials, erosion controls, revegetation, monitoring, and labor. Capital costs are estimated at approximately $64,700 and overhead and maintenance at $7,800 per year. Present worth is estimated to be approximately $138,000. Individual unit costs are summarized in Table 5-3.

5.3.5 Alternative 5 - Institutional Controls/Grading/Capping

5.3.5.1 **Description of Alternative 5**

This alternative combines the institutional actions presented in Alternative 2 and regrading as presented in Alternative 3 with an asphalt cover over the flatter surface areas east of the pesticide storage Building 348. The sloped area from elevation 1076 to 1070 is covered with concrete to direct surface runoff away from the area. This concrete extension will cover the chlordane contamination of Area 5 as shown in Figure 4-4. The asphalt and concrete covers will be primarily for surface water runoff and infiltration and erosion control. An asphalt berm or curb will be provided between the two areas to prevent runoff from the asphalt to flow onto the concrete cover.

5.3.5.2 **Evaluation of Alternative 5**

Overall Protection

This alternative is capable of meeting the goals of preventing or minimizing both human contact and continued migration of hazardous substances from the site. This alternative would also provide some protection to the ground water from degradation due to potential leaching of contaminants from the soil. While capable of protecting human health and the environment, with this alternative, contaminant concentrations are not reduced except as affected by natural degradation.

Compliance with ARARs

The chemical-specific ARARs identified for soils are the RCRA CALs. Soils will not be "cleaned-up" to levels derived from ARARs/TBCs with this alternative. Soil removal action objectives would be met by controlling exposure to and erosion of the soils exceeding the RCRA CALs and/or site remediation goals.

Long-Term Effectiveness and Permanence

As with Alternative 4, the cover would significantly limit infiltration of surface water into the contaminated soil. This alternative would reduce the migration, caused by leaching or erosion, of site constituents. Both the asphalt covers and concrete would require maintenance to assure long-term effectiveness.

Short-Term Effectiveness

The slope east of the pesticide storage building will need to be regraded. The risk of temporary exposure to the workers and public should be minimal since the areas of contamination (except Area 5) is subsurface and fill will be utilized to cover Area 5. Fugitive dust from grading may need to be suppressed and appropriate personal protective equipment should be provided. Personal protective equipment should be worn to protect workers from respirable contaminants and external contact. Dust suppression and soil erosion control measures could also be instituted to reduce and control exposure.

Reduction of Mobility, Toxicity and Volume

Mobility and surface exposure are the main parameters affected by capping. With this alternative, nothing is done to chemically or physically alter the state of the contaminated area. By capping, infiltration and percolation of rain water through the contaminated soil area is reduced. The cap will help prevent erosion and exposure to contaminants. The toxicity and volume of the contaminants and soil medium would not be altered except as affected by natural degradation.

Implementability

As with Alternative 4, this alternative can be implemented at the site. Construction of the asphalt cap would require surface soil disturbances as indicated in Alternative 4. Fill would need to be brought in before concrete could be put in place. Subsurface exposure would be limited. The materials used for this application are easily attainable.

Cost

This cost includes mobilization, site preparation, cover materials, erosion controls, revegetation, monitoring, and labor. Capital costs are estimated at approximately $68,400 and operational and maintenance at $7,800 per year. Present worth is estimated to be approximately $174,500. Individual unit costs are summarized in 5-4.

5.3.6 Alternative 6 - Removal and Disposal

5.3.6.1 **Description of Alternative 6**

With this alternative, excavation with off-site treatment/ disposal are utilized to physically remove the contamination from areas 1, 2, 3, 4 and 5. Excavation can be accomplished using either a front end loader or a backhoe. Soil would be removed to a depth of approximately five feet maximum at which time additional testing is needed to verify that additional excavation is not needed. Based upon the areas identified in Figure 4-1, the following volumes of contamination are estimated for each set of clean-up criteria:

Alternative 6A
RCRA CALs

Area 1:	299 cy
Area 2:	14 cy
Area 3:	7 cy
Area 4:	42 cy
Area 5:	88 cy
Total :	**450 cy**

Alternative 6B
Site-Specific RGs
Future Utility Worker

Area 1:	0 cy
Area 2:	0 cy
Area 3:	0 cy
Area 4:	265 cy
Area 5:	0 cy
Total :	**265 cy**

Alternative 6C
Site-Specific RGs
Future Site Worker

Area 1:	477 cy
Area 2:	20 cy
Area 3:	29 cy
Area 4:	231 cy
Area 5:	83 cy
Total :	**840 cy**

Alternative 6D
EPA Maximum Risk Based Conc.
Occupational Scenario

Area 1:	58 cy
Area 2:	13 cy
Area 3:	0 cy
Area 4:	277 cy
Area 5:	0 cy
Total :	**348 cy**

Because of bulking of soils during excavation, the soil volumes used in the cost estimates for transportation and disposal are approximately 30% greater than the values shown above. Once excavation is complete in all areas, clean fill is utilized to fill in the excavated areas and utilized for regrading the area for erosion control. During remediation, confirmation sampling of the underlying soils would be performed. After the contaminated soils are removed, clean borrow soil is used to fill in the excavated areas and regraded for erosion control. No special security or site restrictions should need to be constructed or enforced.

The following assumptions were used in determining the capital costs for the disposal portion of alternative 6:

For the confirmation testing several factors were considered to arrive at the estimated costs. The confirmation sampling is done while the soil is being removed in one foot increments. The purpose is to identify that both the horizontal and vertical extent of the contamination has been removed from the site. Each layer typically requires 10 samples at approximately $450 ($200 labor, $250 analytical cost) each. Therefore, each foot of soil costs $4,500 for confirmation sampling. Additionally, if multiple areas are excavated, then the confirmation sampling is performed for each area. (Other confirmation sampling approaches could be used.)

The disposal cost per cubic yard represents the cost to have the soil treated and landfilled by a RCRA permitted landfill. The cost estimate of $550 per cubic yard is a mid range estimate provided by the Highway 36 Landfill located in eastern Colorado. The cost estimate is assumed to include treatment for both metals (arsenic) and pesticides as well as the cost to landfill the soil.

The disposal testing cost is the cost to conduct all chemical analysis required to meet the landfill's requirements. The cost of $1,650 per sample is the estimated cost (provided by the US Army Corps of Engineers, Kansas City District) to conduct the analysis. Generally, composite samples are obtained from one or more containers (depending on the size) to appropriately characterize the waste being disposed of. One composite sample per 20 cubic yard container is assumed to be sufficient.

5.3.6.2 **Evaluation of Alternative 6**

<u>Overall Protection</u>

This alternative will effectively eliminate potential for longterm exposure associated with dermal contact and inhalation. This alternative will also eliminate the potential for contaminant migration from the soil into the ground water.

<u>Compliance with ARARs</u>

The chemical-specific ARARs identified for soils are the RCRA CALs. By reducing contaminant mass in the soil to very low levels and eliminating human exposure, this alternative is capable of meeting soil clean-up levels established by the

ARARs/TBCs. Ambient air monitoring and proper handling procedures during implementation can be used to meet action-specific ARARs. The remains of the barn/shed would qualify the site as an historic site subject to all applicable federal and state regulations governing historic sites. However, according to a USACE archeologist, finding anything attributable to the old hay shed would be unlikely as it was torn down over 60 years ago. Nevertheless, excavation activities would need to be monitored for possible cultural/historic materials. Should anything be uncovered, excavations would need to be halted pending consultation with the State Historic Preservation Office (SHPO) to determine potential significance. This process could take one week to a month or more depending upon what is found. If the site is determined to have significance, further delays would be incurred during preparation and execution of a preservation or mitigation plan.

Long-Term Effectiveness and Permanence

This alternative provides long-term effectiveness and permanence since contaminated soil media is physically removed from the site.

Short-Term Effectiveness

This alternative will involve disturbance of the contaminated soil and a high probability of direct worker contact with contaminated surface soils and subsurface soils. Also, temporary above-ground closed storage containers are necessary for excavated materials. Therefore, the potential risk of temporary exposure to the workers and public is of concern due to potential inhalation. As a precaution, fugitive dust and volatile emissions from excavation, storage, and containerization may need to be controlled. Appropriate personnel protective equipment will be needed to protect workers from both respirable contaminants and dermal exposure to particulate as well as direct dermal contact.

Reduction of Mobility, Toxicity, and Volume

Toxicity, mobility, and volume of constituents are all reduced at the site by the physical removal of the contaminants. Disposal in a RCRA Subtitle C landfill would invoke the Land Disposal Restrictions (LDRs), which specify a level of treatment which must be attained prior to disposal. Offsite treatment would include incineration for pesticides resulting in a reduction of toxicity. Stablization reduces the moblity of metals such as arsenic, but increases the volume.

Implementability

This alternative can be implemented. Construction requires significant exposure potential and disturbance of the site due to soil excavation. Additional fill and excavation requirements are required to resurface the site. Permitted transporters and disposal facilities can be utilized to transport and dispose of contaminated soils. Implementation of this option will require submission of analytical results to the permitted landfill and receipt of confirmation of acceptability. Also, the landfill must be acceptable under USEPA requirements for disposal facilities receiving CERCLA remediation wastes (EPA off-site disposal policy).

Cost

The capital costs include design, mobilization, site preparation, implementation, materials, monitoring, decontamination, and labor. The annual operation and maintenance cost for maintaining the area after excavation and disposal for this alternative is estimated at approximately $1,600 for lawn care.

No costs have been included for the activities related to the possible discovery of cultural/historic features. This cost could be great depending on the size and/or significance of whatever is found. It may include paying an archaeologist to monitor the excavations full-time.

The following is a summary of the costs associated with this alternative for each set of clean-up criteria:

Alternative 6A:	RCRA CALs	$ 714,000
Alternative 6B:	Future Utility Worker	$ 417,000
Alternative 6C:	Future Site Worker	$ 1,221,500
Alternative 6D:	EPA Risk-based (Occ)	$ 569,000

Detailed individual unit costs are summarized in Tables 5-5A through 5-5D.

6.0 COMPARATIVE ANALYSIS

In the comparative analysis presented below, the assembled alternatives carried forward for detailed analysis from Section 4.0 are compared relative to each other based on the seven evaluation criteria developed in Section 5.0. Only the relative advantages and disadvantages of the six alternatives are presented in this section. These alternatives are:

- Alternative 1 - No-Action
- Alternative 2 - Institutional Controls
- Alternative 3 - Institutional Controls/Grading
- Alternative 4 - Institutional Controls/Grading/Capping (Asphalt)
- Alternative 5 - Institutional Controls/Grading/Capping (Asphalt/Concrete)
- Alternative 6 - Removal and Disposal

6.1 OVERALL PROTECTION

Based upon the discussion of overall protection presented in Sections 3 and 4, the alternatives are ranked for overall protection as follows:

Approach	Ranking
Alternative 6	1st
Alternative 5	2nd
Alternative 4	3rd
Alternative 3	4th
Alternative 2	5th
Alternative 1	6th

6.2 COMPLIANCE WITH ARARs AND TBCs

6.2.1 Compliance with ARARs

Chemical-specific ARARs include RCRA CALs. Alternative 2 restricts exposure to soils exceeding RCRA CALs. Alternatives 3, 4 and 5 restricts exposure to and reduces erosion of soils exceeding RCRA CALS (and/or site RGs). Alternative 6 satisfies the RCRA CALs through removal and offsite disposal. General action-specific ARARs identified for remedial response activities are for the protection of on-site workers and record keeping requirements. The location specific and general action-specific

ARARs can be met by all the alternatives considered for detailed analysis, by proper control and management activities.

6.2.2 Compliance with TBCs

The chemical-specific TBCs for the soils are the site specific remediation goals calculated using exposure scenarios developed in the baseline risk assessment. As with the ARARs, all of the alternatives appropriately address the TBCs, except under Alternative 6 where various levels of compliance with RGs may be achieved.

6.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 6 (Removal and Disposal) has the greatest potential for long-term effectiveness and permanence since the constituents of concern in the soil are physically removed from the site. However, if only a portion of the contaminated soils are excavated and removed then some of the activities necessary for alternatives 2-5 may be required (ie. long term monitoring, etc.).

Alternatives 3, 4 and 5 are considered to be effective for the prevention of infiltration and percolation, as well as soil erosion control measures and surface water divergence. Of these three alternatives, Alternative 5 provides the highest measure of erosion control with the utilization of asphalt and concrete. Alternative 4 also provides a high measure of erosion control in the area of contamination. Alternative 3 provides grading for flow divergence and erosion control.

Alternative 2 (Institutional Controls) is effective in preventing surface exposure at the site by increasing the fenced area to include the area of concern. The potential for exposure in this area is limited due to the depth of the contaminant source (3.5 to 4.5 feet). Alternative 1 (No-Action) leaves the site as it is and like Alternative 2, is effective only if the constituents of concern are immobile. These two alternatives are effective for protection of groundwater since the constituents of concern are not migrating into the groundwater. Soils, however, are susceptible to eroding and migrating into surface waters and sediments at the site.

Alternatives 3, 4, and 5 rely on maintenance and possible replacement to achieve permanence. Maintenance of the slope grade and vegetative cover would be important for Alternatives 3 and 4. Alternative 4 and 5 would require periodic patching/sealing of the paved/concrete areas. Risk associated with maintenance would be minimal while risk associated with replacement would be similar to initial implementation.

Based upon these factors, the alternatives are ranked as follows for long-term effectiveness and permanence:

Approach	Ranking
Alternative 6	1st
Alternative 5	2nd
Alternative 4	3rd
Alternative 3	4th
Alternative 2	5th
Alternative 1	6th

6.4 SHORT-TERM EFFECTIVENESS

Both Alternatives 1 and 2 offer relatively low short-term exposure potential since Alternative 1 involves no disturbance of contaminated soils, while disturbance of soils under Alternative 2 is limited to fence installation.

Alternatives 3, 4 and 5 have similar magnitude of short-term exposure. Due to the depth of the contaminated soil and the use of backfill, it is unlikely that these soils will be disturbed significantly under the implementation of these alternatives.

Alternative 6 (Removal and Disposal) has the highest short-term exposure due to excavation of contaminated material, on-site handling and containerization, and transportation and unloading of soils.

Based upon these factors, the alternatives are ranked as follows for short-term effectiveness and exposure potential:

Approach	Ranking
Alternative 1	1st
Alternative 2	2nd
Alternative 3, 4 and 5	3rd
Alternative 6	4th

6.5 REDUCTION OF MOBILITY, TOXICITY AND VOLUME

Only Alternative 6 (Removal and Disposal) eliminates the mobility, toxicity and volume of constituents of concern in the soil and direct removal. Excavation and hauling of the soil from the site will reduce the mobility, toxicity, and volume. The method of disposal will determine whether there is a complete reduction in volume, mobility, and toxicity. It has been assumed that the method of disposal is by landfilling.

Alternatives 3, 4, and 5 are primarily aimed at reducing the mobility and potential on-site exposure of contaminants and do not directly reduce the toxicity and/or volume.

Alternatives 1 (No-Action) and 2 (Institutional Controls) do not reduce the toxicity, mobility and volume of waste at the site. Alternative 2 reduces the exposure through access control. Based upon these factors, the alternatives are ranked as follows for reduction of mobility, toxicity, and volume:

Approach	Ranking
Alternative 6	1st
Alternative 5 and 4	2nd
Alternative 3	3rd
Alternative 2	4th
Alternative 1	5th

6.6 IMPLEMENTABILITY

Alternative 6 is the most difficult to implement at the site. Alternative 6 involves the excavation of contaminated media, temporary storage, packaging, transportation, and disposal of contaminated material. The controls needed to prevent or control for human exposure for Alternative 6 is the greatest with the excavation of the contaminated media. Alternative 5 employs conventional construction techniques and is therefore rather easily implemented. The exposure controls associated with Alternative 5 are not as great as with Alternative 6. Alternative 5 will require somewhat more extensive controls for on-site exposure than Alternative 3 or 4.

Alternatives 3 and 4 are relatively easy to implement, however, the site must be carefully graded. Annual maintenance is also required. Alternatives 1 and 2 are the easiest to implement as no direct physical interactions with contaminated soils take place at the site during implementation except for placement of fence posts under Alternative 2. Alternative 1 (No-Action) does nothing at the site.

Based upon these factors, the alternatives are ranked as follows for implementability:

Approach	Ranking
Alternative 1	1st
Alternative 2	2nd
Alternative 3	3rd
Alternative 4	4th
Alternative 5	5th
Alternative 6	6th

6.7 COST

The cost comparison among alternatives is based both on the present worth of a 30 year life cycle and on initial capital construction cost and annual operation and maintenance costs. Based on the discussions in Section 4.0, the alternatives are ranked according to cost as follows:

Approach	Ranking	Present Worth ($1000)
Alternative 1	1st	0
Alternative 2	2nd	49
Alternative 3	3rd	112
Alternative 4	4th	138
Alternative 5	5th	175
Alternative 6B	6th	417
Alternative 6D	7th	569
Alternative 6A	8th	714
Alternative 6C	9th	1,221

7.0 PROPOSED REMOVAL ACTION

The selection of an alternative will be based upon a consensus between all parties involved with the site, including state (KDHE) and federal (EPA Region VII) regulators, Fort Riley and the U.S. Army Corps of Engineers, considering comments received from the public and interested agencies.

The primary concerns arising from the PSF site are the potential exposure to site soils by human and animal populations and the potential for migration of contaminants due to erosion. The National Contingency Plan (NCP) recognizes that protectiveness may be achieved by reducing exposure as well as reducing contaminant levels.

Leaching of contaminants into ground water is not considered a great concern for several reasons. First, the practices that caused the contamination ceased 15 years ago. Second, the pesticides of concern are not very mobile in the PSF environment and therefore have low potential for leaching into the groundwater. Finally, data indicates that no significant migration of pesticides into the groundwater has occurred. Thus, removal of the potential source (in soils) of contamination to groundwater is not required to be protective of the groundwater resource.

Based upon the results of the detailed analysis of remedial alternatives, Alternatives 3, Institutional Controls/Grading and 4, Institutional Controls/Grading/Capping (Asphalt) are considered to represent the best balance of protectiveness, technical feasibility, implementability and cost effectiveness.

However, one of Fort Riley's objectives is to utilize the area at a minimal risk to human health and the environment. Therefore, Alternative 5, Institutional Controls/Grading/Capping (Asphalt/ Concrete) is the preferred removal alternative to provide a higher level of future productive land use. It provides the maximum amount of protection between Alternatives 3, 4 and 5. By including a concrete cover over the slope adjacent to the existing lined channel, greater protection against the migration of contaminants through erosion is provided. Alternative 5 has a significantly lower cost than the most protective alternative, Alternative 6, Removal and (Offsite) Disposal and is viewed as equally protective.

Based on the analyses in this EE/CA, discussions with the regulators, and the risk assessment activities performed to date, Alternative 5 is expected to be consistent with the Final Remedy. Pending completion of the Remedial Investigation Report (including the Baseline Risk Assessment) and the full-site Feasibility Study, additional work may be identified. However, additional work (if needed) to address other site media (surface water, sediment and/or groundwater) could be performed largely if not completely independent of this action to address the soil media.

RCRA CALs have been identified as chemical-specific ARARs for addressing site soils, and are being used in this EE/CA to delineate the areas to be addressed. Other site characteristics and construction considerations (s.a. topography, land use) result in a much larger area than the limited areas of soils exceeding RCRA CALs and/or TBCs being covered by the preferred alternatives. Indeed, essentially the entire area of contamination, regardless of contaminant level, is addressed.

Alternatives 3, 4, and 5 effectively limit or prevent exposure to and migration of contaminated soils.

For alternative 6 total cost includes treatment of the soil, soil excavation and hauling, and disposal in a RCRA subtitle C landfill. Alternative 6 does not have the same long-term costs associated with it as do the others alternatives. Additionally, alternative 6 addresses all aspects of reducing toxicity, mobility, and volume, whereas alternative 5 does not. Alternative 6 removes the contaminated media, whereas alternative 5 removes the pathways of exposure to the contaminated medias. Alternative 6 also must adhere to all applicable state and federal historic and archaeological site ARARs which may increase costs, short term exposure, and increase implementation time.

In summary, overall protection of human health and the environment may be achieved through containment at a significantly lower cost than treatment and/or offsite disposal.

8.0 REFERENCES

Alternative Treatment Technology Information Center (ATTIC), Version 1.3

ATSDR, 1987-1991. Toxicological Profile for "Constituents." Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.

Barrio-Lage, G., Parsons, F.Z., Nassar, R.S., and Lorenzo, P.A.,1986, Sequential Dehalogenation of Chlorinated Ethenes. Environmental Science Technology, 20, pp. 96-99.

Baysinger-Daniel, 1992, Verbal communication with Sherry Baysinger-Daniel (co-op risk assessor to USEPA Region VII) by Lynn Borowski (Law), 13 August, 1992.

Callahan, M. et al., 1979, Water-related Environmental Fate of 129 Priority Pollutants. EPA-440/4-49-029.

CERCLA Compliance with Other Laws Manual: Interim Final Guidance U.S. EPA/540/G-89/006 August 1988.

CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements, EPA/540/G-89/009, August 1989.

Chief Chemist, Entomological Division AEHA, Personal Interview, March 1992.

Chief, DEH, Fort Riley, Personal Interview, February, September 1992.

Chief, Maintenance Division, DEH, Personal Communication, Fort Riley, November, 1992.

Closure Plan for Hazardous Waste Storage Facilities Building 292 and Two Conexs, Fort Riley, Kansas, U.S. Army Environmental Hygiene Agency Project No. 37-26-0153-87, February 1987.

Compendium of Costs of Remedial Technologies at Hazardous Waste Sites, USEPA EPA/600/2-87/087

Conex Closure Building 348 Fort Riley, Kansas, Epic, Inc., August 31, 1990.

Cost of Remedial Action (CORA), Version 3.0

Cowherd C., Muleski, G., Englehart P. and Gillette D., 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination, Prepared by Midwest Research Institute, Washington, DC: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, EPA-600/8-85-002.

DEH, 1992a, Personal interview between Chief of Maintenance (Fort Riley - Directorate of Engineering and Housing [DEH]) and the Mobile Equipment Operator - General Foreman (Fort Riley DEH) and Law Environmental's risk assessor, November 1992.

DEH, 1993, Personal Communication between DEH Master Planner (1975 to present) and Law, Fort Riley, January 1993.

Determining Soil Response Action Levels Based on Potential Contaminated Migration to Ground Water: A Compendium of Examples, USEPA EPA/540/2-89/057

Determining When Land Disposal Restrictions are Applicable to CERCLA Response Actions, EPA directive 9347.3-05FS

Drinking Water Regulations and Health Advisories; USEPA Office of Water, December 1992.

Entomological Special Study No. 44-015-75/76 Monitoring of Pesticide Contamination, Fort Riley, Kansas, U.S. Army Environmental Hygiene Agency, 23 November 1974 - 21 August 1975.

Environmental Engineer, UST Coordinator, Fort Riley DEH, Personal Interview, February, September 1992.

EPA, 1992b, Memorandum from USEPA Region VII re: Exposure Scenarios for Fort Riley Pesticide Storage Facility Risk Assessment, November 6, 1992.

EPA, 1992b, Personal interview between USEPA Region VII contacted risk assessor and Law's risk assessor re: standard defaults for dermal exposures in Region VII, September 1992.

Estimation of Small System Water Treatment Costs, NTIS PB85-161644

Extension Entomologist State of Kansas, Livestock Entomology Division and Professor of Entomology, Kansas State University, Personal Interview, October 9, 1992.

Federal Facility Agreement, U.S. EPA Region VII, State of Kansas and U.S.Army Fort Riley, Docket No. VII-90-F-0015, February 28, 1991.

Federal Register, 1987. Maximum Contaminant Levels and Maximum Contaminant Level Goals, 40 CFR Subpart B.

Federal Register, 1990, RCRA Action Levels, Federal Register Volume 55, No. 145 July 27, 1990, Corrective Action for Solid Waste Management Facilities, Proposed Rule. Pages 30798-30884.

Federal Register, 1990a, RCRA Action Levels, Vol. 55, No. 145, pp 30798-30884. Corrective Action for Solid Waste Management Facilities, Proposed Rule.

Federal Register Vol. 55 No. 145, pg. 30798 to 30884, July 27, 1990 Corrective Actions for Solid Waste Management Facilities, Subpart S, Proposed Rule

Field Sampling Plan (Volume V, Draft, Modified Field Sampling Investigation/Feasibility Study)

Fish and Wildlife Administrator, Fort Riley, Personal Interview, August, October 1992.

Fort Riley Communication Extension Service, Personal Communication, November, 1992.

Fort Riley, 1992. Memorandum transmitted by IRP Manager via fax re: threatened and endangered species and occurrence on Fort Riley. August, 1992.

Fort Riley, Its Historic Past, U.S. Government Printing Office 1987-757-071/60010.

Geary County Kansas, Flood Insurance Study, February 4, 1988, Federal Emergency Management Agency.

Geologic History of Kansas (The), Merriam, Daniel F., et al., Kansas Geological Survey, Bulletin No. 162, December 1963, reprinted 1983.

Gilbert, Richard O., 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, Company, New York.

Ground Water in the Kansas River Valley Junction City to Kansas City, Kansas, Fader S.W., Kansas Geological Survey Bulletin No. 206, Part 2 1974.

Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, U.S. EPA/540/G-89/004

Guidance on Remedial Action for Contaminated Ground Water at Superfund Sites, USEPA 540/G-88 003

Guide for Conducting Treatability Studies Under CERCLA, Aerobic Biodegradation Remedy Screening, USEPS EPA/540/2-91/013A

Guide for Conducting Treatability Studies Under CERCLA, Chemical Dehalogneation, USEPA EPA/540/R-92/013A

Guide for Conducting Treatability Studies Under CERCLA, Interim Final, NIIS PB90-249772

Guide for Conducting Treatability Studies Under CERCLA, Soil Vapor Extraction, Interim Guidance, USEPA EPA/540/2-91/019A

Guide for Conducting Treatability Studies Under CERCLA: Soil Washing, USEPA EPA/540/2-91/020A

Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, U.S. EPA/540/G-89/004, October 1988

Guidance for Remedial Action for Contaminated Ground Water at Superfund Sites, USEPA 540/G-88 003

Handbook for Stabilization/Solidification of Hazardous Wastes, USEPA EPA/540/2-86/001

Hawley, J.K., 1984, Assessment of Health Risk from Exposure to Contaminated Soil - Risk Analysis, Volume 5, pp. 289-302.

Hazard Ranking System Report for Fort Riley, Kansas, USEPA, Region VII,reviewer, January 12, 1988.

HEAST, 1992, Health Effects Assessment Summary Tables. USEPA Office of Research and Development.

Howard, P. A., 1990, Handbook of Environmental Fate and Exposure Data, Volume II. Lewis Publishers, Inc., Chelsea, MI.

Howard, P.H., 1989, Handbook of Environmental fate and exposure Data, Vol. 1, Lewis Publishers, Inc., Chelsea, MI.

Howard, P.H., Boethling, R.S., Jarvis, W.F., Meylan, W.M., and Michalenko, E.M., 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc., Chelsea, MI.

HSDB, 1988, Hazardous Substances Database, National Library of Medicine, Bethesda, Maryland.

Hwang T.S., and Falco, J., W. 1986, Estimation of multimedia exposures related to hazardous waste facilities. Pollutants in a Multimedia Environment, New York, NY, Plenum Publishing Corporation. pp 229-264.

Installation Assessment of the Headquarters, 1st Infantry Division (Mechanized), and Fort Riley, Kansas. Report No. ESE-341. Govt. Report No. AMXTH-AS-IA-82341. B.N. McMaster, C.D. Henry, J.D. Bonds, S.A. Denahah, C.F. Jones, D.F. McNeill, C.R. Neff, K.A. Civitarese. December 1984.

Installation Pest Management Program Review No. 16-66-0502-80, FortRiley, Kansas, U.S. Army Environmental Hygiene Agency, 30 July-9 August 1979.

Interim Guidance on Establishing Soil Lead Clean-up Levels at Superfund sites. Memorandum from H. Longest and B. Diamond to EPA Regions, OSWER Directive No. 9355.4-02.

Iris, 1992, Integrated Risk Information System, USEPA, Cincinnati, Ohio.

IRP, 1989, The Installation Restoration Program Toxicology Guide, under DOE Interagency Agreement No. 1891-A076-A1, Biomedical and Environmental Information Analysis, Oak Ridge, TN.

IRP Manager, Fort Riley DEH, Personal Interviews/Conversations, 1992.

Kansas Extension Entomologist (ret.) 1949 through 1982, State of Kansas, Personal Interview, October 9, 1992.

KAR, 1987, Kansas Water Quality Standards. Kansas Administrative Regulations, Title 28, Department of Health and Environment, Article 16-Water Pollution Control, Chapter 28. Last 28, Last Amended 1 May, 1987.

KAR, 1988, Kansas Water Quality Standards. Kansas Administrative Regulations, Title 28, Department of Health and Environment, Article 15-Application for Permits; Domestic Water Supply, Last amended 1 May, 1988.

KDHE, 1988, Memorandum entitled Revised Groundwater Contaminant Cleanup Target Concentrations for Aluminum and Selenium. Kansas Department of Health and Environment, 5 December, 1988.

KDHE, Letter Confirming Closure of Building 348 Waste Storage Area and CONEXs, December 3, 1990.

Klaassen, C.D., Amdur, M.O., and Doull, J. (editors), 1986. Toxicology: The Basic Science of Poisons, 3rd ed, Macmillan Publishing Company, New York, NY.

Land, C.E., 1975. Tables of Confidence Limits for Linear Functions of the Normal Mean and Variance, Selected Tables in Mathematical Statistics, Vol. III, American Mathematical Society.

Law, 1992, Modified Working Draft Work Plan, Volume I, for Remedial Investigation/Feasibility Study. Pesticide Storage Facility, Fort Riley, Kansas. Law Environmental, Inc., Government Services Branch, Kennesaw, GA, April 1992.

Law, 1992,Remedial Investigation Report for the Pesticide Storage Facility Fort Riley, Kansas, Draft Final: Remedial Investigation/Feasibility Study, Pesticide Storage Facility, Fort Riley Military Installation, Fort Riley, Kansas, February 1993.

Law Environmental National Laboratory, Quality Control Officer (ret.), Personal Interview with Senior Chemist, LEGS, November 18, 1992.

Map: "Miscellaneous Areas, Survey Control" Map No. 6139-407.0-G, Widmer Engineering Co., St. Louis, Missouri, June 15, 1941.

Maximum Contaminant Levels and Maximum Contaminant Level Goals, 40 CFR 141 Subpart B.

Military Entomology Operational Handbook Navfac Mo-310, Army TM 5-632, Air Force AFM 91-16, December 1971.

Montgomery, John H. and Welkom, Linda M., 1990, Ground-Water Chemicals Desk Reference, Lewis Publishers, Chelsea, MI.

National Academy of Sciences, 1977, Drinking Water and Health, Vol. 1.

National Public Drinking Water Rules for 38 Inorganic and Synthetic Organic Chemicals, 1991, Phase II Fact Sheet.

NOAA, 1990, National Oceanic and Atmospheric Administration. Technical Memorandum entitled The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, NOS OMA 52

PCB Program Manager, Fort Riley DEH, Personal Interview, February 1992.

Pesticide Inventory (December 1983), Headquarters, 1st Infantry Division (Mechanized) and Fort Riley (FR) Directorate of Facilities Engineering (DFAE). 1983.

Pesticide Monitoring Study No. 17-44-1356-88, "Pesticide Residue Sampling in the Vicinity of the Pesticide Storage Site, Fort Riley, Kansas", U.S. Army Environmental Hygiene Agency, May 1986.

Pesticide Transformation Products, Division of Agrochemicals Symposium, August 1990.

Preliminary field sampling data for sediments, soil boring, surface water and ground water Rao, P.F.C., and Hornsby, A.G., 1989. Behavior of Pesticides in Soil and Water. Institute of food and Agricultural Sciences, University of Florida, Gainesville, FL.

Real Property Specialist, Fort Riley, Personal Communication, August 1992.

Regional Applicable or Relevant and Appropriate Requirements (ARARs) and Land Disposal Restrictions, EPA directive 9234.1-03

Remedial Action Costing Procedures Manual, USEPA EPA/600/8-87/049

Remedial Action, Treatment and Disposal of Hazardous Waste, USEPA EPA/600/9-90/006 Review of In-Place Treatment Techniques for Contaminated Surface Soil, Volume 1: Technical Evaluation, USEPA EPA-540/2-84-003a

Review of In-Place Treatment Techniques for Contaminated Surface Soil, Volume 1: Technical Evaluation, USEPA EPA 540/2-84-003a

Riley County Extension Service, 1992, Personal communication between extension service and Law's risk assessor, November 1992.

Risk Assessment Contractor to USEPA Region VII, Personal Communication, September, 1992.

RREL Treatability Database, Version No. 4.0, 03/31/92

Seminar on the Use of Treatability Guidelines in Site Remediation, USEPA EPA/600/K-92/003

Senior Pesticide and Herbicide Program Manager, Fort Riley, Personal Interview, February 1992.

Sittig, M., 1985, Handbook of Toxic and Hazardous Chemicals and Carcinogens, Noyes Publications, Park Ridge, NJ.

Soil Survey of Riley County and Part of Geary County, Kansas, United States Department of Agriculture Soil Conservation Service, June 1975.

Stratigraphic Succession in Kansas, Edited by Doris Zeller, Kansas Geological Survey, Bulletin No. 189, 1968.

Summary of Fort Riley Hunting Regulations, 1992-1993, Natural Resources Branch, Directorate of Engineering and Housing, Pamphlet.

Superfund LDR Guide #1: Overview of RCRA Land Disposal Restrictions (LDRs), EPA/9347.3-01FS

Superfund LDR Guide #3: Treatment Standards and Minimum Technology Requirements Under Land Disposal Restrictions, EPA/9347.3-03FS

Superfund LDR Guide #5: Determining When LDRs are Applicable to CERCLA Response Actions, EPA/9347.3-05FS

Superfund Remedial Design and Remedial Action Guidance, USEPA PB89-107529

Supervisor, Exterior Utilities, Fort Riley, Personal Interview, February 1992, Technology Screening Guide for Treatment of CERCLA Soils and Sludges, NTIS PB89-132674

Technology Screening Guide for Treatment of CERCLA Soils and Slugdes, NTIS PB89-132674

Terrain Analysis, Fort Riley, Kansas, Soil Systems, Inc. Marietta, Georgia. December 1977.

United States Army Corps of Engineers, Letter to LEGS Branch Chief, Law Environmental, Inc., June 12, 1992.

United States Army Environmental Hygiene Agency Interim Final Report: Hazardous Waste Management Consultation No. 37-26-0190-89 Evaluation of Solid Waste Management Units, Fort Riley, Kansas, 9-13 May 1988.

US Department of Health and Human Services, 1991, Strategic Plan for the Elimination of Childhood Lead Poisoning, Public Health Service and Centers for Disease Control. February 1991.

USEPA, 1986. Superfund Public Health Evaluation Manual, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. EPA/540/1-861060.

USEPA, 1986b, U.S. Environmental Protection Agency, Quality Criteria for Water. Atlanta, Georgia: USEPA

USEPA, 1987, Quality Criteria for Water 1986, U.S. Environmental Protection Agency, Office of Water Regulations and Standards, USEPA Publication No. EPA/44015-86-001.

USEPA, 1988, CERCLA Compliance with Other Laws Manual Part I, Interim Final. OSWER Directive no. 9234.1-01.

USEPA, 1988, Memorandum to Assistant Administrators, Recommended Agency Policy on the carcinogenicity Risk Associated with the Ingestion of Inorganic Arsenic, USEPA, Office of the Administrator, Washington, D.C.

USEPA, 1989a, Risk Assessment Guidance for Superfund, Volume I, Health Evaluation Manual, USEPA Publication No. 540/1-89/002.

USEPA, 1989b, Exposure Factors Handbook. USEPA Exposure Assessment Group. EPA/600/8-89/043.

USEPA, 1989c, Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual, USEPA Publication No. 540-/1-89/001.

USEPA, 1990, Guidance for Data Useability in Risk Assessment, Interim Final, Office of Emergency and Remedial Response, EPA/540/G-90/008.

USEPA, 1991a, Memorandum from Timothy Fields and Bruce Diamond to USEPA Regional Directors, RE: Human Evaluation Manual, Supplemental Guidance. OSWER Directive 9285.6-03.

USEPA, 1991a, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part B, Development of Risk-Based Preliminary Remediation Goals, USEPA Publication No. 92857.7-01B.

USEPA, 1992a, Dermal Exposure Assessment: Principles and Applications, Interim Report, USEPA EPA/660/8-91/011B, January 1992.

USGS, 1984, Element Concentrations in Soils and Other Surficial Materials of the Continuous United States, USGS Professional Paper #1270.

USGS, Personal Discussions, January through September 1992.

VISITT, Vendor Information System for Innovative Treatment Technologies, USEPA EPA/542/R-92/001

Well Logs, Widmer Engineering Company, St. Louis, MO. June 8, 1941.

Well Logs, U.S. Army Corps of Engineers Kansas City District, June 16, 1982.

Wetland Assessment Specialist, United States Army Corps of Engineers, Personal Interview, October 30, 1992.

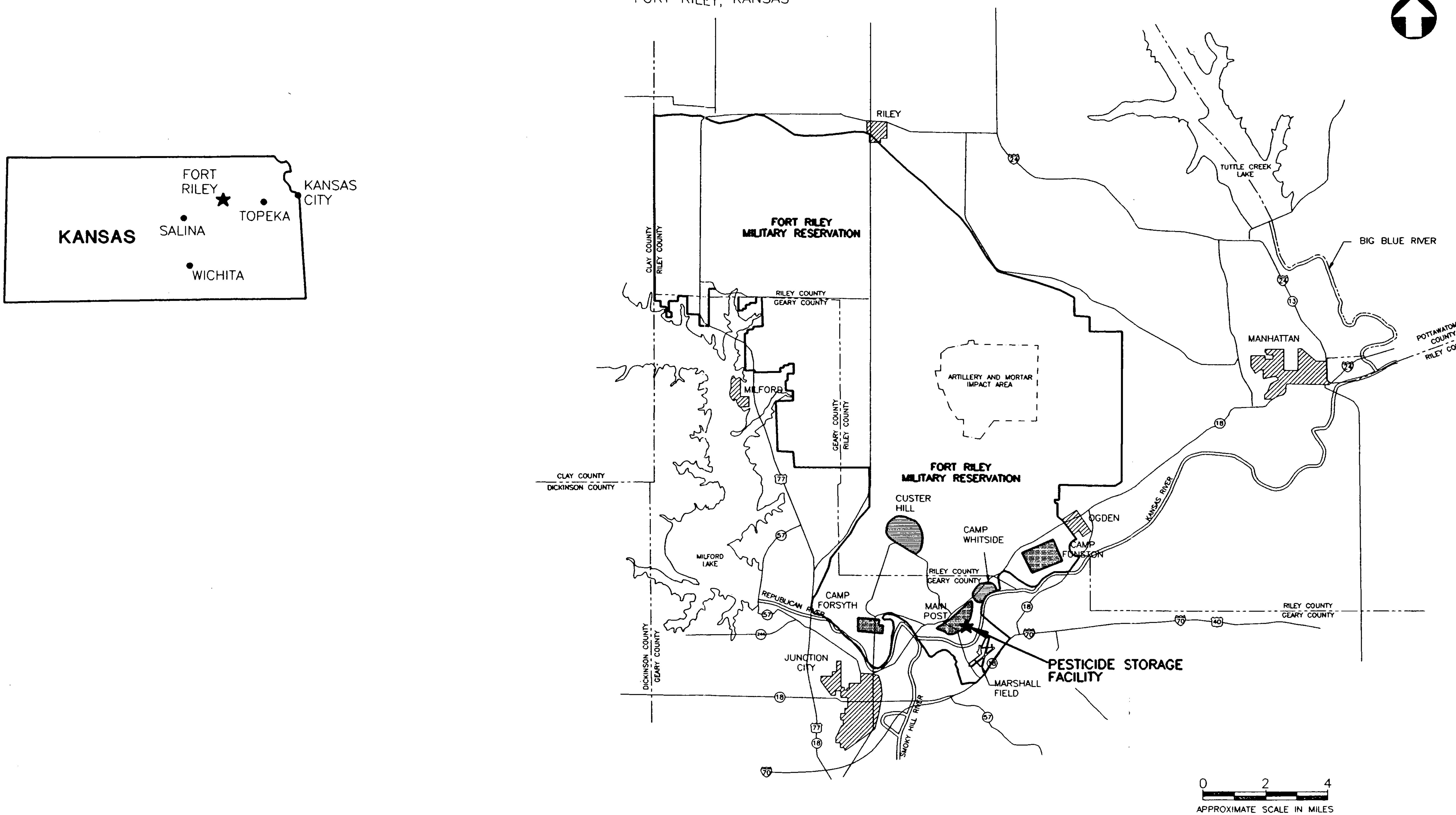
Work Plan (Volume I, Draft, Modified Work Plan for remedial Investigation/Feasibility Study)

9.0 FIGURES

FIGURE 2 - 1

PESTICIDE STORAGE FACILITY LOCATION MAP

FORT RILEY, KANSAS



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filename: pest/fig1-1

Figure 2-1

FIGURE 2-2
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

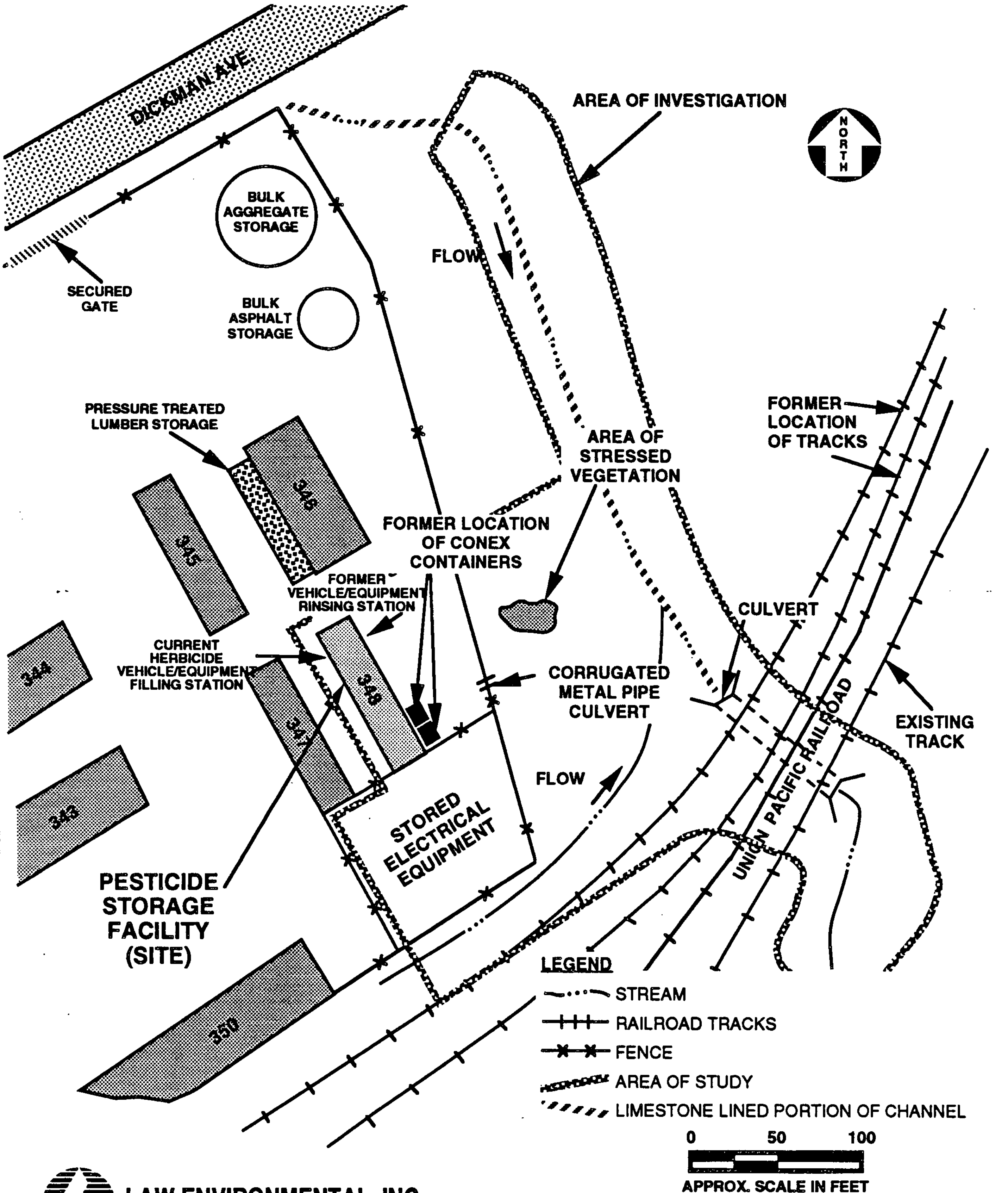

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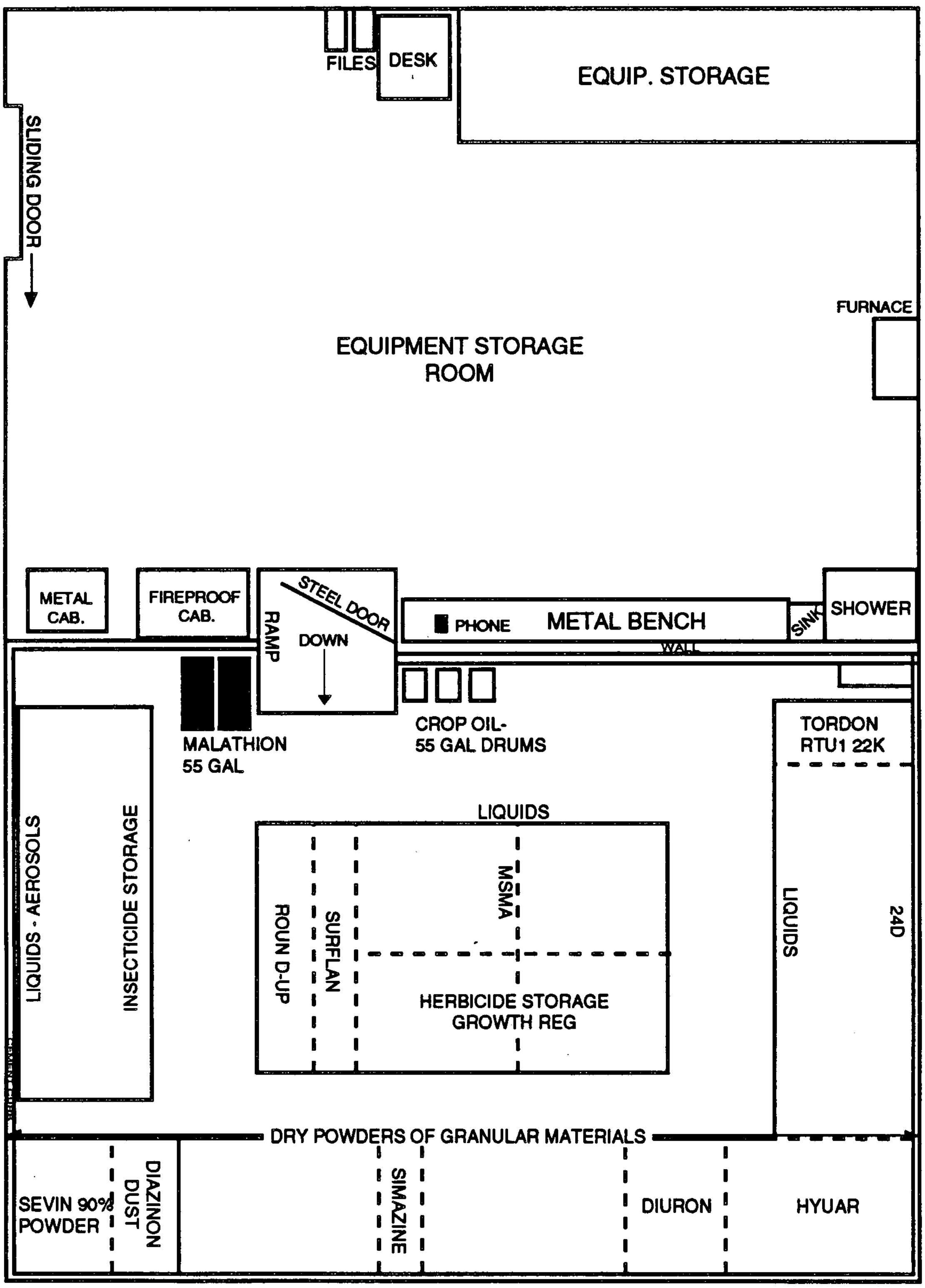
FIGURE 2-3

BUILDING 348 CONFIGURATION

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



NOT TO SCALE

NOTE:
DRAWING TAKEN FROM DEH,
FORT RILEY, KANSAS

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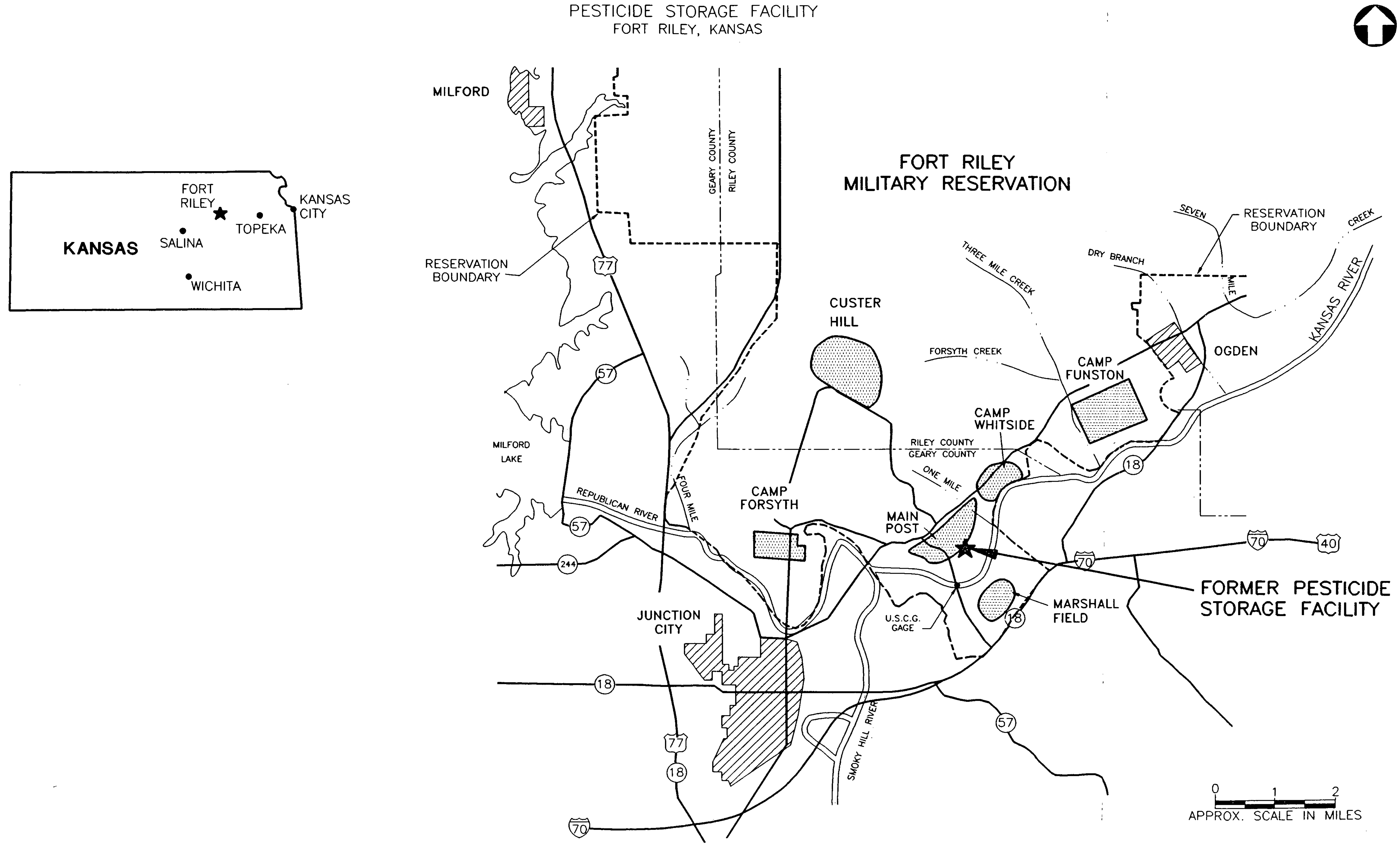
FIGURE 2--4

MAJOR DRAINAGES AND SURFACE WATER FEATURES

PESTICIDE STORAGE FACILITY

FORT RILEY, KANSAS



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FILENAME: RILEY/PEST/FIG3-1.DWG

Figure 2-4

FIGURE 2-5
OBSERVED PATH OF SURFACE WATER RUNOFF
FORT RILEY, KANSAS

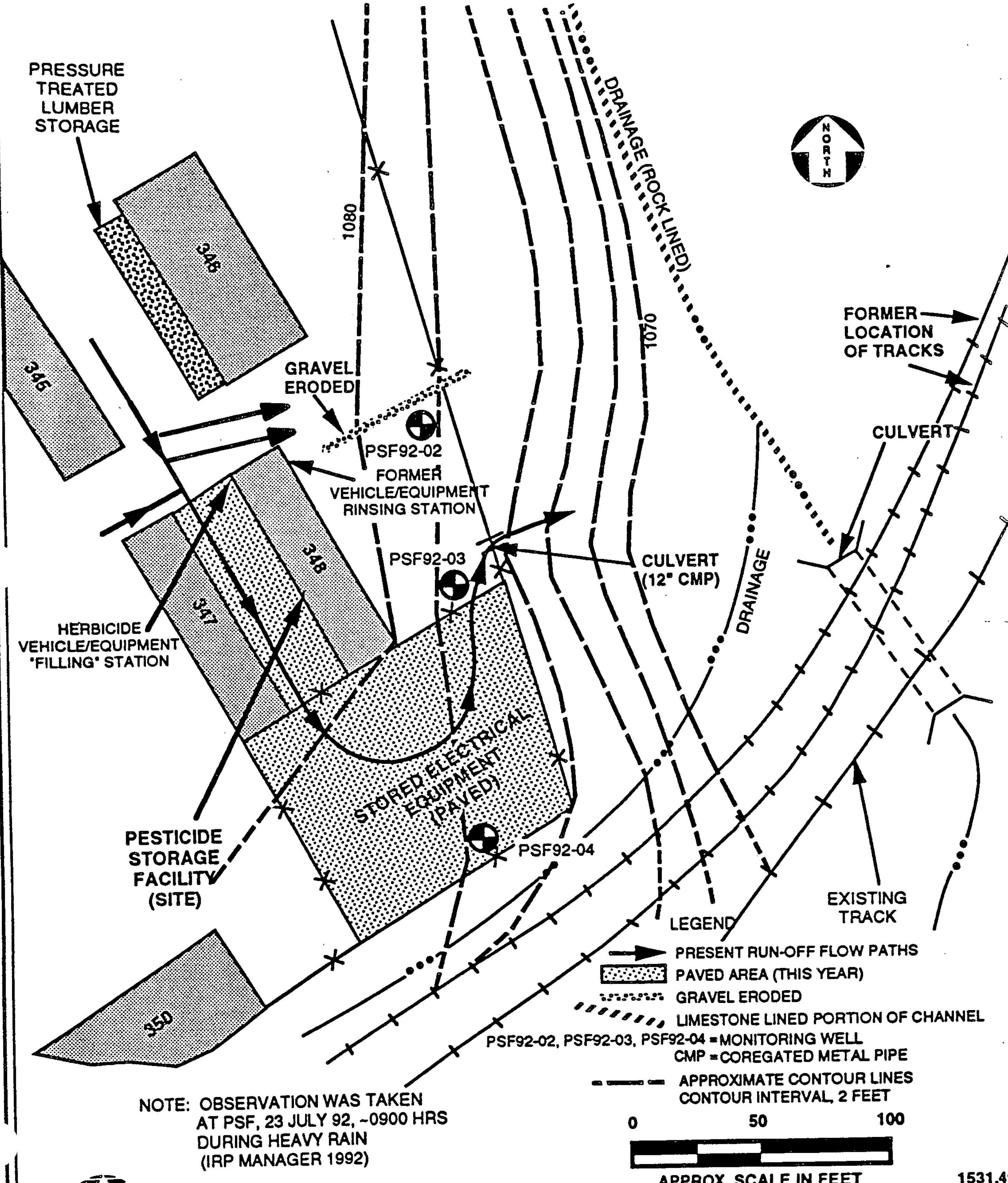

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FIGURE 2-6
GENERAL STRATIGRAPHIC SEQUENCE-ROCK COLUMN
FORT RILEY, KANSAS

Members	Formations	Group
	Odell Shale	Chase Group
Cresswell Ls. Mbr.	Winfield Limestone	Chase Group
Grant Shale Member	Winfield Limestone	Chase Group
Stovall Limestone Mbr.	Winfield Limestone	Chase Group
Gage Shale Member	Doyle Shale	Chase Group
Towanda Limestone Mbr.	Doyle Shale	Chase Group
Holmesville Sh. Mbr.	Doyle Shale	Chase Group
Fort Riley Ls. Mbr.	Barneston Limestone	Chase Group
Oketo Shale Member	Barneston Limestone	Chase Group
Florence Ls. Mbr.	Barneston Limestone	Chase Group
Blue Springs Sh. Mbr.	Matfield Shale	Chase Group
Kinney Limestone Mbr.	Matfield Shale	Chase Group
Wymore Shale Member	Matfield Shale	Chase Group
Schroyer Ls. Mbr.	Wreford Limestone	Chase Group
Havensville Shale Mbr.	Wreford Limestone	Chase Group
Threemile Ls. Mbr.	Wreford Limestone	Chase Group
	Speiser Shale	Council Grove Group
	Funston Limestone	Council Grove Group
	Blue Rapids Shale	Council Grove Group
	Crouse Limestone	Council Grove Group
	Easly Creek Shale	Council Grove Group
Middleburg Ls. Mbr.	Bader Limestone	Council Grove Group
Hooser Shale Member	Bader Limestone	Council Grove Group
Eiss Limestone Member	Bader Limestone	Council Grove Group
	Stearns Shale	Council Grove Group
Morrill Limestone Mbr.	Beattie Limestone	Council Grove Group
Florena Shale Member	Beattie Limestone	Council Grove Group
Cottonwood Ls. Mbr.	Beattie Limestone	Council Grove Group
	Eskridge Shale	Council Grove Group
Neva Limestone Mbr.	Grenola Limestone	Council Grove Group
Salem Point Shale Mbr	Grenola Limestone	Council Grove Group
Burr Limestone Mbr	Grenola Limestone	Council Grove Group
Legion Shale Member	Grenola Limestone	Council Grove Group
Sallyards Ls. Mbr.	Grenola Limestone	Council Grove Group
	Roca Shale	Council Grove Group
Howe Limestone Member	Red Eagle Limestone	Council Grove Group
Bennett Shale Member	Red Eagle Limestone	Council Grove Group
Glenrock Ls. Mbr.	Red Eagle Limestone	Council Grove Group
	Johnson Shale	Council Grove Group
Long Creek Ls. Mbr.	Foraker Limestone	Council Grove Group
Hughes Creek Sh. Mbr	Foraker Limestone	Council Grove Group
Americus Ls. Mbr	Foraker Limestone	Council Grove Group

GEARYAN STAGE — LOWER PERMIAN SERIES — PERMIAN SYSTEM

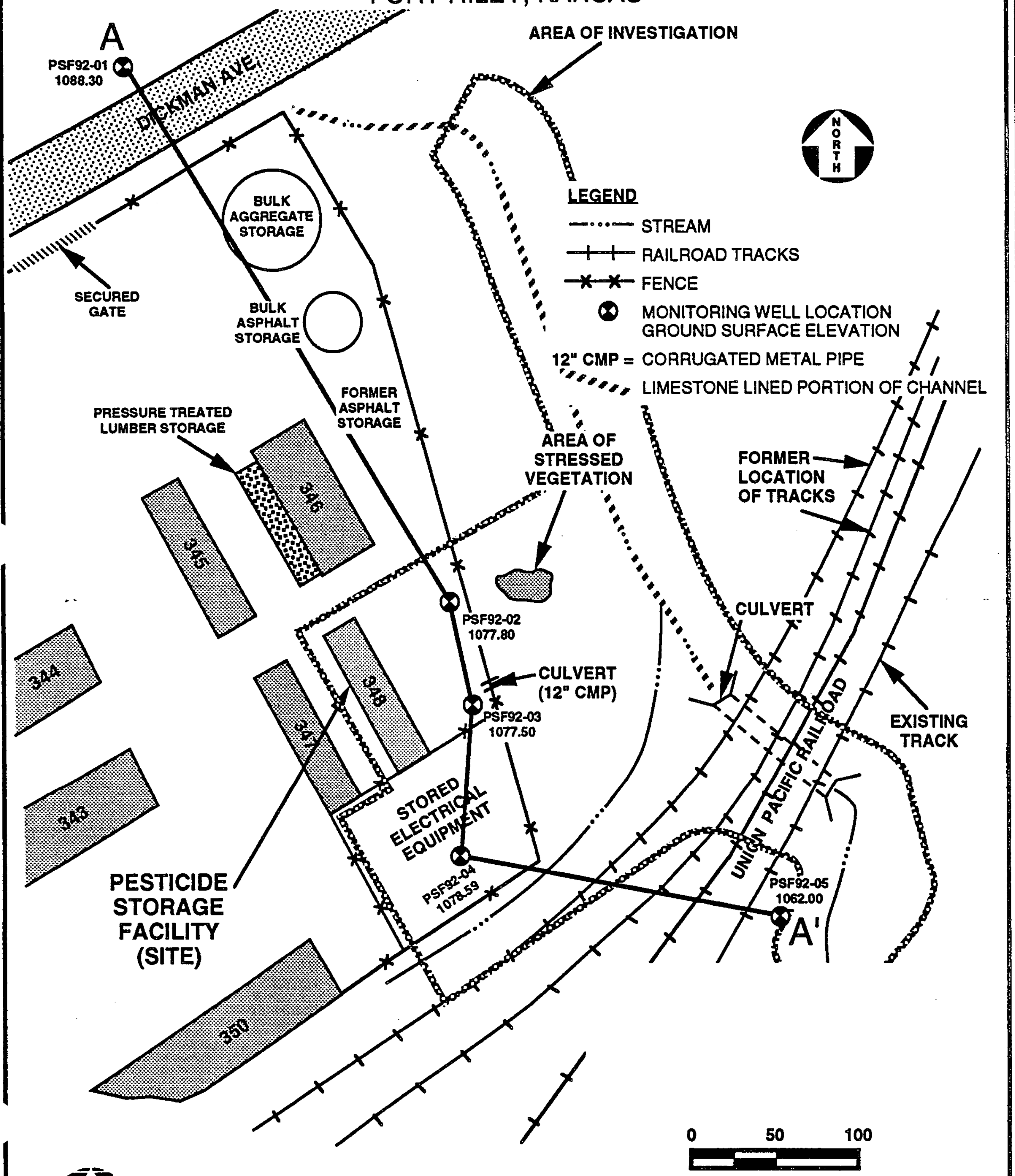
SOURCE: ZELLER, 1968

LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES BRANCH

FIGURE 2-7

LOCATION OF GEOLOGIC CROSS SECTION

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

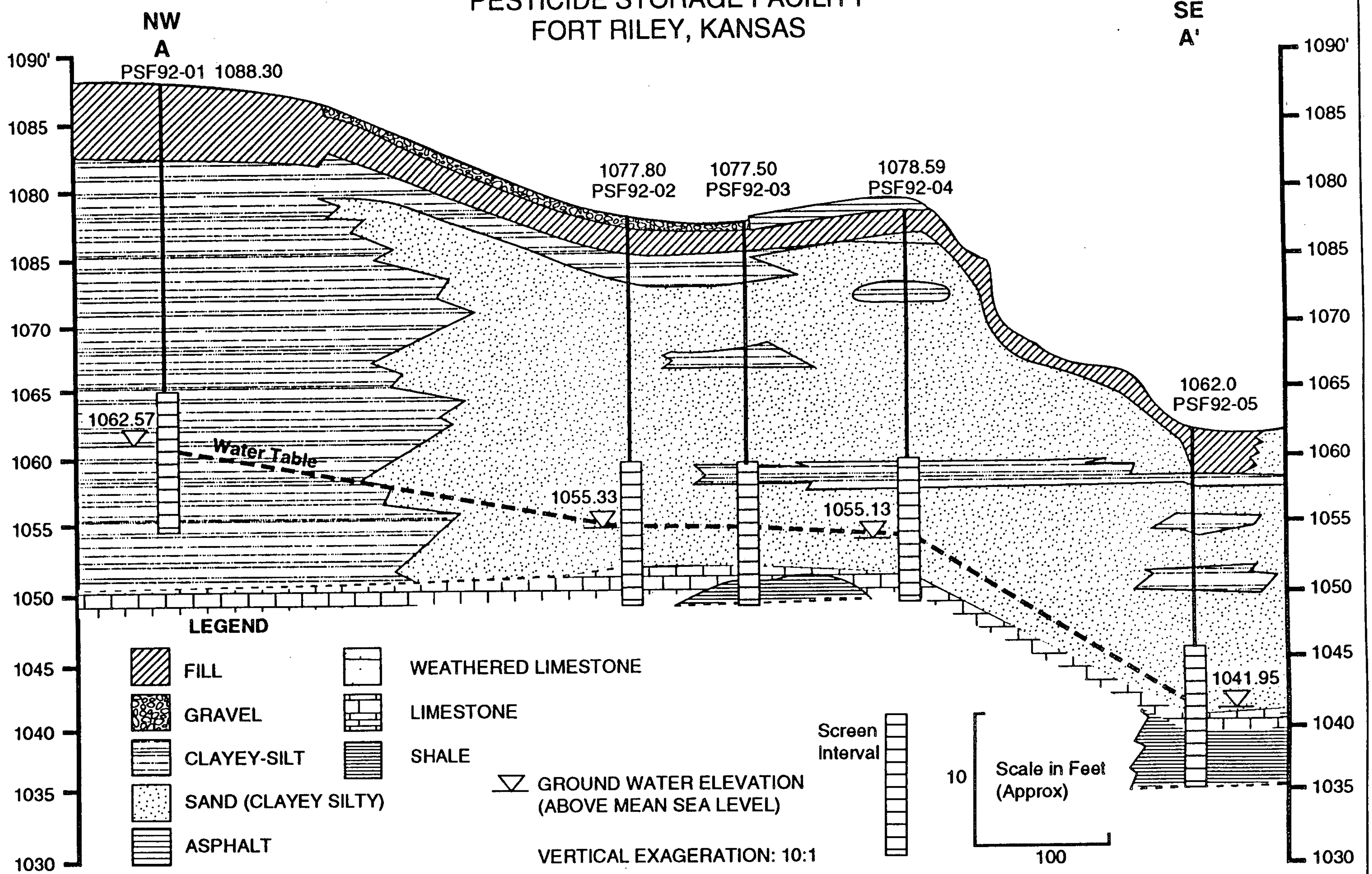


LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

FIGURE 2-7A

GEOLOGIC CROSS SECTION A-A'

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



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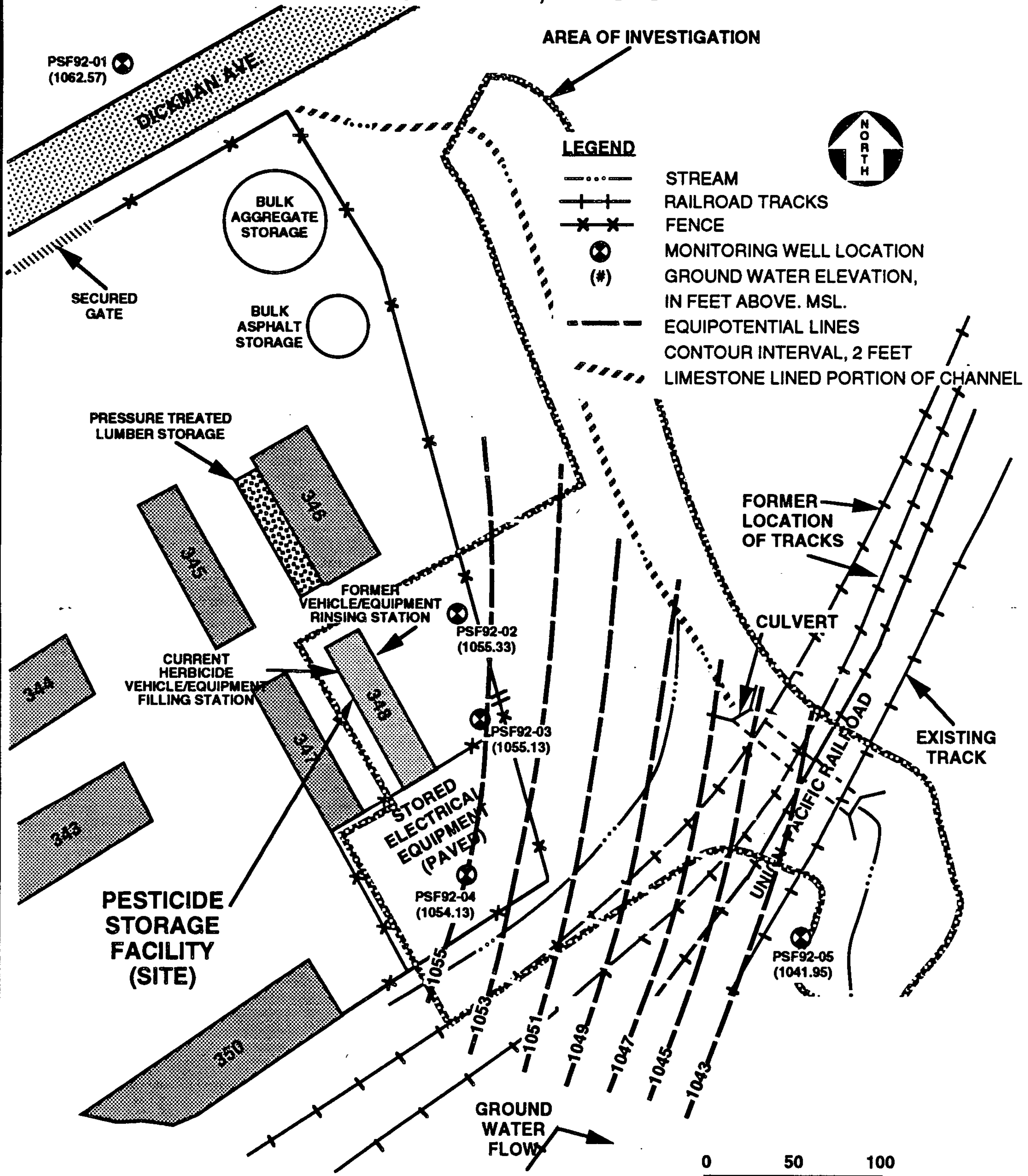
GOVERNMENT SERVICES DIVISION

FIGURE 2-8

POTENTIOMETRIC SURFACE MAP, DEC. 1992

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



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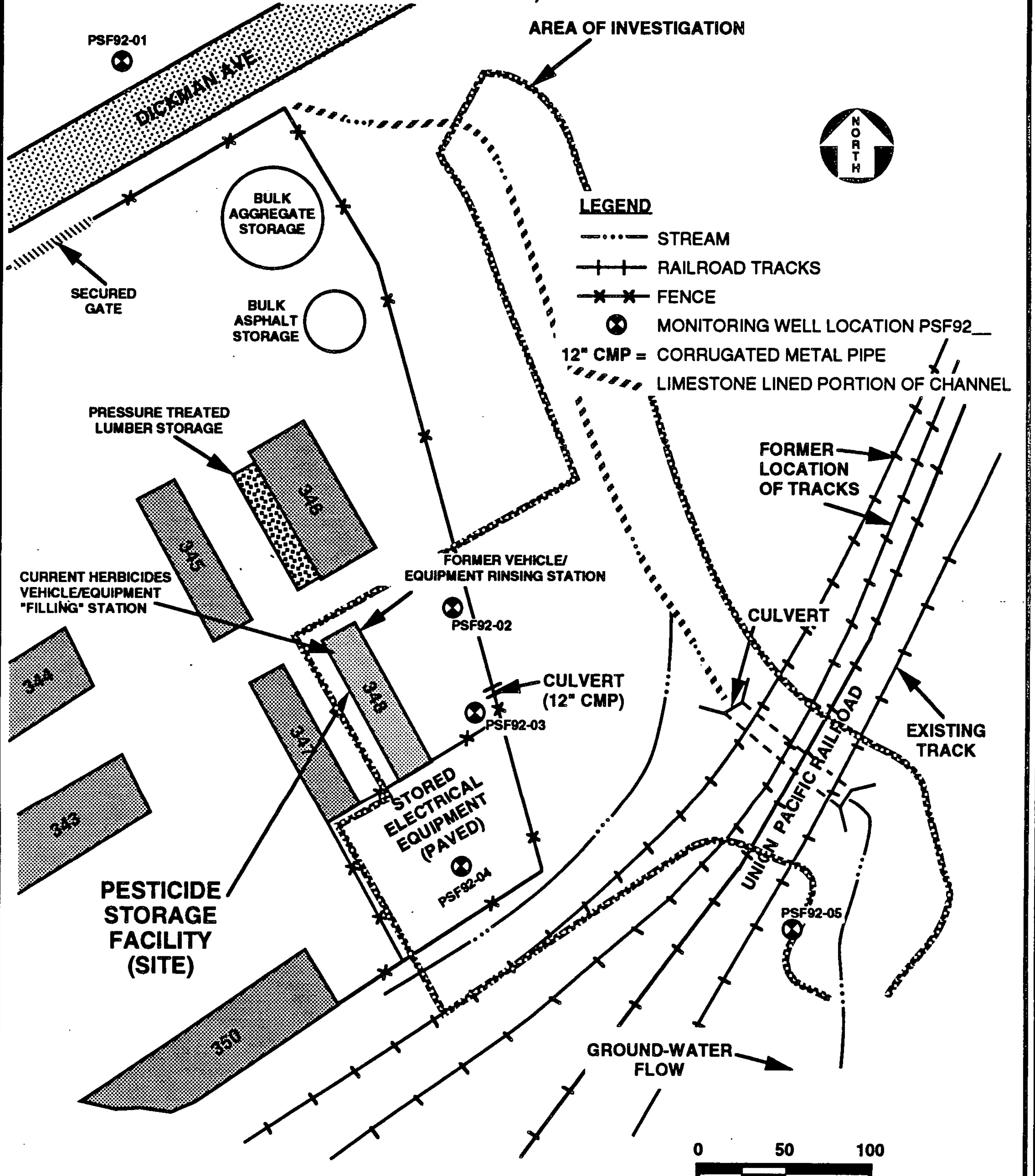
GOVERNMENT SERVICES DIVISION

FIGURE 2-9

MONITORING WELL LOCATIONS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



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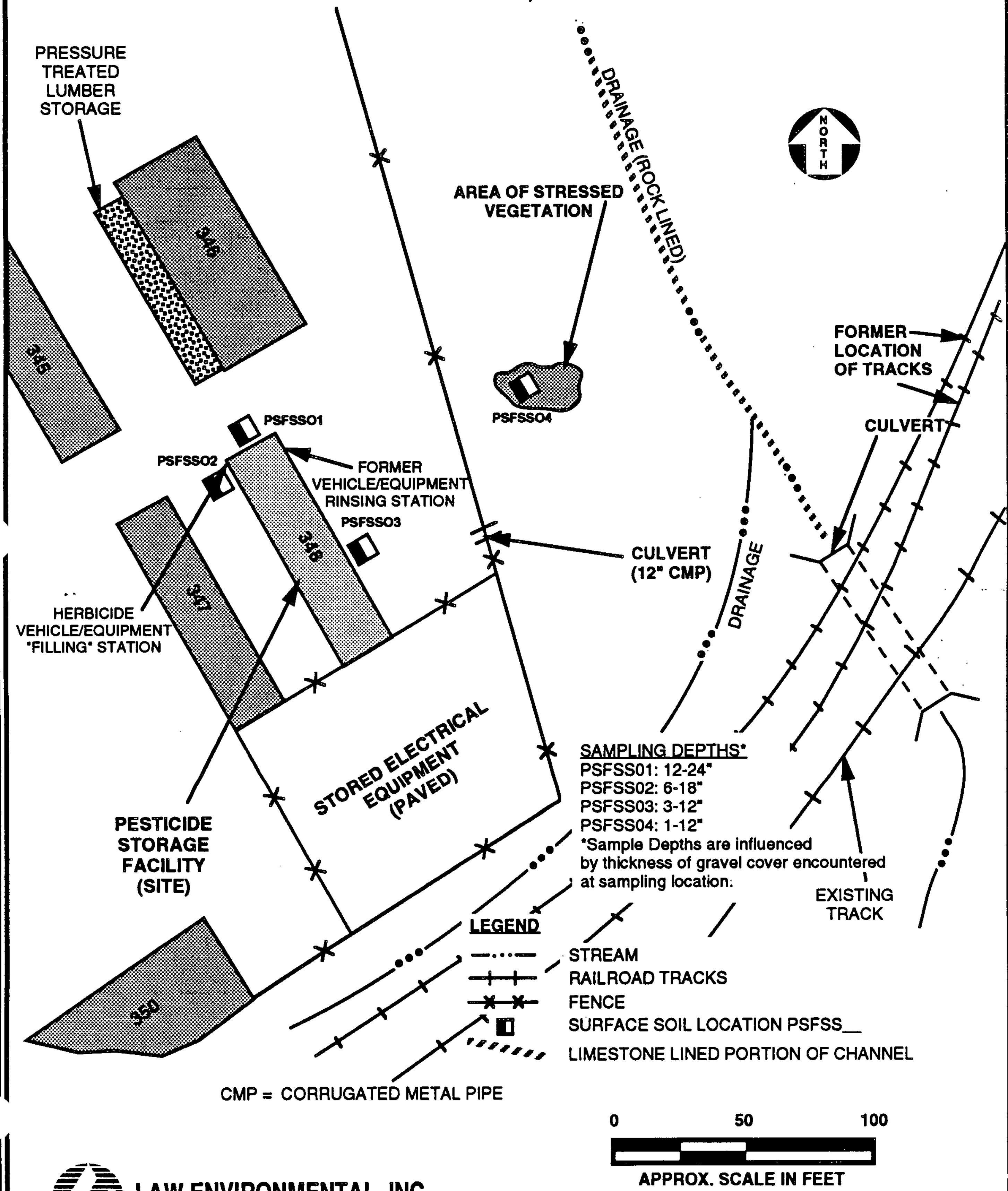
GOVERNMENT SERVICES DIVISION

FIGURE 2-10

SURFACE SOIL SAMPLE LOCATIONS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

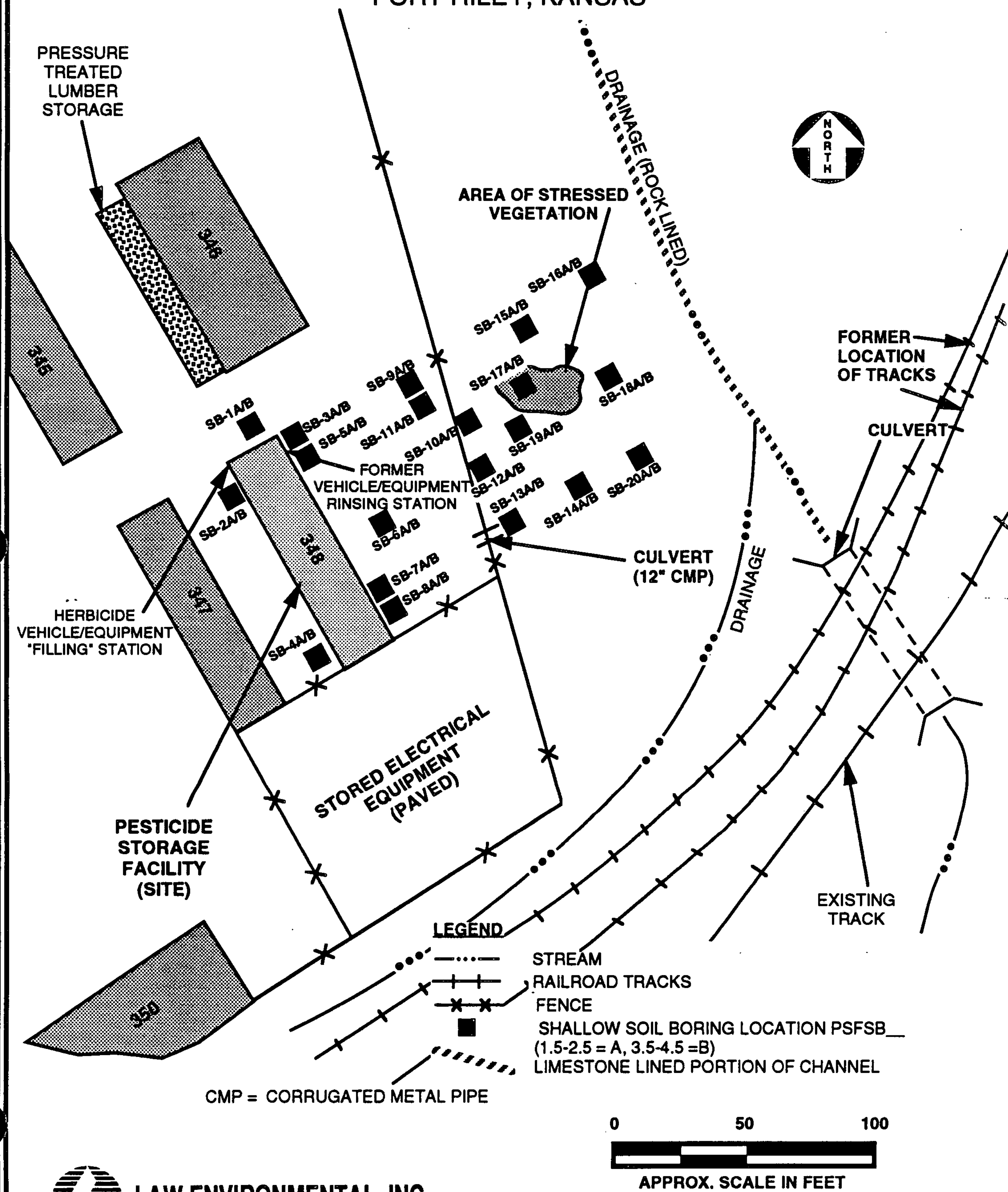


LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

FIGURE 2-11

SHALLOW SOIL BORING SAMPLE LOCATIONS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

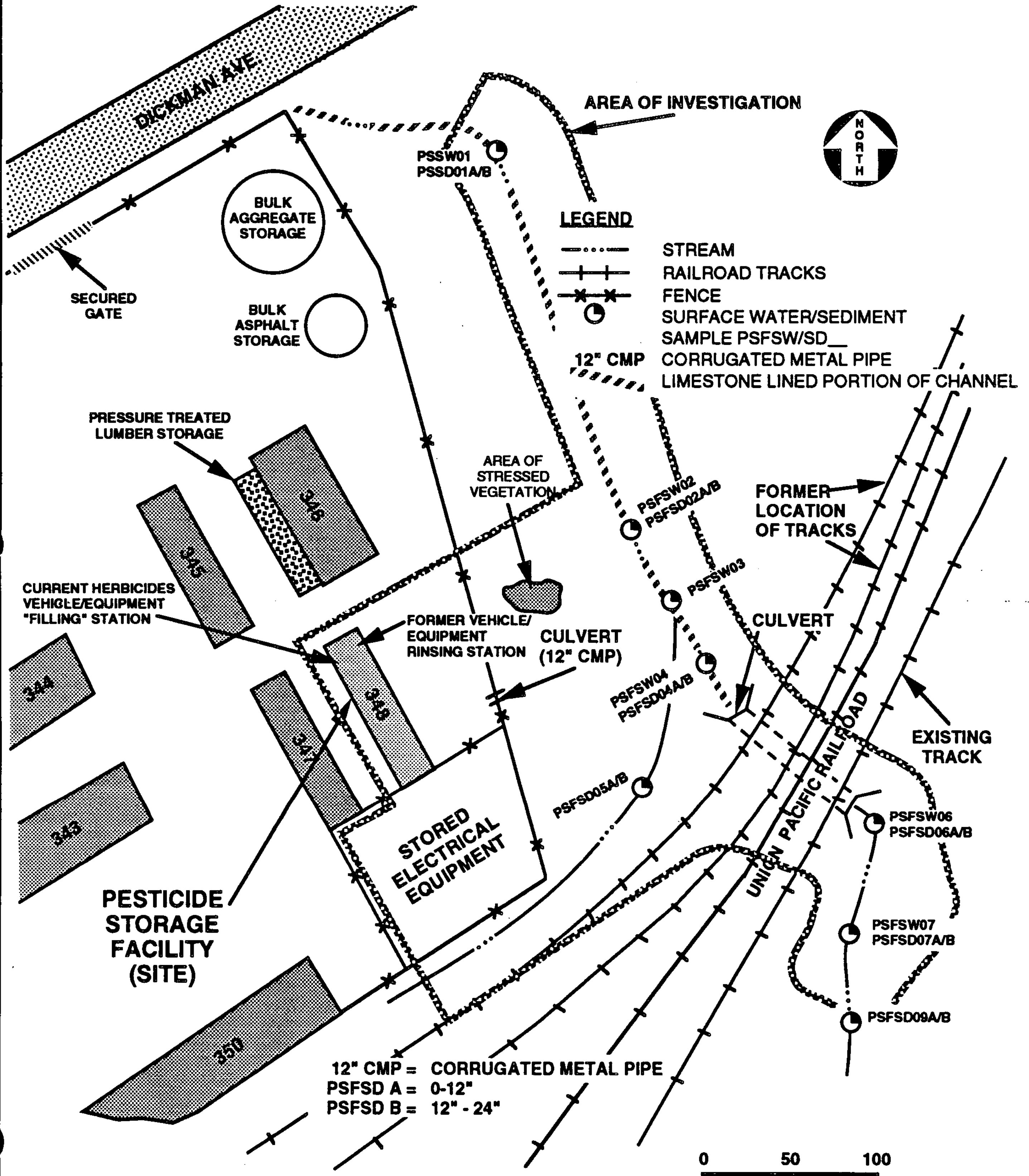


LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

FIGURE 2-12

SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

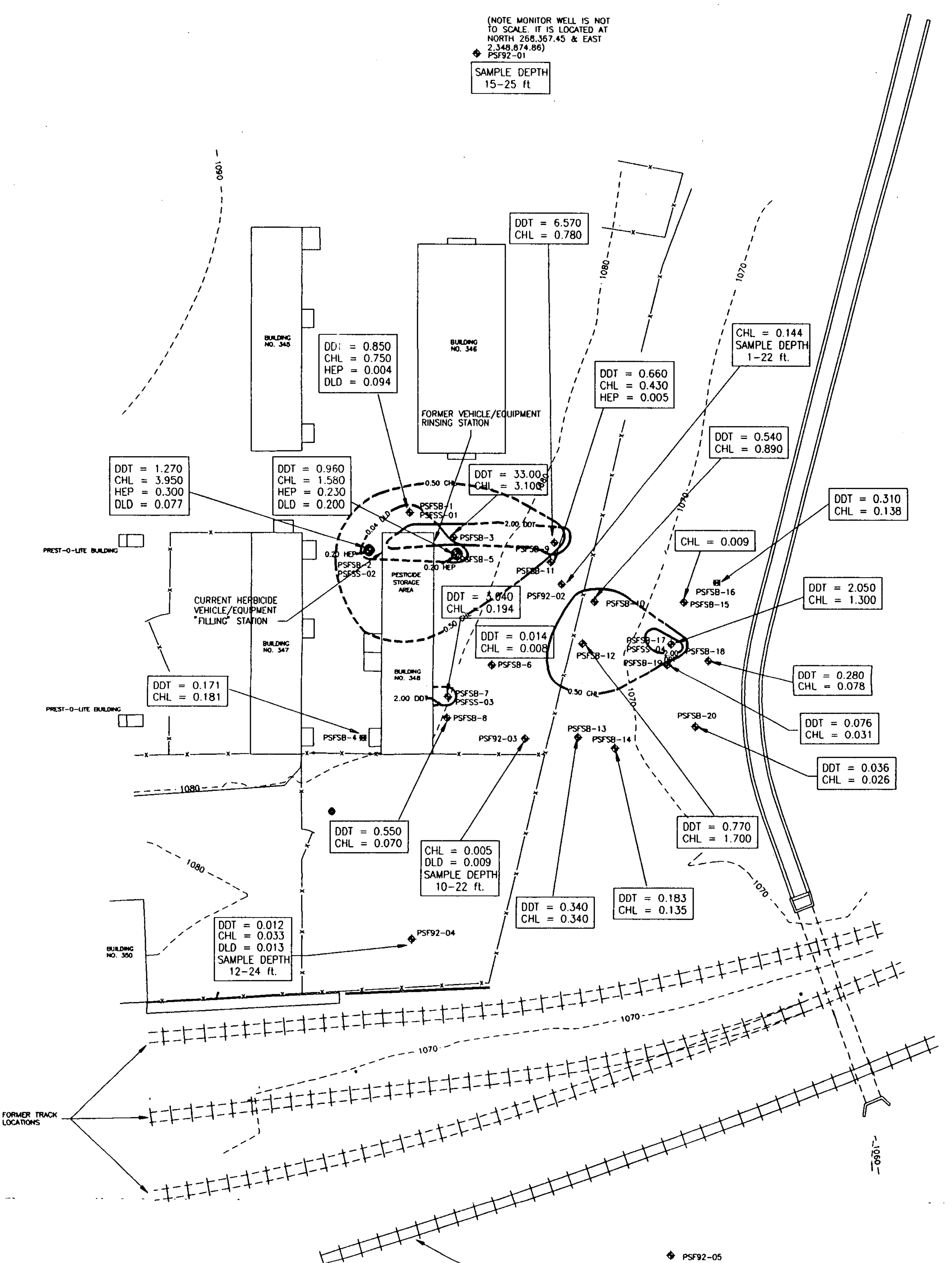


LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

FIGURE 2-13

PESTICIDE CONTAMINATION OF SOIL (BASED ON RCRA SOIL ACTION LEVELS)

PESTICIDE STORAGE AREA
FORT RILEY, KANSAS



LEGEND

◆	SAMPLING LOCATION
SB-2	SOIL BORING (HAND AUGER)
SS-1	SURFACE SOIL BORING
MW-5	MONITORING WELL BORING
ELEV=1082.9	ELEVATION OF GROUND SURFACE AT SAMPLING LOCATION IN FEET ABOVE SEA LEVEL
--1070--	TOPOGRAPHIC CONTOUR LINES (SEE FIGURE 4-6)
---x---	FENCE
	RAILROAD
	LINED PORTION OF DRAINGE DITCH
HEP	HEPTACHLOR
CHL	CHLORDANE
DLD	DIELDRIN
—2.00 DDT--	INTERPOLATED CONTOUR LINE OF DDT CONCENTRATIONS-RCRA ACTION LEVEL: 2.00 mg/Kg
—0.50 CHL--	INTERPOLATED CONTOUR LINE OF CHLORDANE CONCENTRATIONS-RCRA ACTION LEVEL: 0.50 mg/Kg
—0.20 HEP--	INTERPOLATED CONTOUR LINE OF HEPTACHLOR CONCENTRATIONS-RCRA ACTION LEVEL: 0.20 mg/Kg
—0.04 DLD--	INTERPOLATED CONTOUR LINE OF DIELDRIN CONCENTRATIONS-RCRA ACTION LEVEL: 0.04 mg/Kg

NOTES:

1. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/Kg).
2. ALL CONCENTRATIONS REPRESENT SAMPLES COLLECTED FROM 0-4.5 FEET BELOW GROUND SURFACE, UNLESS OTHERWISE INDICATED.
3. SAMPLES COLLECTED IN APRIL/MAY, 1992.
4. DDT CONCENTRATIONS REPRESENT TOTAL CONCENTRATION OF DDT AND ITS METABOLITES (DDE AND DDD).
5. CHLORDANE CONCENTRATIONS REPRESENT SUM OF ALPHA- AND GAMMA-CHLORDANE CONCENTRATIONS.
6. THIS MAP DISPLAYS POSITIVE CONCENTRATIONS OF CONTAMINANTS ONLY (NON-DETECT READINGS ARE NOT SHOWN).
7. CONCENTRATIONS SHOWN REPRESENT THE HIGHEST VALUE OF EACH PARAMETER FROM SAMPLES COLLECTED FROM 0 - 4.5 FEET BELOW GROUND SURFACE

0 60 120
SCALE IN FEET

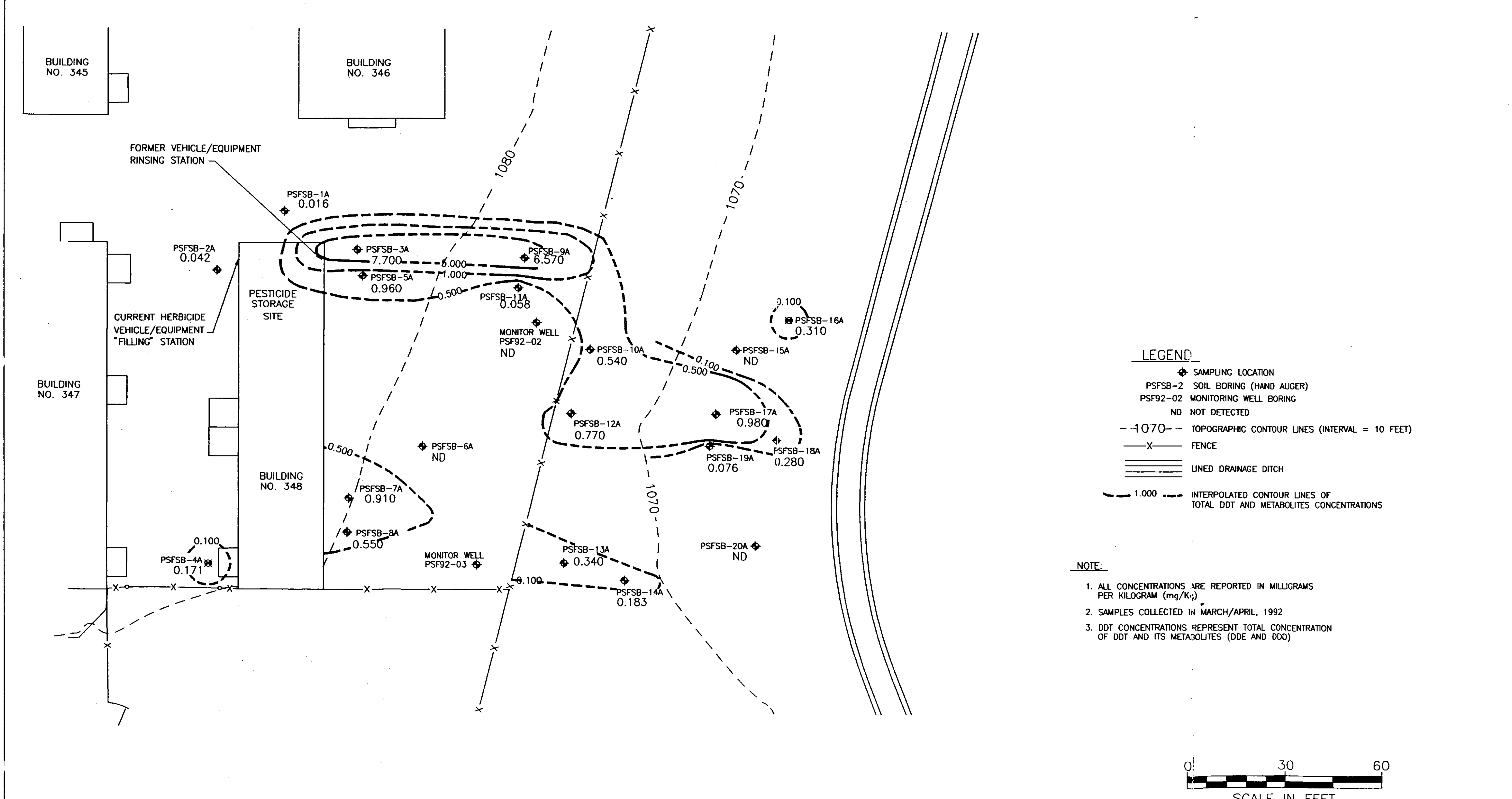
LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

filename: 36383pef.dwg

FIGURE 2-14

TOTAL DDT AND METABOLITES CONCENTRATIONS FROM SOIL BORINGS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 1.5 – 2.5 FT



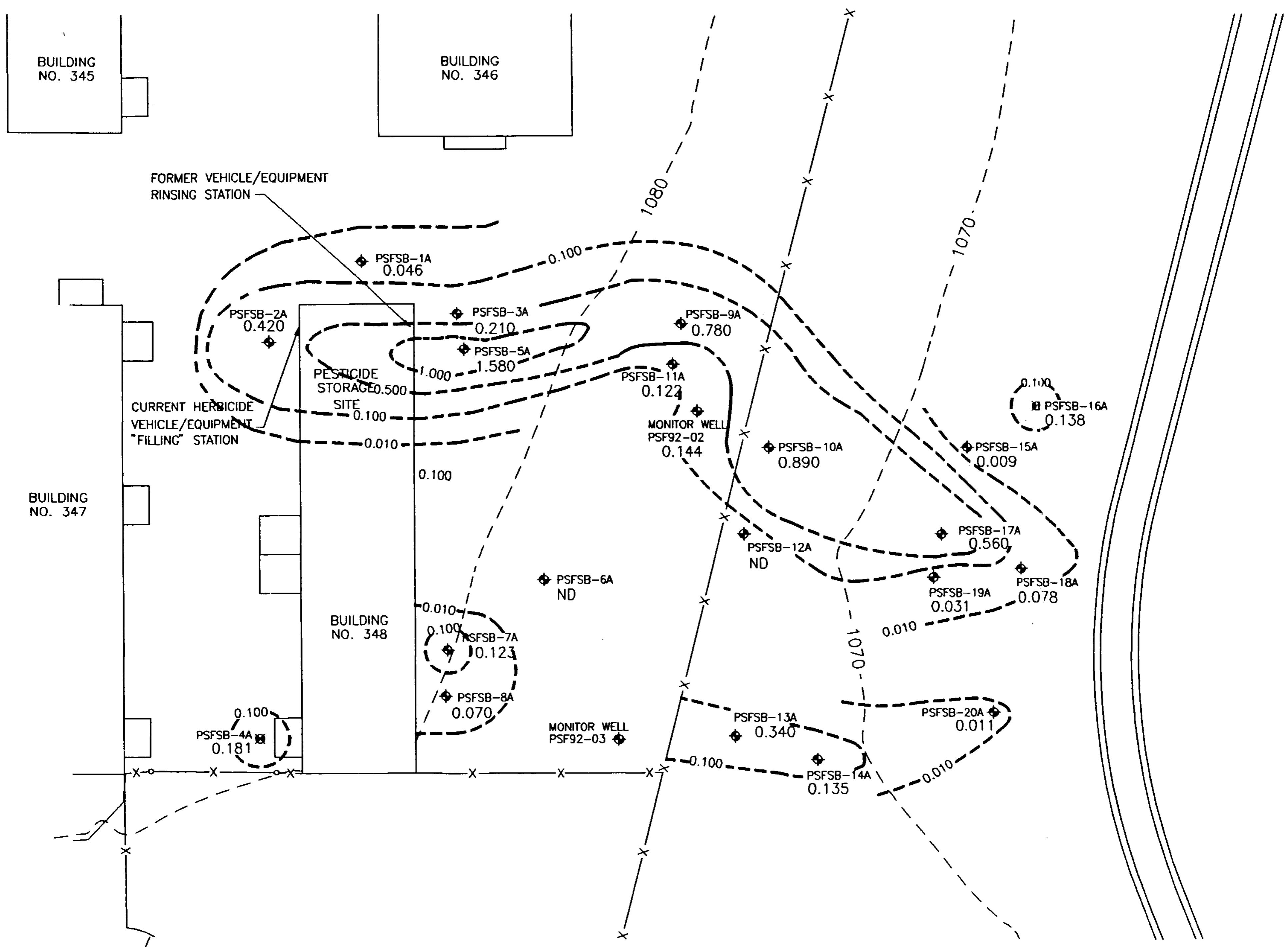
NOTE:

1. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/Kg)
2. SAMPLES COLLECTED IN MARCH/APRIL, 1992
3. DDT CONCENTRATIONS REPRESENT TOTAL CONCENTRATION OF DDT AND ITS METABOLITES (DDE AND DDD)

FILENAME: 11X17.DWG
LAYER: DDTCO-25

LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

FIGURE 2-15
TOTAL CHLORDANE CONCENTRATIONS FROM SOIL BORINGS
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 1.5 – 2.5 FT.



LEGEND

- ◆ SAMPLING LOCATION
- PSFSB-2 SOIL BORING (HAND AUGER)
- PSF92-02 MONITORING WELL BORING
- ND NOT DETECTED
- 1070 TOPOGRAPHIC CONTOUR LINES (INTERVAL = 10 FEET)
- —X— FENCE
- LINED DRAINAGE DITCH
- 1.000 INTERPOLATED CONTOUR LINES OF CHLORDANE CONCENTRATIONS

NOTE:

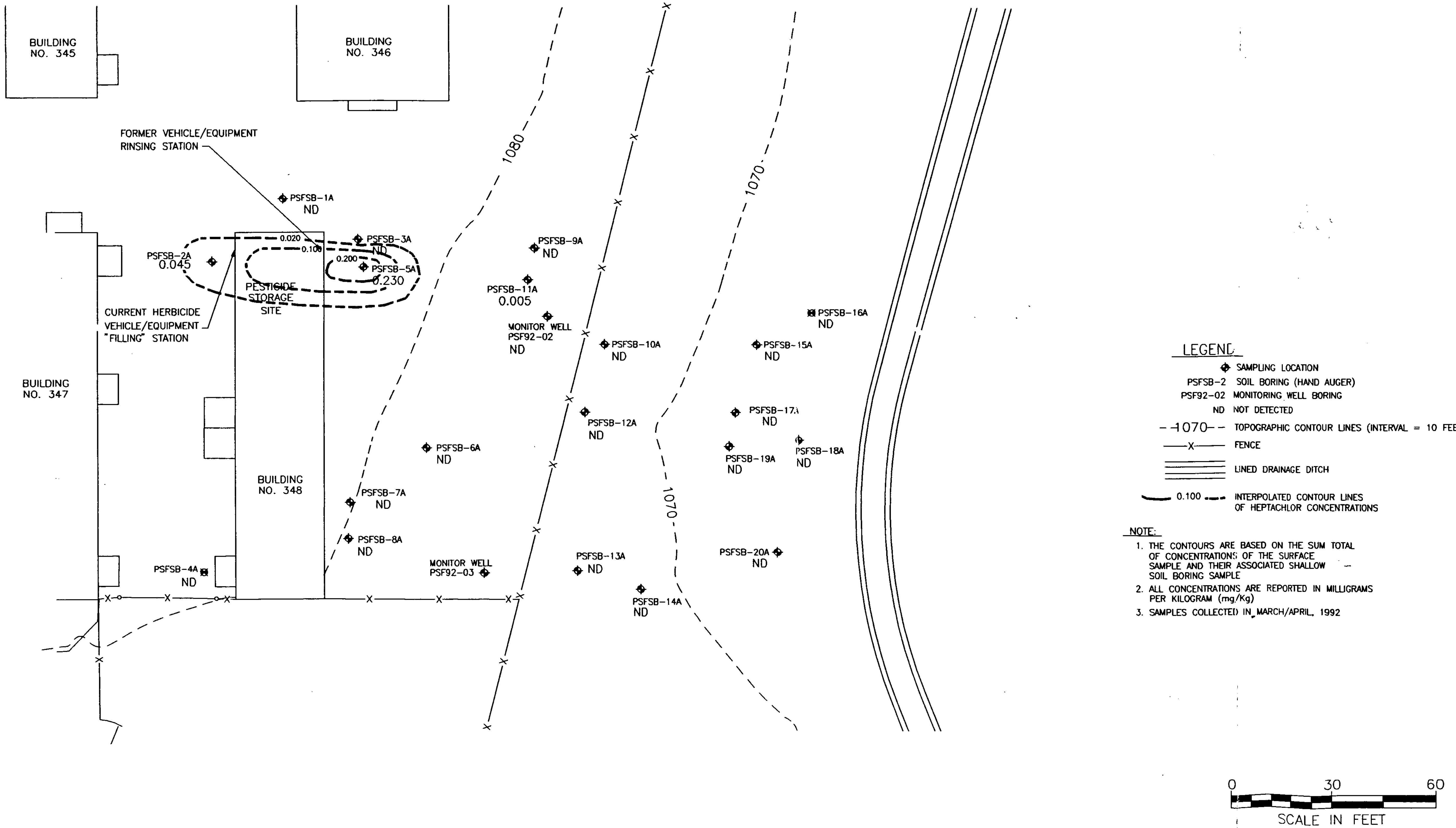
1. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/Kg).
2. SAMPLES COLLECTED IN MARCH/APRIL, 1992.
3. CHLORDANE CONCENTRATIONS REPRESENT SUM OF ALPHA- AND GAMMA- CHLORDANE CONCENTRATIONS.

0 30 60
SCALE IN FEET

FILENAME: 11X17.DWG
LAYER: CCO-25

LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

FIGURE 2-16
HEPTACHLOR CONCENTRATIONS FROM SOIL BORINGS
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 1.5 – 2.5 FT



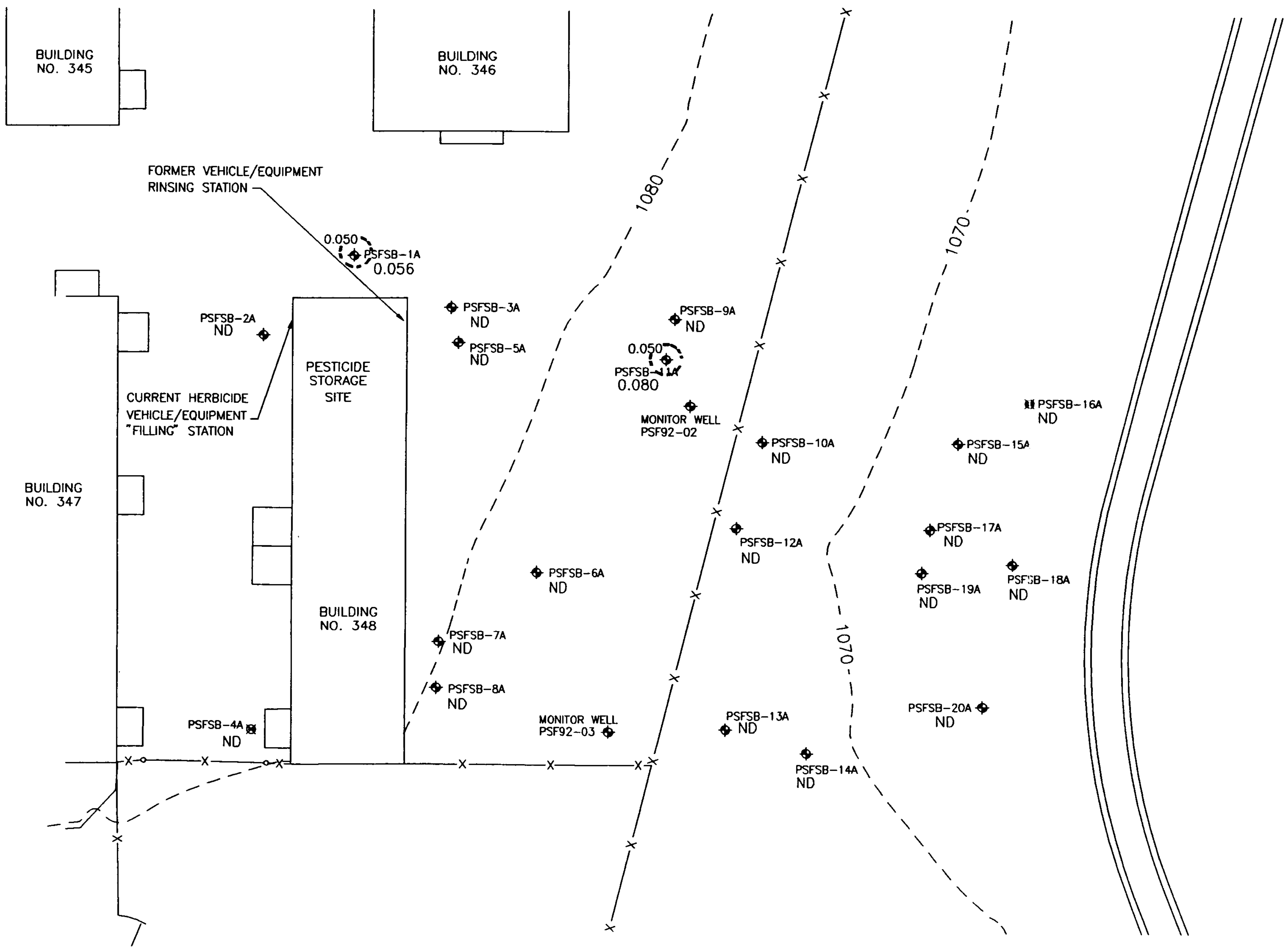
FILENAME: 11X17.DWG
LAYER: HEPTCO-25

LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

FIGURE 2-17

METHOXYCHLOR CONCENTRATIONS FROM SOIL BORINGS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 1.5 – 2.5 FT



LEGEND

- ◆ SAMPLING LOCATION
- PSFSB-2 SOIL BORING (HAND AUGER)
- PSF92-02 MONITORING WELL BORING
- ND NOT DETECTED
- --1070-- TOPOGRAPHIC CONTOUR LINES (INTERVAL = 10 FEET)
- —X— FENCE
- LINED DRAINAGE DITCH
- 0.050 INTERPOLATED CONTOUR LINES OF METHOXYCHLOR CONCENTRATIONS

NOTE:

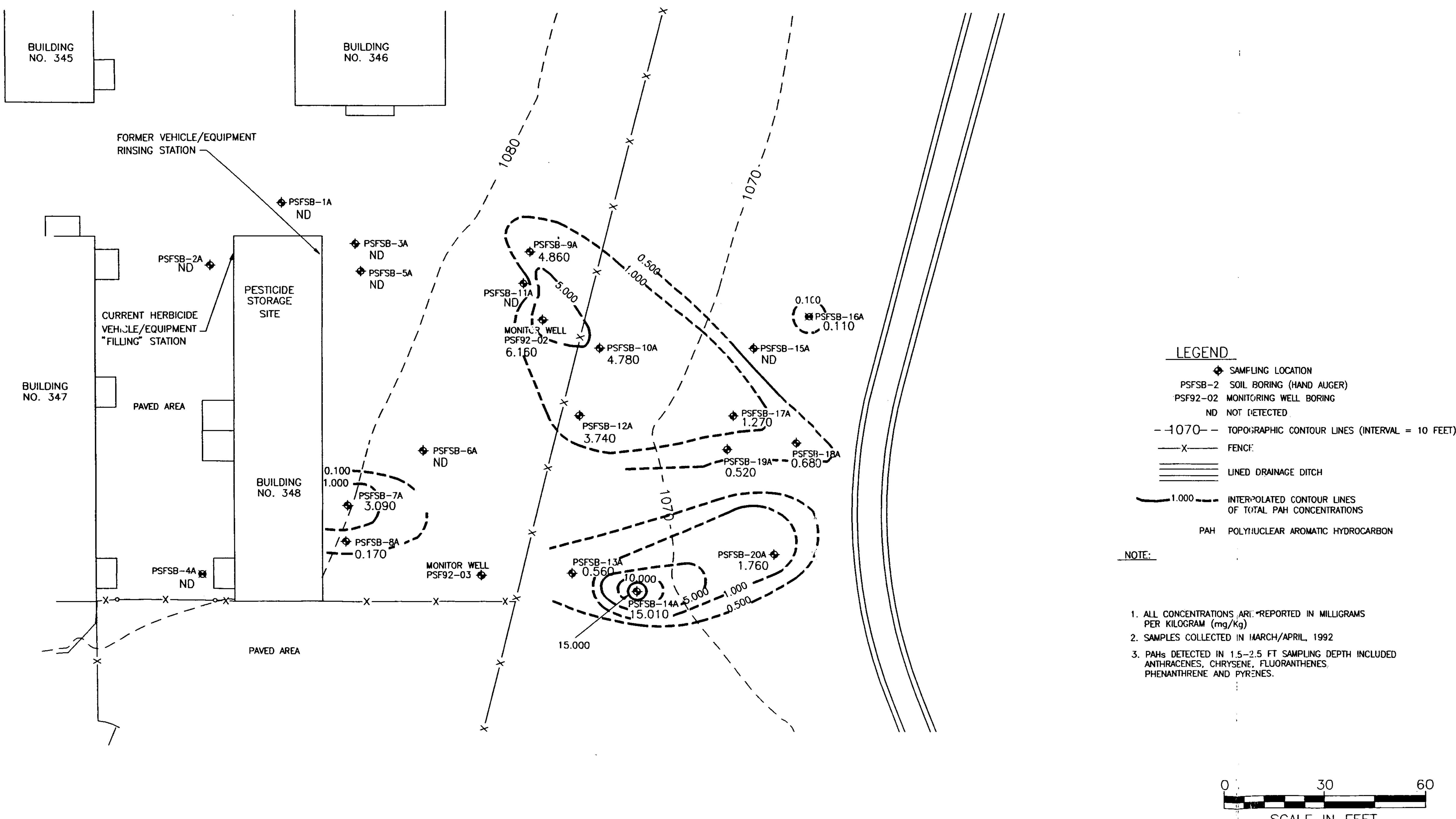
1. SAMPLES COLLECTED IN MARCH/APRIL, 1992
2. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/Kg).

0 30 60
SCALE IN FEET

FILENAME: 11X17.DWG
LAYER: methc0-25

LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

FIGURE 2-18
TOTAL PAH CONCENTRATIONS FROM SOIL BORINGS
PESTICIDE STORAGE FACILITY
FORT RILEY KANSAS
SAMPLING DEPTH: 1.5 – 2.5 FT



FILENAME: 11X17.DWG
LAYER: TOTALPAHCO-25

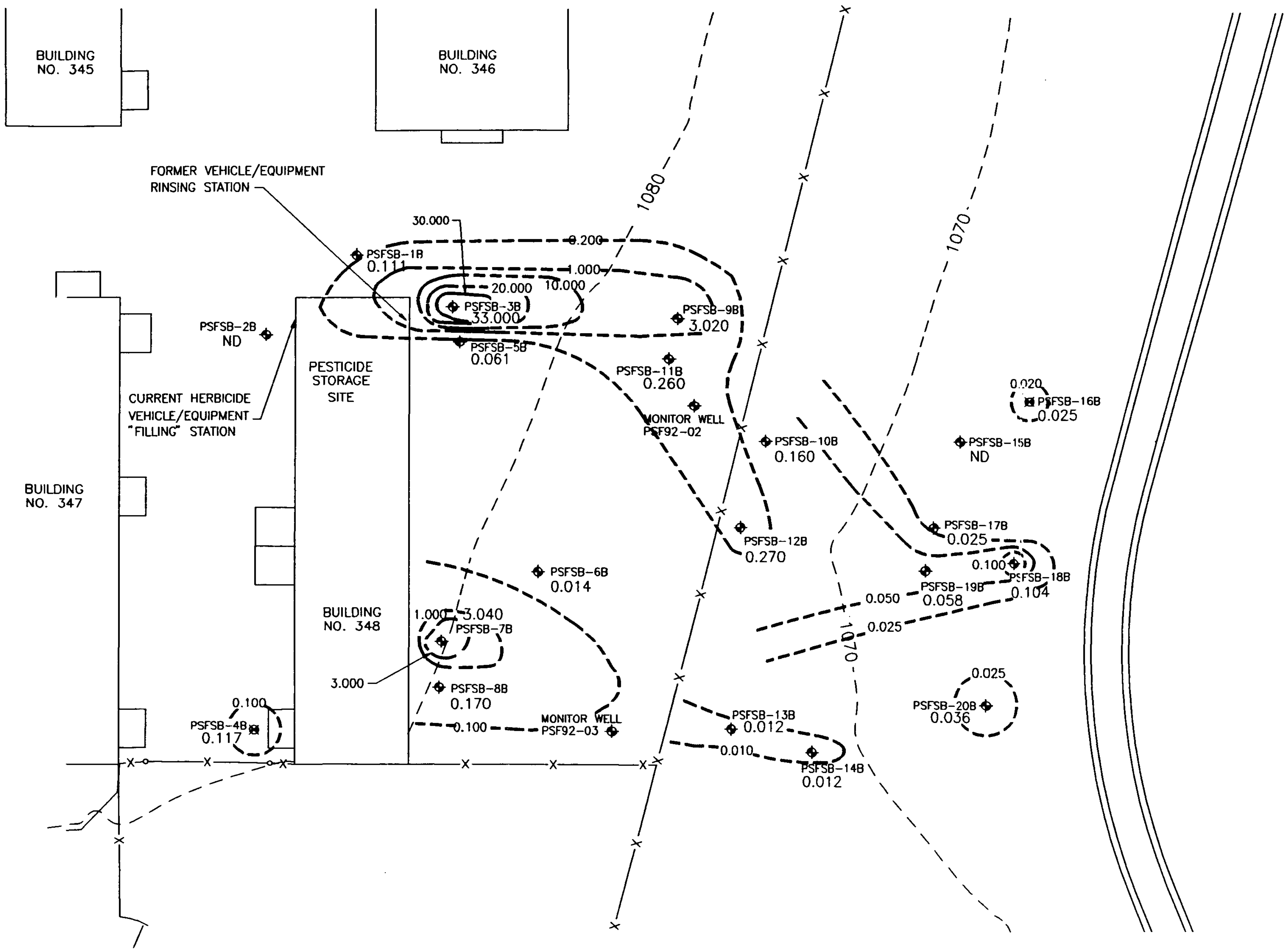
LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

Figure 2-18

FIGURE 2-19

TOTAL DDT AND METABOLITES CONCENTRATIONS FROM SOIL BORINGS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 3.5 – 4.5 FT.



LEGEND

- ◆ SAMPLING LOCATION
- PSFSB-2 SOIL BORING (HAND AUGER)
- PSF92-02 MONITORING WELL BORING
- ND NOT DETECTED
- –1070– – TOPOGRAPHIC CONTOUR LINES (INTERVAL = 10 FEET)
- —X— FENCE
- LINED DRAINAGE DITCH
- —1.000 – – INTERPOLATED CONTOUR LINES OF TOTAL DDT AND METABOLITES CONCENTRATIONS

NOTE:

1. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)
2. SAMPLES COLLECTED IN MARCH/APRIL, 1992
3. DDT CONCENTRATIONS REPRESENT TOTAL CONCENTRATION OF DDT AND ITS METABOLITES (DDE & DDD)

0 30 60
SCALE IN FEET

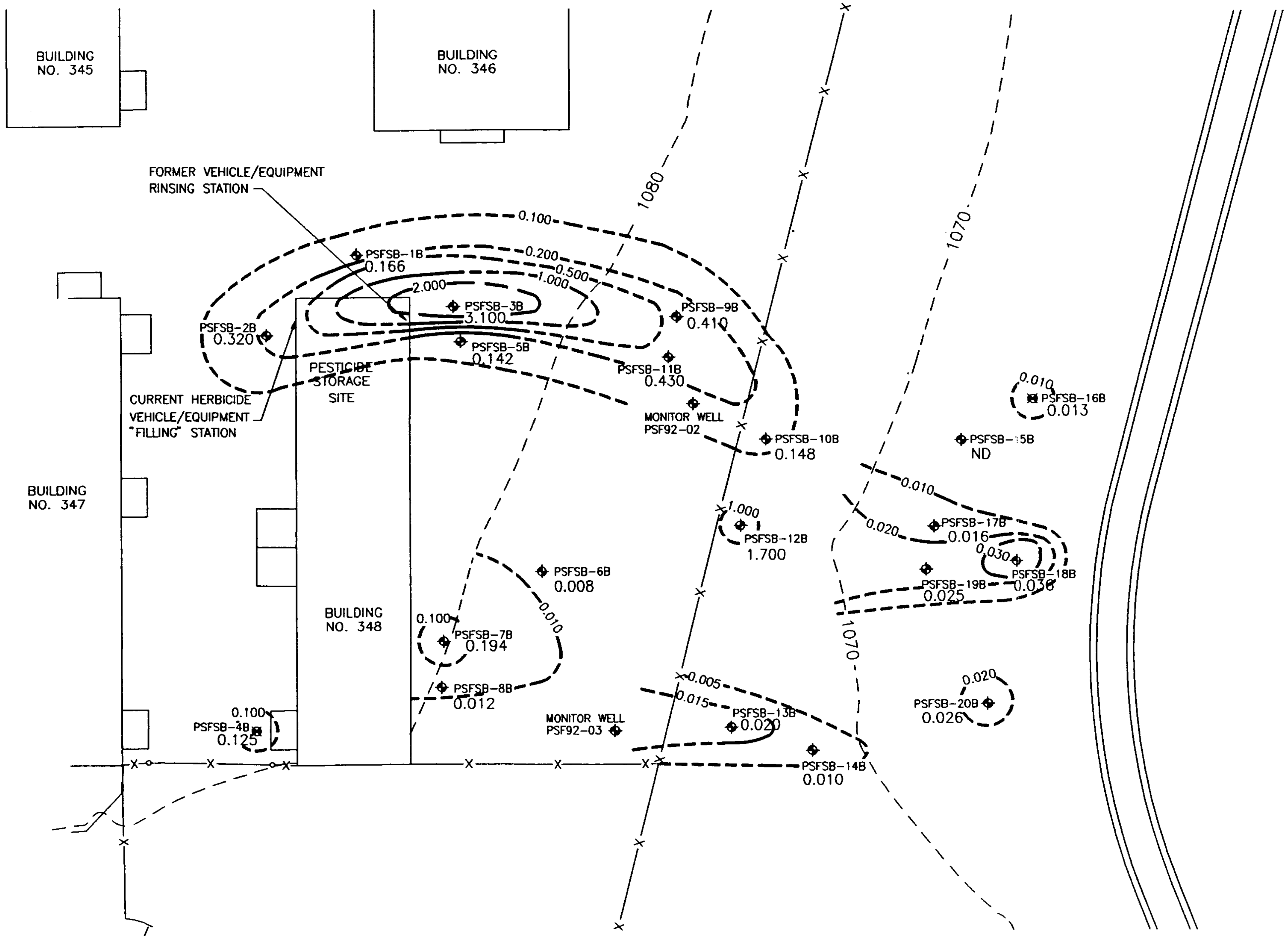
FILENAME: 11X17.DWG
LAYER: DDTC35-45

LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

FIGURE 2-20

TOTAL CHLORDANE CONCENTRATIONS FROM SOIL BORINGS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 3.5 – 4.5 FT.



LEGEND

- ◆ SAMPLING LOCATION
- PSFSB-2 SOIL BORING (HAND AUGER)
- PSF92-02 MONITORING WELL BORING
- ND NOT DETECTED
- – 1070 – – TOPOGRAPHIC CONTOUR LINES (INTERVAL = 10 FEET)
- —X— FENCE
- LINED DRAINAGE DITCH
- —1.000– – INTERPOLATED CONTOUR LINES OF CHLORDANE CONCENTRATIONS

NOTE:

1. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/Kg)
2. SAMPLES COLLECTED IN MARCH/APRIL, 1992
3. CHLORDANE CONCENTRATIONS REPRESENT SUM ALPHA- AND GAMMA- CHLORDANE CONCENTRATIONS.

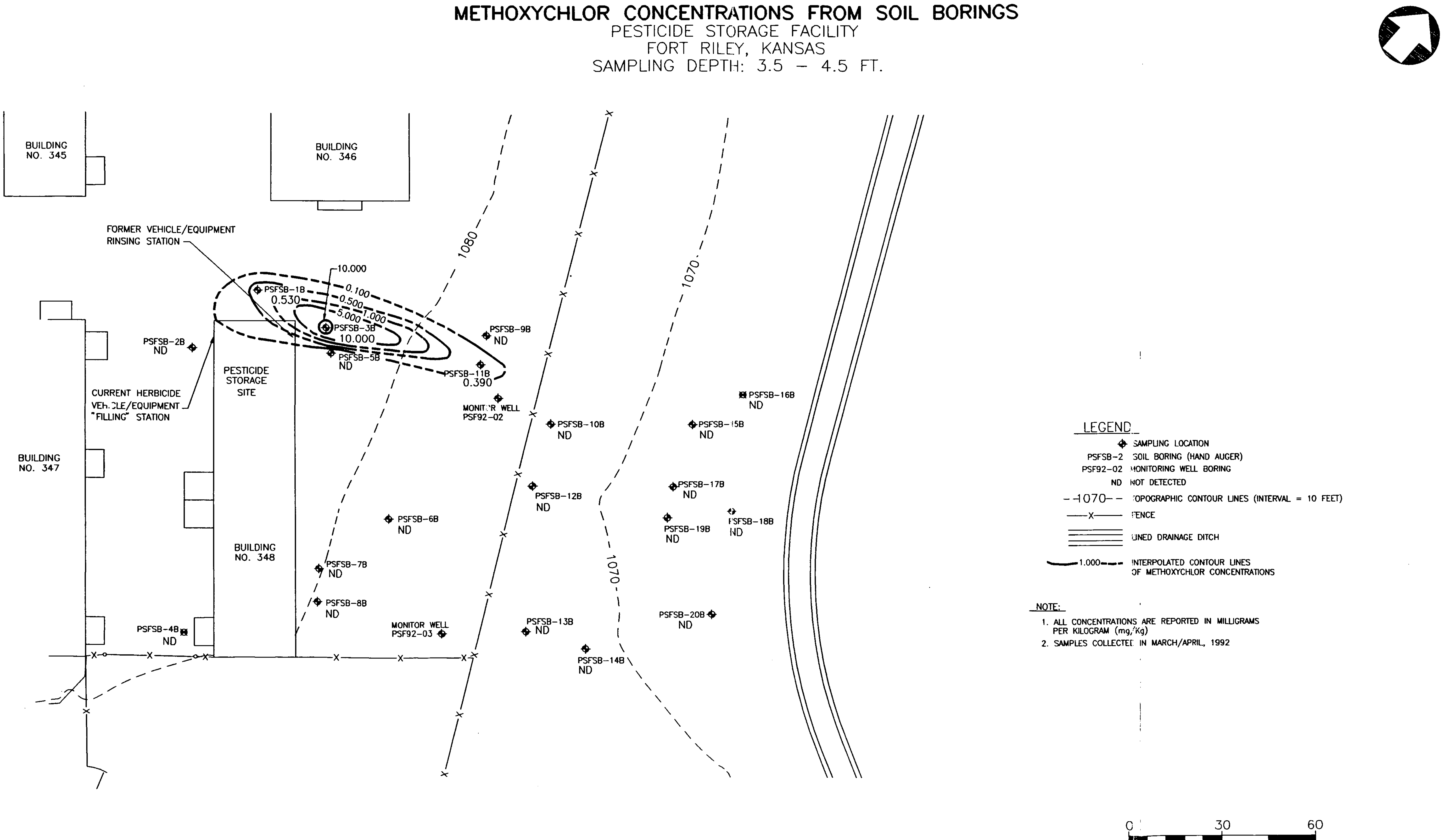
0 30 60
SCALE IN FEET

FILENAME: 11X17.DWG
LAYER: CC35-45

LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

Figure 2-20

FIGURE 2-21
METHOXYCHLOR CONCENTRATIONS FROM SOIL BORINGS
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 3.5 – 4.5 FT.



FILENAME: 11X17.DWG
LAYER: methc35-45

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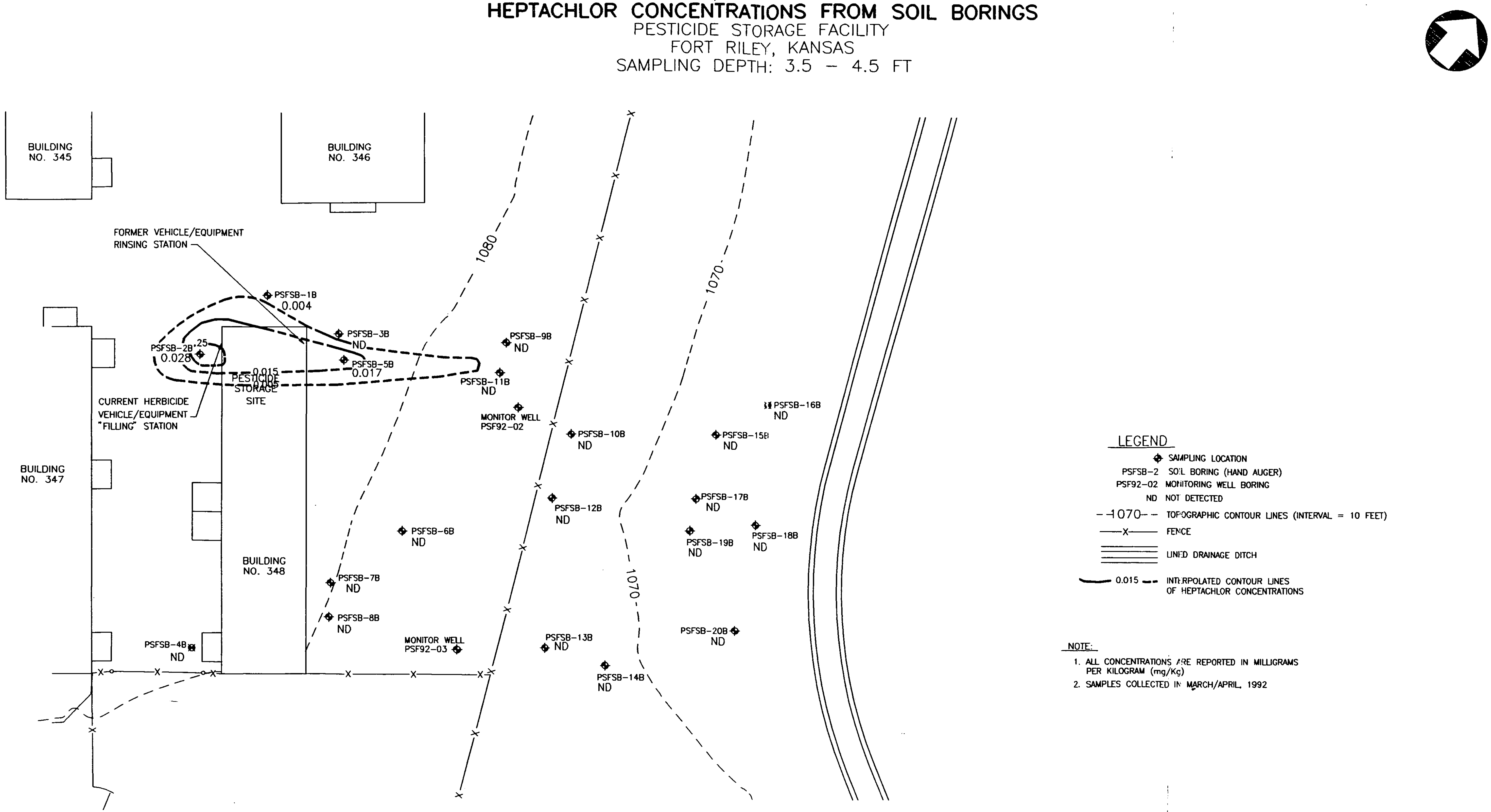
GOVERNMENT SERVICES BRANCH

FIGURE 2-22
HEPTACHLOR CONCENTRATIONS FROM SOIL BORINGS
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 3.5 – 4.5 FT



FILENAME: 11X17.DWG
LAYER: HEPTC35-45

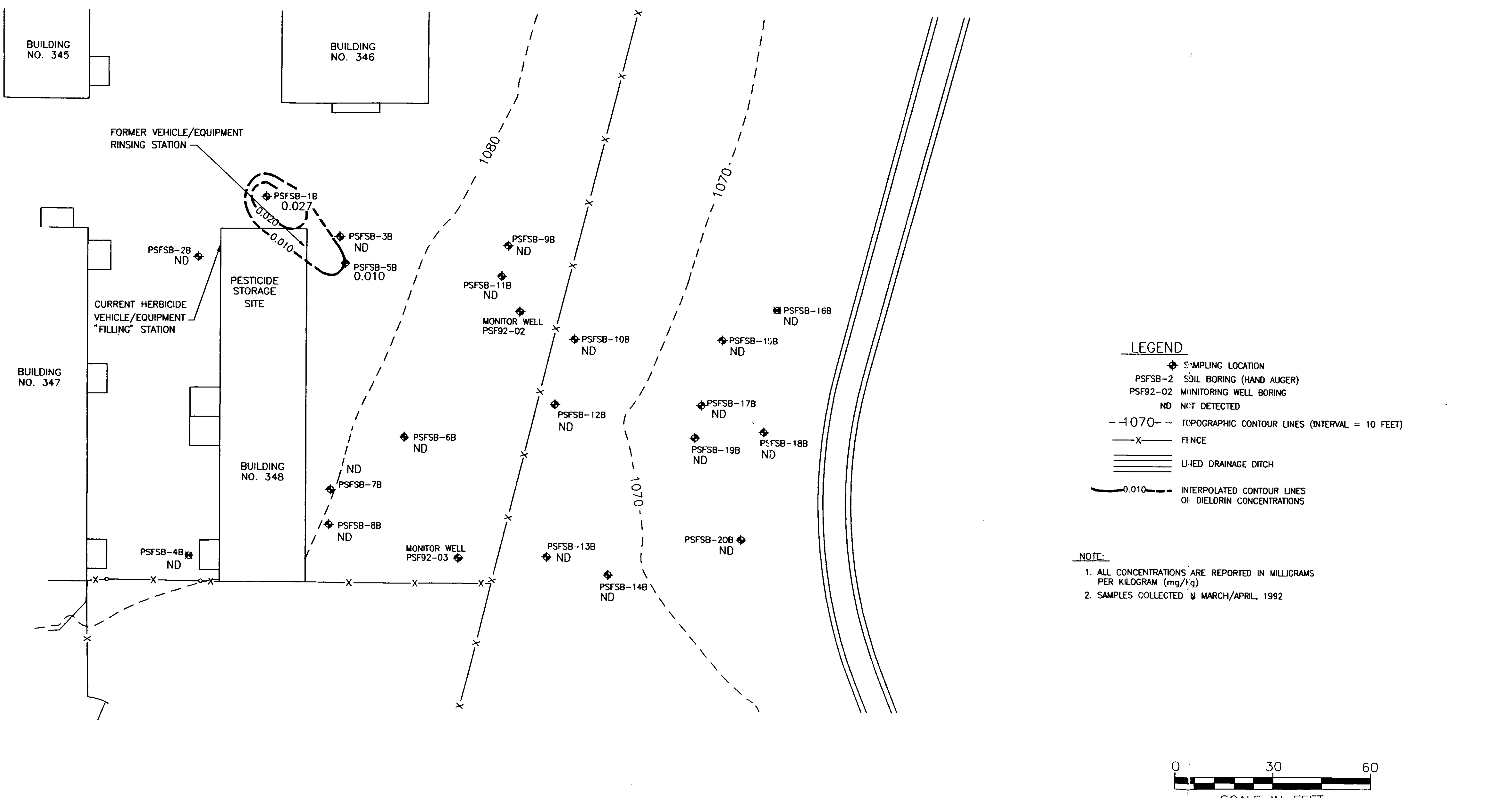
LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

Figure 2-22

FIGURE 2-23

DIELDRIN CONCENTRATIONS FROM SOIL BORINGS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 3.5 – 4.5 FT.



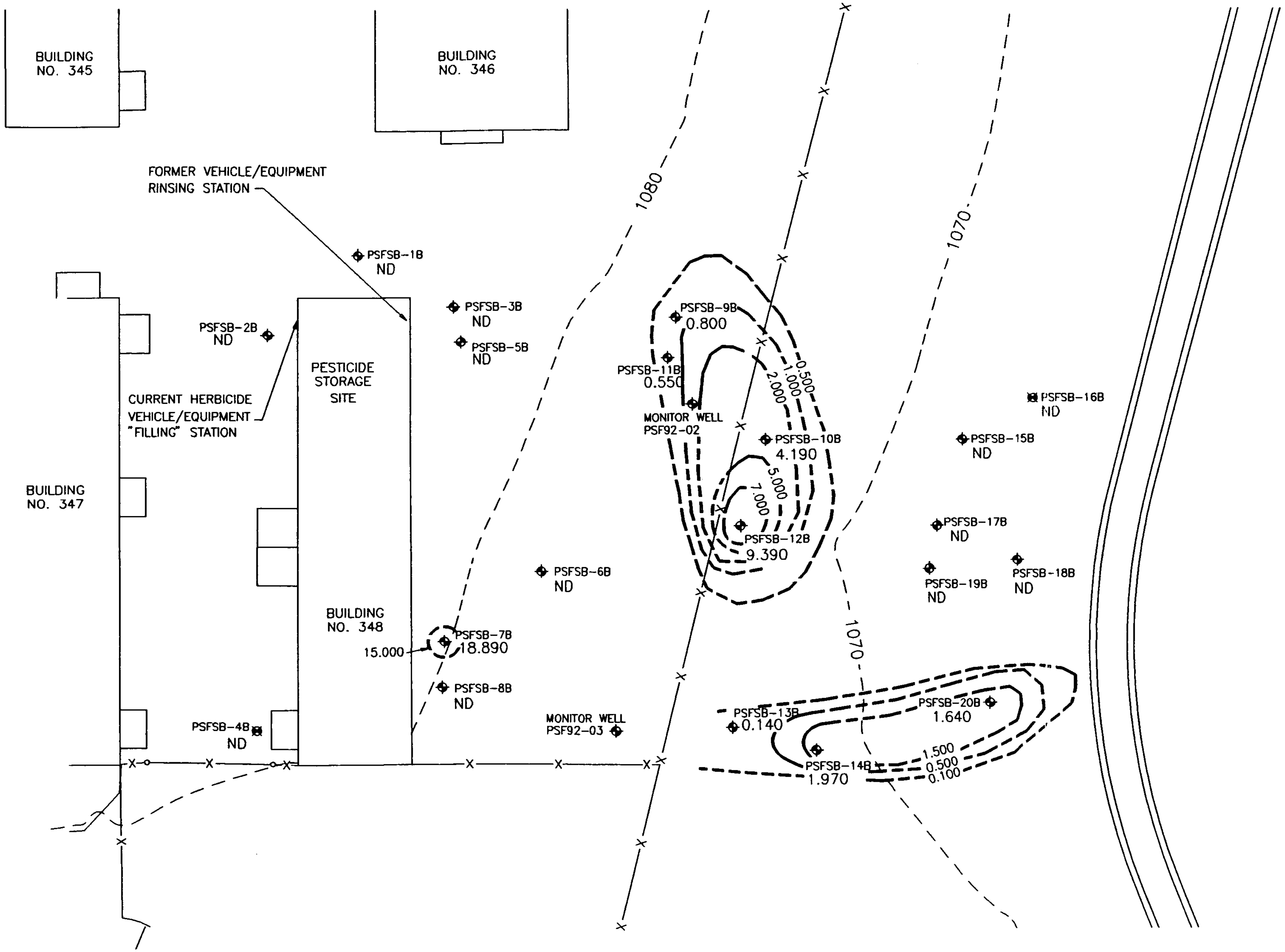
LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

Figure 2-23

FIGURE 2-24

TOTAL PAH CONCENTRATIONS FROM SOIL BORINGS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS
SAMPLING DEPTH: 3.5 – 4.5 FT



LEGEND

- ◆ SAMPLING LOCATION
- PSFSB-2 SOIL BORING (HAND AUGER)
- PSF92-02 MONITORING WELL BORING
- ND NOT DETECTED
- – –1070– – TOPOGRAPHIC CONTOUR LINES (INTERVAL = 10 FEET)
- —x— FENCE
- LINED DRAINAGE DITCH
- —1.000– – INTERPOLATED CONTOUR LINES OF TOTAL PAH CONCENTRATIONS
- PAH POLYNUCLEAR AROMATIC HYDROCARBON

NOTE:

1. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/Kg)
2. SAMPLES COLLECTED IN MARCH/APRIL, 1992
3. PAHs DETECTED IN 3.5 – 4.5 FT SAMPLING DEPTH INCLUDED ACENAPHTHENE, ANTHRACENES, CHRYSENE, FLUORANTHENES, NAPHTHALENE, PHENANTHRENE AND PYRENES.

0 30 60
SCALE IN FEET

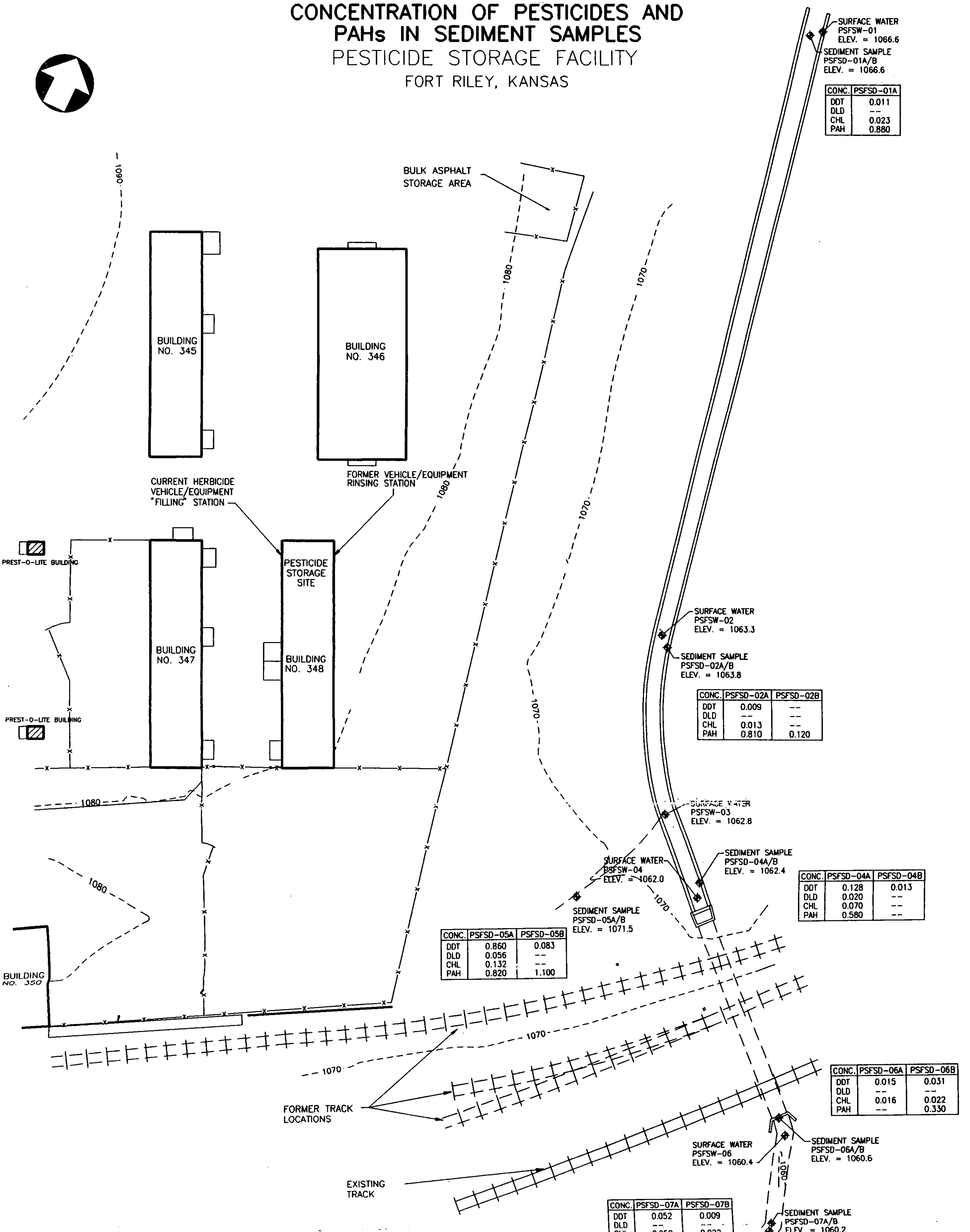
FILENAME: 11X17.DWG
LAYER: TOTALPAHC35-45

LAW ENVIRONMENTAL INC.
GOVERNMENT SERVICES BRANCH

Figure 2-24

FIGURE 2-25
CONCENTRATION OF PESTICIDES AND PAHs IN SEDIMENT SAMPLES
PESTICIDE STORAGE FACILITY

FORT RILEY, KANSAS



CONC.	PSFSD-01A
DDT	0.011
DLD	--
CHL	0.023
PAH	0.880

CONC.	PSFSD-02A	PSFSD-02B
DDT	0.009	--
DLD	--	--
CHL	0.013	--
PAH	0.810	0.120

CONC.	PSFSD-04A	PSFSD-04B
DDT	0.128	0.013
DLD	0.020	--
CHL	0.070	--
PAH	0.580	--

CONC.	PSFSD-05A	PSFSD-05B
DDT	0.860	0.083
DLD	0.056	--
CHL	0.132	--
PAH	0.820	1.100

CONC.	PSFSD-06A	PSFSD-06B
DDT	0.015	0.031
DLD	--	--
CHL	0.016	0.022
PAH	--	0.330

CONC.	PSFSD-07A	PSFSD-07B
DDT	0.052	0.009
DLD	--	--
CHL	0.050	0.022
PAH	[illegible]	[illegible]

CONC.	PSFSD-09A	PSFSD-09B
DDT	0.040	0.017
DLD	--	--
CHL	0.035	0.031
PAH	1.560	1.140

NOTES:

1. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg).
2. SAMPLES COLLECTED IN MARCH/APRIL, 1992. (SAMPLES PSFSD-09A AND PSFSD-09B COLLECTED JULY 16, 1992).
3. THE SAMPLES WERE COLLECTED FROM SURFACE TO ONE FOOT (PSFSD-01A, PSFSD-02A, etc.) AND ONE FOOT TO TWO FEET (PSFSD-01B, PSFSD-02B etc.) BELOW GROUND LEVEL.
4. DDT CONCENTRATION REPRESENTS TOTAL CONCENTRATION OF DDT AND ITS METABOLITES (DDE AND DDD)
5. CHLORDANE CONCENTRATIONS REPRESENT SUM OF ALPHA- AND GAMMA- CHLORDANE CONCENTRATIONS.
6. PAH CONCENTRATION REPRESENTS TOTAL PAHs DETECTED.
7. THIS MAP DISPLAYS POSITIVE CONCENTRATIONS OF CONTAMINANTS ONLY (NON-DETECT READINGS ARE NOT SHOWN)

LEGEND

- ◆ SAMPLING LOCATION
- ELEV=1082.9 ELEVATION OF GROUND SURFACE AT SAMPLING LOCATION IN FEET ABOVE SEA LEVEL
- — —1070— — TOPOGRAPHIC CONTOUR LINES (SEE FIGURE 4-6) (INTERVAL=10 FEET)
- —x— FENCE
- RAILROAD TRACKS
- LINED PORTION OF DRAINAGE DITCH
- PAH POLYNUCLEAR AROMATIC HYDROCARBON
- DLD DIELDRIN
- CHL CHLORDANE

0 50 100

SCALE IN FEET

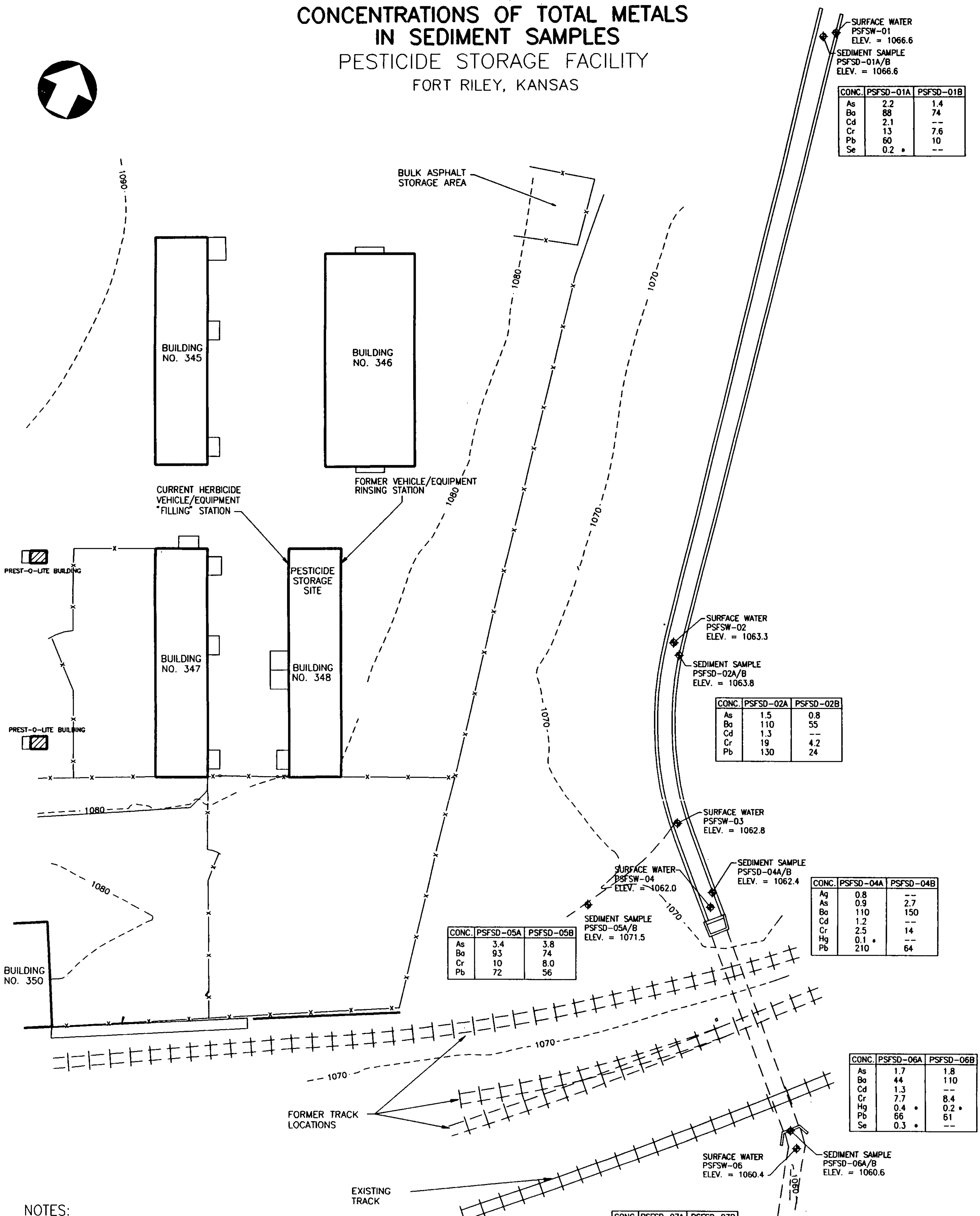
filename: sd-loc.dwg

layer: pesticides-pah

LAW ENVIRONMENTAL INC.

GOVERNMENT SERVICES BRANCH

FIGURE 2-26
CONCENTRATIONS OF TOTAL METALS IN SEDIMENT SAMPLES
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



CONC.	PSFSD-01A	PSFSD-01B
As	2.2	1.4
Ba	88	74
Cd	2.1	--
Cr	13	7.6
Pb	60	10
Se	0.2 •	--

CONC.	PSFSD-02A	PSFSD-02B
As	1.5	0.8
Ba	110	55
Cd	1.3	--
Cr	19	4.2
Pb	130	24

CONC.	PSFSD-04A	PSFSD-04B
Ag	0.8	--
As	0.9	2.7
Ba	110	150
Cd	1.2	--
Cr	25	14
Hg	0.1 •	--
Pb	210	64

CONC.	PSFSD-05A	PSFSD-05B
As	3.4	3.8
Ba	93	74
Cr	10	8.0
Pb	72	56

CONC.	PSFSD-06A	PSFSD-06B
As	1.7	1.8
Ba	44	110
Cd	1.3	--
Cr	7.7	8.4
Hg	0.4 •	0.2 •
Pb	66	61
Se	0.3 •	--

CONC.	PSFSD-07A	PSFSD-07B
As	1.4	1.4
Ba	76	52
Cr	9.4	6.1
Hg	0.1 •	--
Pb	24	15

CONC.	PSFSD-09A	PSFSD-09B
As	2.6	2.5
Ba	97	130
Cd	1.9	3.3
Cr	14	17
Hg	--	0.4
Pb	88	140
Se	0.2 •	0.3 •

NOTES:

1. ALL CONCENTRATIONS ARE REPORTED IN MILLIGRAMS PER KILOGRAM (mg/Kg)
2. SAMPLES COLLECTED IN MARCH/APRIL, 1992 (SAMPLES PSFSD-09A AND PSFSD-09B COLLECTED JULY 16, 1992).
3. THE SAMPLES WERE COLLECTED FROM THE SURFACE TO ONE FOOT (PSFSD-01A, PSFSD-02A, etc.) AND ONE FOOT TO TWO FEET (PSFSD-01B, PSFSD-02B, etc.) BELOW GROUND LEVEL
4. THIS MAP DISPLAYS POSITIVE CONCENTRATION OF METALS ONLY (NON-DETECT READINGS ARE NOT SHOWN)

LEGEND

◆ SAMPLING LOCATION

ELEV=1082.9 ELEVATION OF GROUND SURFACE AT SAMPLING LOCATION IN FEET ABOVE SEA LEVEL

— —1070— — TOPOGRAPHIC CONTOUR LINES (SEE FIGURE 4-6) (INTERVAL=10 FEET)

—x— FENCE

RAILROAD TRACKS

LINED PORTION OF DRAINAGE DITCH

Ag SILVER
As ARSENIC
Ba BARIUM
Cd CADMIUM
Cr CHROMIUM
Hg MERCURY
Pb LEAD
Se SELENIUM
• RESULT IS AN ESTIMATED VALUE

0 50 100
SCALE IN FEET

filename: sd-loc.dwg
layer: metals

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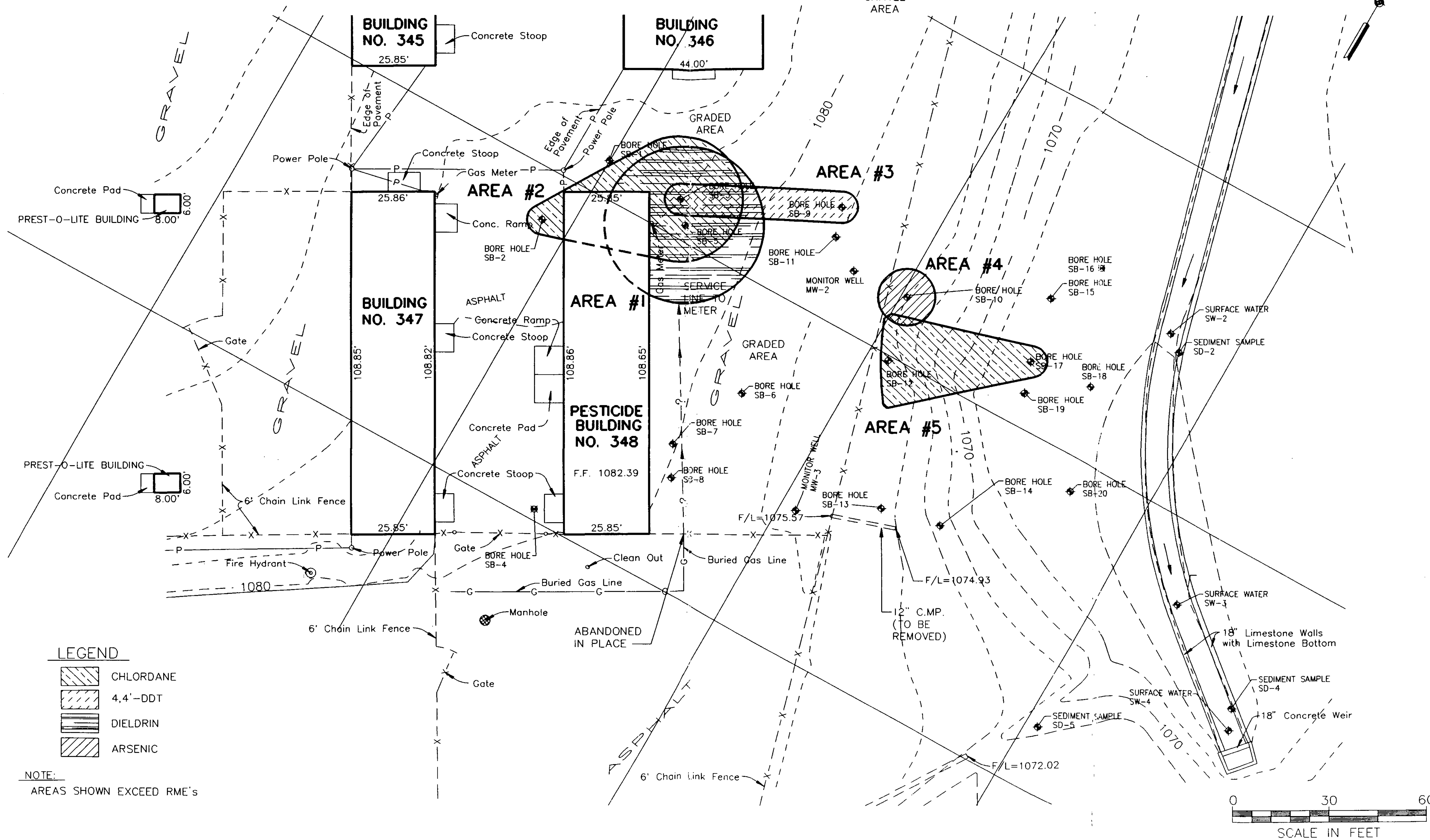
GOVERNMENT SERVICES BRANCH

FIGURE 4-1

AREAS OF CONTAMINATION

FORT RILEY FEASIBILITY STUDY DISCUSSION PAPER
PESTICIDE STORAGE FACILITY



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FILENAME: G:/FT-RILEY/00-cont.DWG

Figure 4-1

FIGURE 4-2

ALTERNATIVE 3 (GRADING)

FORT RILEY FEASIBILITY STUDY
PESTICIDE STORAGE FACILITY

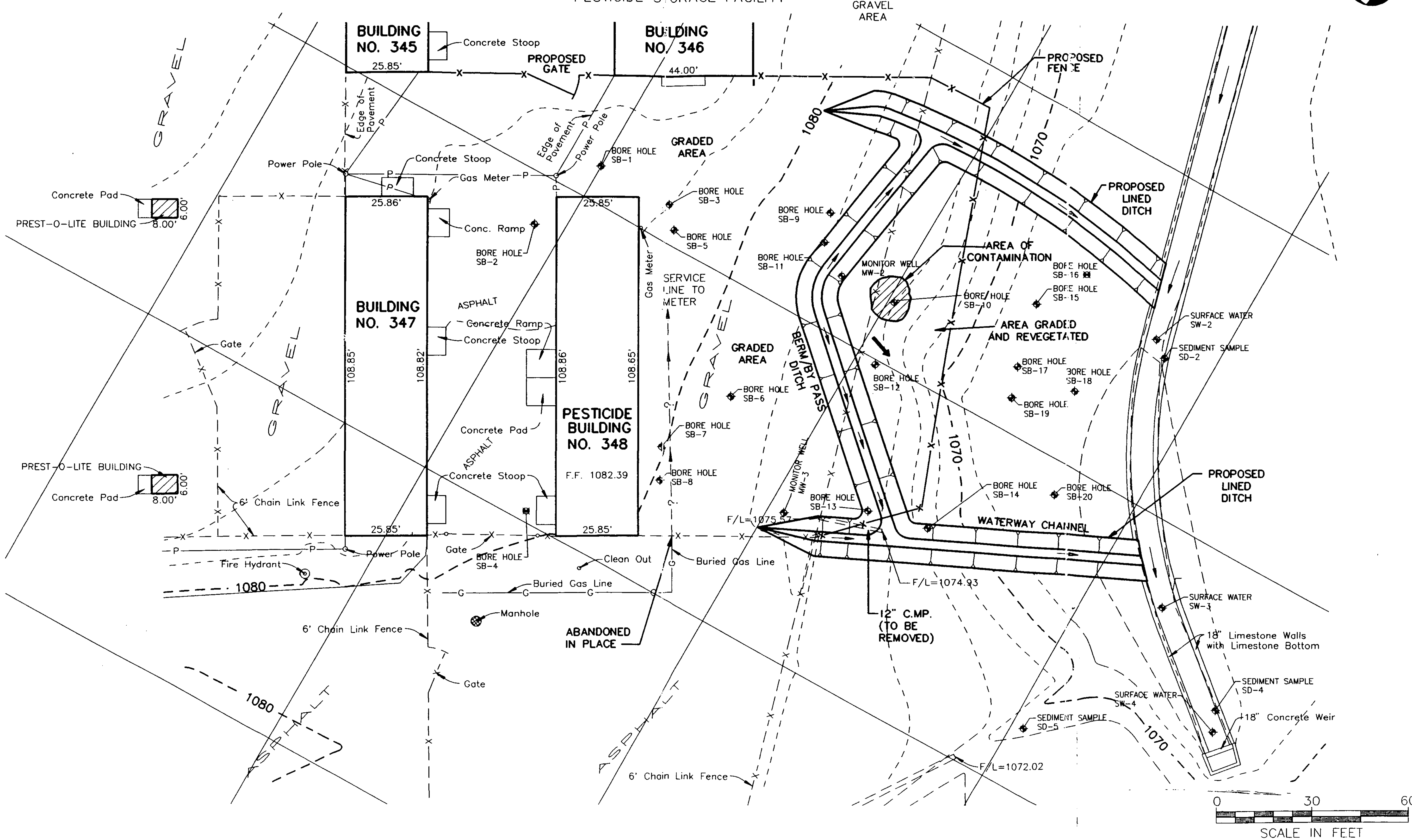
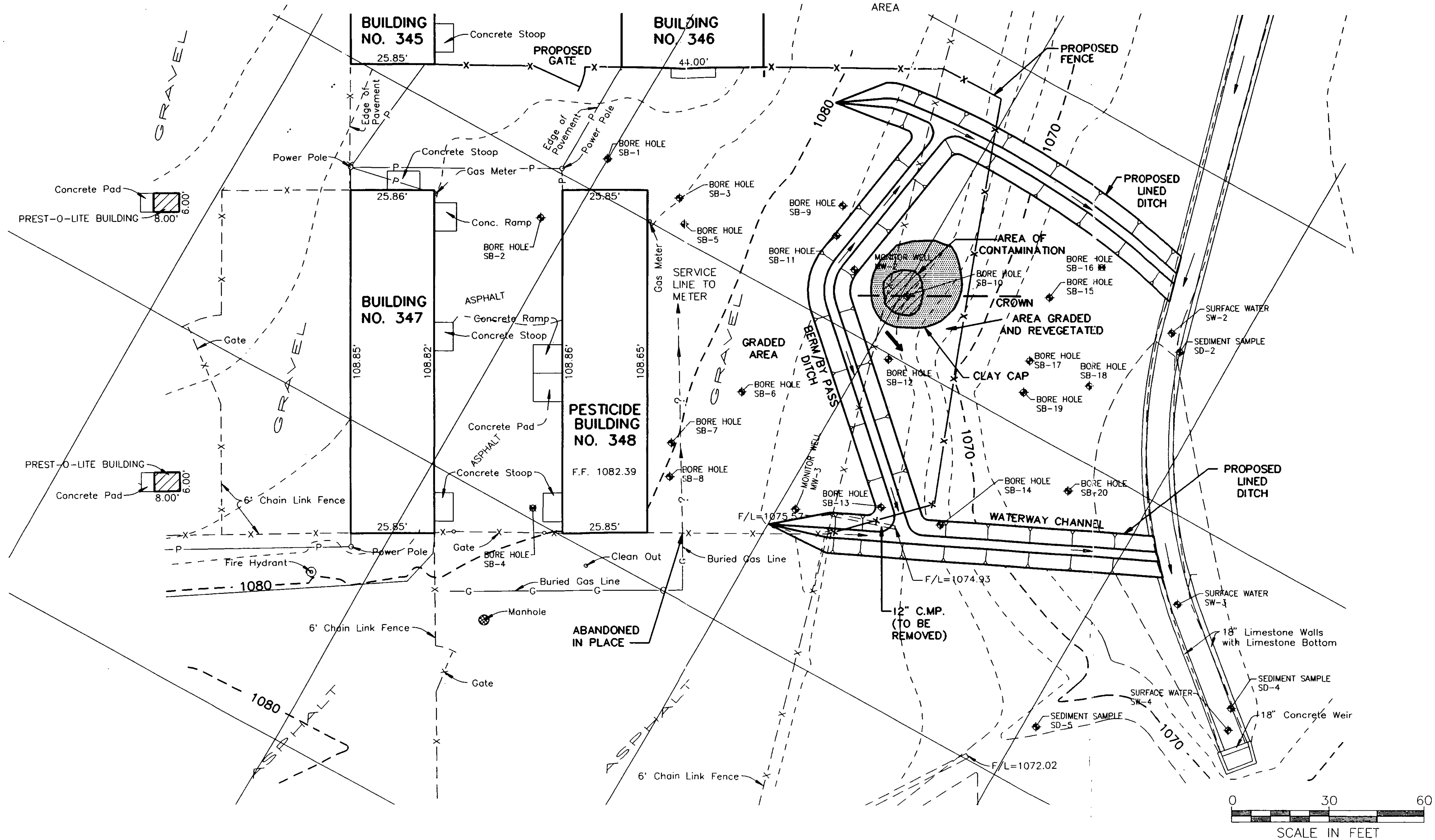


FIGURE 4-3

ALTERNATIVE 4 (CLAY CAP/GRADING)

FORT RILEY FEASIBILITY STUDY
PESTICIDE STORAGE FACILITY



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FILENAME: G:/FT-RILEY/ALTERN-4.DWG

FIGURE 4-3

ALTERNATIVE 4 (ASPHALT COVER)

FORT RILEY FEASIBILITY STUDY DISCUSSION PAPER
PESTICIDE STORAGE FACILITY

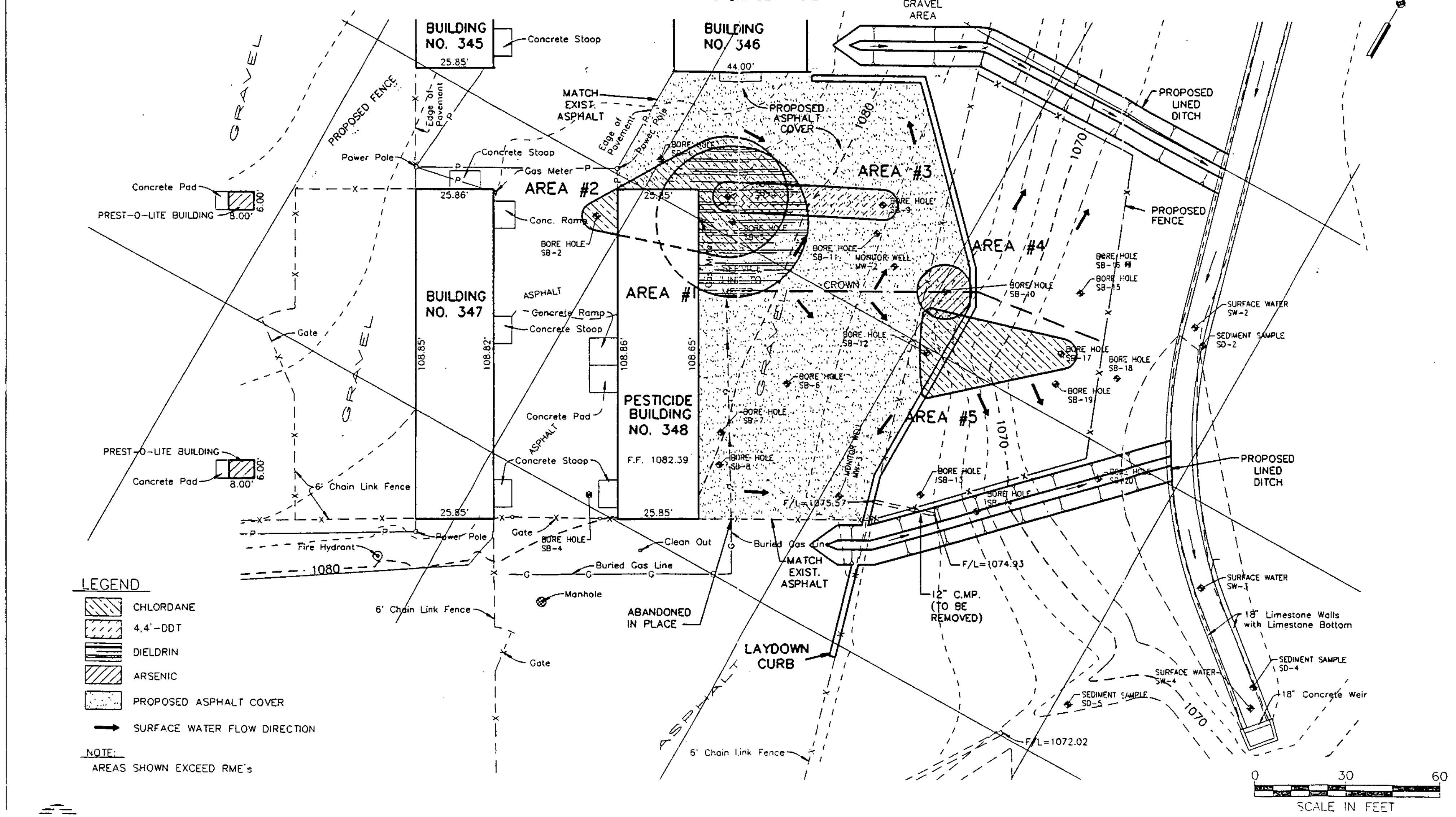
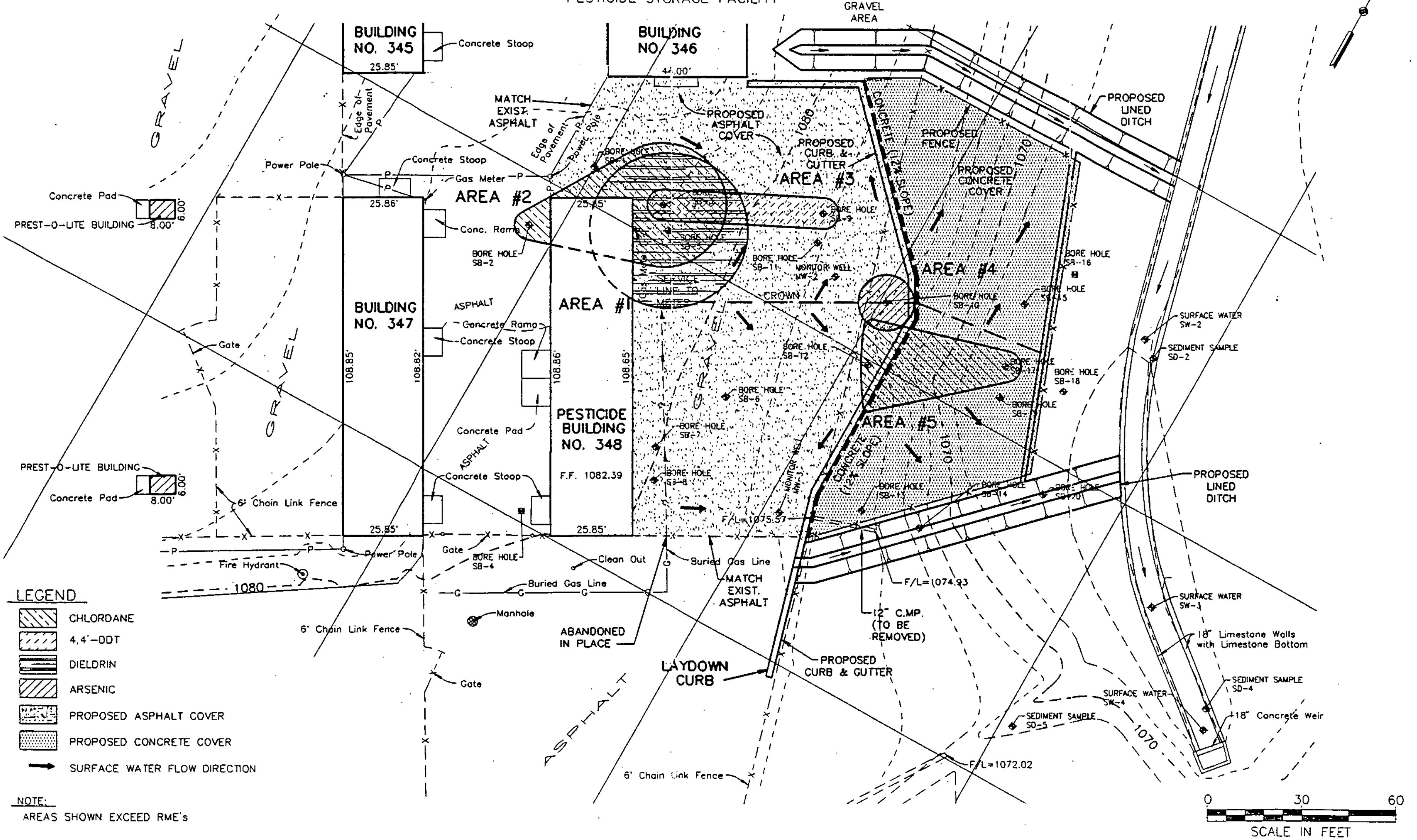


FIGURE 4-4

ALTERNATIVE 5 (ASPHALT/CONCRETE COVER)

FORT RILEY FEASIBILITY STUDY DICUSSION PAPER
PESTICIDE STORAGE FACILITY



LAW ENVIRONMENTAL INC.

10.0 TABLES

Table 2-1

ANALYTICAL RESULTS - GEOTECHNICAL SAMPLES
Pesticide Storage Facility
Fort Riley, Kansas

WELL NO/ SAMPLE DEPTH	% SAND	% SILT	% CLAY	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIFIED SOIL CLASSIFICATION
PSF92-01 GT/ 7' - 9'	46.0	46.0	8.0	26	18	8	CL
PSF92-01 GT/ 25' - 27'	27.0	62.0	11.0	27	18	9	CL
PSF92-02 GT/ 2' - 4'	19.5	60.0	20.5	19	19	N.P.	SC
PSF92-02 GT/ 22' - 24'	82.5	13.0	4.5	NR	NR	N.P.	SC
PSF92-03 GT/ 2' - 4'	12.5	67.5	20.0	35	22	13	CL
PSF92-03 GT/ 20' - 22'	17.0	69.5	13.5	24	18	6	CL
PSF92-04 GT/ 2' - 4'	69.5	25.0	5.5	15	15	N.P.	SC
PSF92-04 GT/ 22' - 24'	12.0	80.0	8.0	24	21	3	ML
PSF92-05 GT/ 3' - 5'	56.0	35.0	9.0	22	18	4	SC
PSF92-05 GT/ 17' - 19'	61.0	33.5	5.5	NR	NR	N.P.	SC

NOTES: CL = Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
SC = Clayey sands, sand-clay mixtures.
ML = Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity.
GT = Geotechnical
NP = Non Plastic
NR = Not Reported

Source: Unified Soil Classification System

Table 2-2

PESTICIDES COMMONLY AVAILABLE FOR USE
Army/DOD Facilities
1971

	PESTICIDE	STOCK NO.
Insecticides:		
	Aluminum phosphide, tablets	6840-145-0016
	Aluminum phosphide, pellets	6840-442-5698
	Baygon, 1% solution	6840-180-6069
	Baygon, 2% bait	6840-498-4057
	Carbaryl, 80% powder	6840-932-7297
	Carbaryl-DDT, micronized dust***	6840-180-6141
	Carbaryl-DDT, micronized dust***	6840-180-6142
	Carbaryl-DDT, micronized dust***	6840-180-6143
	Chlordane, 72% emulsifiable concentrate	6840-270-8262
	Chlordane, 5%-6% dust	6840-543-7825
	Diazinon, 2% dust	6840-753-5038
	Diazinon, 0.5% solution	6840-844-7355
	Diazinon, 48% emulsifiable concentrate	6840-782-3925
	Dieldrin, 15% emulsifiable concentrate	6840-264-9043
	DDT, 25% emulsiviable concentrate	6840-246-6432
	DDT, 75% wettable powder	6840-264-6692
	DDT-Pyrethrum aerosol, G-1152*	6840-766-9631
	Dichlorovos, 20% impregnated pellets	Not yet assigned
	Dichlorovos, 20% impregnated strips	Not yet assigned
	Dursban, 40.8% emulsifiable concentrate	Not yet assigned
	Lindane, 12% emulsifiable concentrate	6840-242-4213
	Lindane, 1% dusting powder	6840-242-4217
	Lindane, 1% dusting powder**	6840-242-4219
	Malathion, 57% emulsifiable concentrate, Grade A	6840-655-9222
	Malathion, 57% emulsifiable concentrate, Grade B	6840-685-5437
	Malathion, 57% emulsifiable concentrate, Grade A	6840-685-5438
	Malathion, 95% solution concentrate	6840-926-1481
	Methyl bromide, 98%	6840-680-0142
	Methyl bromide, 98%	6840-823-7946
	Naled, 85% solution concentrate	6840-926-9163
	Pyrethrum, 0.6% aerosol	6840-823-7849
	Pyrethrum, 0.4% solution	6840-400-2140
Herbicides:		
	Borate-Bromacil mixture	6840-027-6467
	Bromacil, 80% powder	6840-890-2146
	Cacodylic Acid (Blue) ****	6840-926-9094
	Chlorate-Borate mixture	6840-684-8975
	Dacthal, 75% powder	6840-681-9475
	Dalapon, 85% powder	6840-577-4204

Table 2-2 con't

PESTICIDES COMMONLY AVAILABLE FOR USE
Army/DOD Facilities
1971

	PESTICIDE	STOCK NO.
	Dicamba, 49% solution	6840-905-4304
	Diquat, 35.3% solution	6840-815-2799
	Diuron, 80% powder	6840-825-7790
	DSMA, 63% disodium methylarsonate	6840-965-2071
	Monuron, 80% powder	6840-514-0644
	Picloram + 2,4-D	6840-629-1638
	Picloram + 2,4-D, (White) ****	6840-926-9093
	Picloram, 11.6% pellets	6840-990-1464
	Silvex, Low Volatile Ester	6840-882-4810
	Simazinc, 80% powder	6840-814-7334
	2,4-D, Low Volatile Ester	6840-577-4194
	2,4-D, Amine	6840-664-7060
	2,4,5-T, Low Volatile Ester	6840-577-4201
	2,4,5-T, Low Volatile Ester	6840-582-5440
	2,4-D + 2,4,5-T, High Volatile Ester (Orange)****	6840-926-9095
Repellents:		
	Clothing and personal application, 75% DEET	6840-935-0984
	Clothing and personal application, 75% DEET	6840-753-4963
	Clothing and personal application, 75% DEET	6840-935-0984
Rodenticides:		
	Anticoagulant, Ready mixed bait	6840-753-4973
	Anticoagulant, Universal concentrate	6840-753-4972
	Bait block, diaphacin	6840-089-4664
	Calcium cyanide, 42% powder	6840-246-6436
	Zinc phosphide, 80% powder	6840-285-7091
Fungicide:		
	Pentachlorophenol, 5% moisture retardant	8030-634-7970
Soil Fumigant:		
	SMDC (VAPAM) 32.7% solution	Not yet assigned

* For disinsectization of aircraft in compliance with Public-Health Quarantine.
** For use in control of body lice.
*** For disinsection of aircraft in compliance with Agricultural Quarantine.
**** For tactical purposes, not for base-type pest control operations
Source: Military Entomology Operational Handbook, December 1971.

Table 2-3

INVENTORY OF PESTICIDE STORAGE FACILITY IN 1979 (BUILDING 348)
Fort Riley, Kansas

PESTICIDE-PERCENT	REGISTRATION NO.	QUANTITY
aluminum phosphide 55% Phostoxin®	EPA 5857-1	4 cans
benfluralin 2.5% Balan® granular	EPA 1471-62-AC	1480 lb
bromacil 80% Hyvar X®	EPA 352-287-AA	150 lb
carbaryl 80% Sevin®	EPA 1016-43	15 lb
chlorobenzilate 45.5%	USDA 100-458	2.5 gal
chlorpyrifos 40.8%	USDA 464-368	1 gal
chlorpyrifos 10.6% Dursban® 10 CR	EPA 464-517	75 lb
copper 12.75% Bordeaux Mixture	USDA 577-97	4 lb
copper 12.5%	Unknown	8 lb
DCPA 75% Dacthal®W75	EPA 677-166-AA	168 lb
DDT 5%	Unknown	160 gal
diazinon 2%	EPA 6830-19	575 lb
diazinon 47.79%	EPA 7273-131	2 gal
dichlobenil 4% Casoron G-4®	EPA 148-614	150 lb
DSMA 66.6%	EPA 2853-13	300 lb
indandione 0.5%	EPA 255-69	2 lb
malathion 57%	EPA 551-131	20 gal
malathion 95%	EPA 241-76	190 gal
maneb 80% Manzat®D	USDA 352-291	12 lb
methoxychlor 25%	USDA 5602-86	30 gal
monuron 32.25% Urox Liquid®	USDA 218-439	15 gal
norbormide 0.92% Raticate®	Unknown	10 oz
oil 97% Volck® Oil Spray	EPA 239-16	11 qt
pentachlorophenol 5%	Unknown	30 gal
pyrethrins 3% Micro-gen BP 300®	EPA 11540-1	.75 gal
resmethrin 1%		
Prescription Treatment No. 110®	EPA 499-160-AA	52.5 lb
resmethrin 0.5%		
Prescription Treatment No. 140®	EPA 499-166-AA	18 lb
rotenone 2.5% Pro-Nox Fish®	USDA 432-171	2 gal
silvex 63%	EPA 264-289	110 gal
silvex 69.2% KURON®	EPA 464-162-AA	1 gal
simazine 80% Aquazine®	EPA 100-437	5 lb
2,2 Dichloropropionic Acid 74%		
Dowpon®	EPA 464-164	50 lb
2,2-Dichloroproionic Acid 85%		
Dalapon® Grass Killer	EPA 2749-52	200 lb
2,4-D Amine 49.3%	EPA 2217-633-AA	110 gal
2,4-D 49.3% DMA 4®	EPA 464-196	364 gal
2,4-D 39.6%	USDA 218-439	40 gal

Sources: Installation Pest Management Program Review No. 16-66-0502-80, Fort Riley, Kansas, 1979.
AEHA, 1979

Note: Military Army Regulation 420-76

Table 2-4

INVENTORY OF PESTICIDE STORAGE FACILITY IN 1983 (BUILDING 348)
Fort Riley, Kansas

PESTICIDE	REGISTRATION NO.	QUANTITY
Balan	EPA 1471-62-AC	281 kg
Hyvar-X "Bromacil"	EPA 352-287-AA	272 kg
Casoron	EPA 148-614	57 kg
Chemweed-265	EPA 1769-122-AA	26 l
Dacthal W-75	EPA 677-166-AA	45 kg
Dalapon 85	EPA 677-358-ZA	41 kg
2,4-D "Amine"	EPA 39511-64-34704	946 l
2,4-D "Amine"	EPA 2217-633-AA	568 l
2,4-D "Amine" DMA-4	EPA 464-196	8 l
2,4,5-TP "Silvex"	EPA 264-289	53 l
Disodium Methanearsonate 63%	EPA 677-289-AA	45 kg
Embark-25	EPA 7182-7-AA	155 l
Ronstar G	EPA 359-659	907 kg
Round-Up Glyphosate	EPA 524-308-AA	34 l
Simazine 80W	EPA 2749-163-34704	23 kg
Verton-2-D	*	19 l
MH 30T "Malichydrazide"	*	227 l
Bordeaux "Fungicide"	*	4 kg
BP 300 Pyrethins	EPA 4540-1	2 kg
Sevin "Carbaryl" 80%	EPA 264-318	694 kg
Chlordane 72%	EPA 876-63-AA	11 l
Chlordane 46%	EPA 7122-3	4 kg
Chlorobenzilate	Cont. No. 89545 601-403-1	9 l
Diazinon-D-Tox-4E	EPA 551-220	42 l
Diazinon 2% "Powder Form"	EPA 6830-19	175 kg
Dursban 10CR	EPA 464-517	68 kg
Gopher Bait "Mild-Maize"	EPA 8612-97	7 kg
Fungicide Manzate "D"	U.S. Reg. 352-291	5 kg
Methoxychlor 25% E	USDA 5602-86	20 l
Malathion 57%	EPA 551-131	208 l
"Fumigant" Phostoxin	EPA 5857-1	630 tablets
PT-140 Resmethrin	EPA 499-166-AA	82 kg
PT-10 Resmethrin	EPA 499-160-AA	79 kg
Pro-Noxfish "Rotenone"	USDA 432-171	7 kg
Wasp Freeze PT-515	EPA 499-153-ZB	36 kg
Copper Sulfate	*	23 kg
Ferrous Sulfate	*	69 kg
Warfarin Rodenticide Bait	EPA 6830-25	3 kg
Daconil 2787	EPA 677-315-2A	76 l
I.O. Teen Detergent Disinfectant	EPA 267-152	19 l

2,4,5-TP = 2,4,5-trichlorophenoxy propionic acid.
USDA = U.S. Department of Agriculture

*Label torn or illegible

Sources: Fort Riley Directorate of Facilities Engineering, 1983.
ESE, 1984

Table 2-5 ...

CHEMICAL INVENTORY - BUILDING 348
Pesticide Storage Facility
Fort Riley, Kansas
December, 1991

DESCRIPTION	AMOUNT	DESCRIPTION	AMOUNT
24D Amine	90 gals		
Banvil	25 gals		
Simazine (Pricep 80W)	735 lbs		
Crop Oil	195.5 gals		
Dachthal W 75	216.5 lbs	Diazinon 2% Dust	375 lbs
Diuron 80%	1050 lbs		
D.-Phenophrin 2%	36-12 oz cans		
Dursban 10 CR	200 lbs		
Embark 25	24 gals		
Hyvar X	1000 lbs		
Malathion 57%	41 gals		
M.S.M.A.	18 gals	Norosac 10 G	125 lbs
P.T 140 Resmethrin	45 lbs		
Round Up	37.5 gals		
Rodeo	12.5 gals	Roach Bait "Combat"	
Sevin 80%	95 bags		
Strychnine Alkaloid	0		
Spike 40P	80 lbs		
Spike 20P	20 lbs		
Surflan A.S.	99 gals	Sequestrine	
Tordon R.T.U.	5 gals		
Weedone 170	21 gals		
Waspfreeze P.T. 515	12-14 oz		
Wasp & Hornet Freeze	44-14 oz		
Volick Oil Spray	11 qts		
Ornamec	14 gals		

Source: Inventory sheet provided by the Senior Pesticide/Herbicide Program Manager, Dec. 1991.

Table 2-6

TO BE CONSIDERED CRITERIA FOR SOILS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

Parameter	Maximum Detected Concentration (Surface Soils) (mg/kg)	Maximum Detected Concentration (Subsurface Soils) (mg/kg)	RCRA Soil Action Level [b] (mg/kg)
alpha-Chlordane	1.6	1.5	0.5 [T] (boxed)
gamma-Chlordane	1.6	1.6	0.5 [T] (boxed)
4,4'-DDT	1 [b]	33	2 (boxed)
Dieldrin	0.094	0.2 [b]	0.04 (boxed)
Anthracene	-- [b]	0.76	--
Benzo[a]anthracene	0.16	1.8	--
Benzo[b]fluoranthene	-- [b]	1.4	--
Benzo[k]fluoranthene	-- [b]	1.2	--
Chrysene	0.45	1.7	--
Dibenzofuran	-- [b]	0.13	--
Indeno[1,2,3-cd]pyrene	-- [b]	0.38	--
2-Methylnaphthalene	--	0.08	--
Phenanthrene	0.78	2.7	--
Arsenic	16	120	80 (boxed)
Barium	130	160 [b]	4,000
Cadmium	-- [b]	5	40
Chromium	156	41	400 [c]
Lead	540	770	500 – 1000 [d]
Mercury	-- [b]	1.3	200

Boxed areas indicate exceedence of guidance criteria

-- Not detected at concentrations greater than or equal to the Method Detection Limit.

a RCRA Action Levels – Federal Register, Vol. 55, No. 145, 27 July, 1990. Pages 30798–30884. Corrective Action for Solid Waste Management Facilities, Proposed Rule.

b Not selected as a chemical of concern in this medium.

c Value is for hexavalent chromium.

d Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites. Memorandum from H. Longest and B. Diamond to EPA Regions. OSWER Directive No. 9355.4–02.

T Value is for total chlordane.

Table 2-7

COMPARISON OF CONSTITUENTS DETECTED IN SURFACE AND SUBSURFACE SOIL SAMPLES TO RCRA SOIL ACTION LEVELS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

Parameter	Exposure Point Concentration [a] (Surface Soils) (mg/kg)	Exposure Point Concentration [a] (Subsurface Soils) (mg/kg)	RCRA Soil Action Level [b] (mg/kg)
alpha-Chlordane	1.6	0.6	0.5 [T]
gamma-Chlordane	1.6	0.57	0.5 [T]
4,4'-DDT	1 [c]	3.9	2
Dieldrin	0.094	0.057 [c]	0.04
Anthracene	-- [c]	0.15	--
Benzo[a]anthracene	0.16	0.32	--
Benzo[b]fluoranthene	-- [c]	0.31	--
Benzo[k]fluoranthene	-- [c]	0.29	--
Chrysene	0.45	0.33	--
Dibenzofuran	-- [c]	0.065	--
Indeno[1,2,3-cd]pyrene	-- [c]	0.21	--
2-Methylnaphthalene	-- [c]	0.08	--
Phenanthrene	0.78	0.37	--
Arsenic	16	6.4	80
Barium	130	108 [c]	4,000
Cadmium	-- [c]	0.49	40
Chromium	15	9.7	400 [d]
Lead	540	149	500 - 1000 [e]
Mercury	--	0.13	200

Boxed areas indicate exceedence of guidance criteria
-- Not detected at concentrations greater than or equal to the Method Detection Limit.
a The 95% UCL (or maximum detected concentration if the 95% UCL > maximum concentration) of concentrations detected in the site samples.
b RCRA Action Levels - Federal Register, Vol. 55, No. 145, 27 July, 1990. Pages 30798-30884. Corrective Action for Solid Waste Management Facilities, Proposed Rule.
c Not selected as a chemical of concern in this medium.
d Value is for hexavalent chromium.
e Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites. Memorandum from H. Longest and B. Diamond to EPA Regions. OSWER Directive No. 9355.4-02.
T Value is for total chlordane.

Table 2-7a

Comparison of RCRA CALs to EPA (Standard) Risk Based Maximum Concentrations and Site Specific Remediation Goals Pesticide Storage Facility Fort Riley, Kansas

Contaminant of concern	RCRA CAL	EPA Region III * Max Risk Based Concentrations Occptnl	Residntl	PSF Future Site Worker RG's	PSF Future Utility Worker RG's
Arsenic	80	1.6	0.68	0.12	3.9
Chlordane	0.5	2.2	0.92	0.17	5.4
Dieldrin	0.04	0.18	0.08	0.014	0.44
DDT	2	8.4	3.5	0.66	20.8
Heptachlor	0.2	6.64	0.27	0.05	1.6
Methoxychlor	N/A	1000[a]	80[a]	392	626[b]

All values are in (mg/kg)

a - approximations based on EPA value with no Oral Potency Slope Factor (EPA Region VII Project Manager)

b - Value is taken from the future construction worker scenario because it is lower than the future utility worker value.

* - This reference is located in Appendix C.

TABLE 2-8

CHEMICALS DETECTED IN SURFACE SOIL SAMPLES
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

Parameter	Concentration Detected in Background Sample [a]	Frequency of Detection [b]	Method Detection Limit	Arithmetic Mean	Range of Detected Concentrations [c]	95% Upper Confidence Limit [d]
Pesticides:						
* alpha–Chlordane	0.37	4/4	0.0013	0.66	0.029 – 1.6	5,300
* gamma–Chlordane	0.38	4/4	0.0013	0.66	0.03 – 1.6	4,700
4,4'–DDE	0.67	3/4	0.0076	0.59	0.094 – 1.8	54
4,4'–DDT	0.094	2/4	0.0076	0.54	0.45 – 1	440
* Dieldrin	ND	1/4	0.0038	0.053	0.077 – 0.094	40
Heptachlor	ND	1/4	0.0038	0.084	< 0.0038 – 0.3	13,000
Methoxychlor	2.4	1/4	0.038	0.69	< 0.038 – 2.4	62,000
Organophosphorous Pesticides:						
Malathion	0.419	1/4	0.17	0.17	< 0.17 – 0.419	1.1
Volatile Organics:						
Methylene Chloride	0.016 B_2	4/4	0.005	0.029	0.016 – 0.039 B_2	0.054
Toluene	ND	2/4	0.006	0.0048	0.006 I_2 – 0.0073	0.011
Semi–Volatile Organics:						
* Benzo[a]anthracene	ND	1/4	0.12	0.26	< 0.12 – 0.16	3.3
* Chrysene	ND	1/4	0.12	0.33	< 0.12 – 0.45	7.0
Fluoranthene	ND	1/4	0.16	0.62	< 0.16 – 1.3	56
* Phenanthrene	ND	1/4	0.16	0.49	< 0.16 – 0.78	13
Pyrene	ND	1/4	0.12	0.47	< 0.12 – 1	43
bis(2–Ethylhexyl)phthalate	0.62	1/4	0.4	0.89	< 0.4 – 0.62	11
Metals:						
* Arsenic	2.4	3/3	0.34	8.3	2.4 – 16	1,100
* Barium	99	3/3	1.0	95	35 – 130	12,000
* Chromium	9.3	3/3	1.2	9.8	6.9 – 15	49
* Lead	46	3/3	3.4	210	32 – 540	2.6 E+11

Note: All concentrations are in mg/kg (ppm).

ND Not detected at concentrations greater than or equal to the Method Detection Limit.

* Selected as a potential chemical of concern

a Comparison to background concentrations are applicable for inorganic constituents only; the presence of organic constituents in background samples indicates that this sample may have been collected in an area influenced by site contamination.

b Number of samples in which the chemical was positively detected divided by the number of samples available (for organics, the denominator includes the background sample).

c For metals, the range does not include the concentration of chemicals detected in the background sample.

d The 95% Upper Confidence Limit is calculated using statistical procedures appropriate for characterizing lognormal populations (Gilbert, 1987). The UCL may be artificially elevated because of the small sample size and the large standard deviation of the data set.

B_2 Constituent is associated with blanks.

I_2 Low internal standard response and high surrogate recovery. Result is biased high.

Table 2-9

CHEMICALS DETECTED IN SUBSURFACE SOIL SAMPLES
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

	Concentration Detected in Background S [SB01A]	[SB01B]	Frequency of Detection[b]	Method Detection Limit	Arithmetic Mean	Range of Det Concentratio	95% Upper Confidence Limit
Pesticides:							
*alpha-Chlordane	0.022	0.084	35/40	0.005	0.17	0.0037 – 1.5	0.6
*gamma-Chlordane	0.024	0.082	38/40	0.005	0.17	0.004 – 1.6	0.57
4,4'-DDD	ND	ND	3/40	0.007	0.05	0.025 – 0.43	0.085
4,4'-DDE	ND	0.024	25/40	0.007	0.11	0.0083 – 0.87	0.33
*4,4'-DDT	0.016	0.087	34/40	0.0073	1.4	0.012 – 33	3.9
Dieldrin	ND	0.027	3/40	0.007	0.036	0.01 – 0.2	0.057
Endrin aldehyde	ND	ND	1/40	0.008	0.033	< 0.008 – 0.014	0.052
Heptachlor	ND	ND	5/40	0.001	0.023	0.0047 – 0.23	0.043
Heptachlor epoxide	ND	0.004	2/40	0.01	0.036	0.0043 – 0.0054	0.037
Methoxychlor	0.056	0.53	6/40	0.06	0.41	0.056 – 10	0.49
Volatile Organics:							
Methylene chloride	0.014T	0.017T	38/40	0.005	0.027	0.0095B2 – 0.075	0.036
Toluene	ND	ND	13/40	0.002	0.0077	0.0089 – 0.034	0.0096
Semi-Volatile Organics:							
Acenaphthene	ND	ND	1/40	0.18	0.104	< 0.18 – 0.23	0.109
*Anthracene	ND	ND	4/40	0.18	0.13	0.25 – 0.76	0.15
*Benzo(a)anthracene	ND	ND	17/40	0.11	0.25	0.11 – 1.8	0.32
Benzo(a)pyrene	ND	ND	7/40	0.24	0.23	0.27 – 1.3	0.26
*Benzo(b)fluoroanthene	ND	ND	5/40	0.35	0.28	0.38 – 1.4	0.31
*Benzo(k)fluoroanthene	ND	ND	4/40	0.37	0.26	0.46 – 1.2	0.29
*Chrysene	ND	ND	17/40	0.11	0.25	0.11 – 1.7	0.33
*Dibenzofuran	ND	ND	1/40	0.11	0.062	< 0.11 – 0.13	0.065
2,4-Dichlorophenol	ND	ND	1/40	0.21	0.12	<0.21 – 2.3	0.12
Diethylphthalate	ND	ND	3/40	0.35	0.23	0.43 – 0.7	0.24
bis(2-Ethylhexyl)phthalate	ND	0.89	8/40	0.37	0.33	0.4 – 1.4	0.37
Fluoranthene	ND	ND	17/40	0.15	0.38	0.16 – 3.4	0.49
Fluorene	ND	ND	1/40	0.24	0.14	< 0.24 – 0.27	0.15
*Indeno(1,2,3-cd)pyrene	ND	ND	1/40	0.35	0.2	< 0.35 – 0.38	0.21
*2-Methylnaphthalene	ND	ND	1/40	0.15	0.084	< 0.15 – 0.2	0.08
*Phenanthrene	ND	ND	14/40	0.15	0.3	0.23 – 2.7	0.37
Pyrene	ND	ND	20/40	0.11	0.48	0.11 – 4.1	0.71
2,4,6-Trichlorophenol	ND	ND	1/40	0.3	0.16	< 0.3 – 0.33	0.17
Metals:							
*Arsenic	1.2	1.4	38/38	0.34	6.6	0.8 – 120	6.4
Barium	73	99	38/38	1	97	39 – 160	108
*Cadmium	ND	ND	3/38	0.8	0.49	0.7 – 5	0.49
*Chromium	6.7	8.2	38/38	1.2	8.7	4.5 – 41	9.7
*Lead	4.3	11	38/38	3.4	82	4.4 – 770	149
*Mercury	ND	ND	8/38	0.1	0.12	0.1 – 1.3	0.13
Silver	ND	ND	4/38	0.4	0.14	0.8 – 1.2	0.15
Selenium	ND	ND	7/38	0.2	0.42	0.2 – 0.8	0.45

Note: All concentrations are in mg/kg (ppm).
ND Not detected at concentrations greater than or equal to the Method Detection Limit
* Selected as a potential chemical of concern
a Comparison to background concentrations are applicable for inorganic constituents only; the presence of organic constituents in background samples indicates the "background" sample was collected in an area influenced by site contamination
b Number of samples in which the chemical was positively detected divided by the number of samples available (for organics, the denominator includes the background sample).
c Range does not include the concentration of chemicals detected in the background sample.
d The 95% Upper Confidence Limit is calculated using statistical procedures appropriate for characterizing lognormal populations (Gilbert, 1987)
T Sample results are associated with the trip blank (indicates possible cross-contamination).
B2 Sample results are associated with the method blank (indicates possible lab contamination).

TABLE 2-10

CHEMICALS DETECTED IN MONITORING WELL SOIL BORING SAMPLES
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

Parameter	Concentration Detected in Background Samples [a] [MWSB01A]	[MWSB01B]	Frequency of Detection [b]	Method Detection Limit	Arithmetic Mean	Range of Detected Concentrations [c]			95% Upper Confidence Limit [d]
Pesticides:									
alpha-Chlordane	ND	ND	2/13	0.0037	0.0084	0.015	–	0.073	0.014
gamma-Chlordane	ND	ND	3/13	0.0037	0.0087	0.0051	–	0.071	0.019
4,4'-DDE	ND	ND	1/13	0.0073	0.0045	< 0.0073	–	0.012	0.0054
Dieldrin	ND	ND	2/13	0.0073	0.005	0.0087	–	0.013	0.0061
Volatile Organics:									
Benzene	0.0066	0.0059	2/13	0.0031	0.0024	0.0059	–	0.0066 B_2	0.0032
Methylene Chloride	0.062 B_2	0.046 B_2	13/13	0.005	0.03	0.011	–	0.07	0.026
Semi-Volatile Organics:									
Benzo[a]anthracene	ND	ND	2/13	0.11	0.103	0.11	–	0.6	0.14
Benzo[a]pyrene	ND	ND	1/13	0.11	0.18	< 0.11	–	0.68	0.22
Benzo[b]fluoranthene	ND	ND	1/13	0.36	0.25	< 0.36	–	1	0.32
Benzo[g,h,i]perylene	ND	ND	1/13	0.36	0.21	< 0.36	–	0.4	0.23
Chrysene	ND	ND	2/13	0.11	0.11	0.11	–	0.64	0.15
Fluoranthene	ND	ND	2/13	0.14	0.16	0.18	–	1	0.22
Indeno[1,2,3-cd]pyrene	ND	ND	1/13	0.36	0.21	< 0.36	–	0.48	0.25
Phenanthrene	ND	ND	1/13	0.14	0.11	< 0.14	–	0.56	0.15
Pyrene	ND	ND	2/13	0.11	0.12	0.18	–	0.8	0.18
bis(2-Ethylhexyl)phthalate	ND	ND	1/13	0.36	0.21	< 0.36	–	0.48	0.25
Metals:									
Arsenic	1	2.5	11/11	0.34	1.9	0.4	–	3.7	3.9
Barium	61	120	11/11	1.0	88	44	–	190	116
Chromium	6.8	8.7	11/11	1.2	9.0	4.8	–	20	12
Lead	5.1	10	7/11	3.4	16	4.7	–	58	78
Mercury	ND	ND	2/11	0.1	0.077	0.1	–	0.3	0.11
Silver	ND	ND	4/11	0.5	0.58	0.9	–	1.2	0.94

Note: All concentrations are in mg/kg (ppm).
ND Not detected at concentrations greater than or equal to the Method Detection Limit.
* Selected as a potential chemical of concern
a Comparison to background concentrations are applicable for inorganic constituents only; the presence of organic constituents in background samples indicates the "background" sample was collected in an area influenced by site contamination.
b Number of samples in which the chemical was positively detected divided by the number of samples available (for organics, the denominator includes the background sample).
c Range does not include the concentration of chemicals detected in the background sample.
d The 95% Upper Confidence Limit is calculated using statistical procedures appropriate for characterizing lognormal populations (Gilbert, 1987).
B_2 Sample results are associated with the method blank (indicates possible lab contamination).

Table 3-1

REGULATORY AND GUIDANCE CRITERIA FOR GROUNDWATER
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

Parameter	Maximum Detected Concentration (mg/L)	Federal Maximum Contaminant Level[a] (mg/L)	Federal Maximum Contaminant Level Goal[a] (mg/L)	Kansas Maximum Contaminant Level[b] (mg/L)	Kansas Action Level[c] (mg/L)	Kansas Notification Level[c] (mg/L)	Alternate Kansas Action Level[c] (mg/L)	Alternate Kansas Notification Level[c] (mg/L)
Aluminum	0.27	[0.05 – 0.2] S	--	--	5	--	0.75	0.087
Arsenic	0.016	0.05	0	0.05	0.05	0.05	--	--
Barium	0.13	2 d	2 d	1	1	--	--	--
Beryllium	0.003	0.004 *	0	--	[0.00013]	--	--	--
Chromium	0.012	0.1 d	0.1 d	0.05	0.05	--	--	--
Manganese	0.091	[0.05] S	--	--	0.05	--	--	--
Vanadium	0.027	--	--	--	--	--	--	--
Inorganic Chloride	270	[250] S,e	--	--	250	--	--	--
Nitrate	33 (= 10 as N)	10 (as N)	10 (as N)	10 (as N)	10 (as N)	--	--	--
Sulfate	390	250 S,e	--	--	250	--	--	--
Bicarbonate, as $CaCO_3$	490	--	--	--	--	--	--	--

S – Secondary MCL   * – effective date 01–17–94   [Boxed areas indicate exceedence of regulatory or guidance criteria]

a – Maximum Contaminant Levels and Maximum Contaminant Level Goals (40 CFR 141 Subpart B)
b – Kansas Drinking Water Rules (KAR 28.15), last amended 1 May, 1988.
c – KDHE Memorandum, dated 5 December, 1988; Revised Groundwater Contaminant Cleanup Target Concentrations for Aluminum and Selenium.
d – National Public Drinking Water Rules for 38 Inorganic and Synthetic Organic Chemicals (January, 1991), Phase II Fact Sheet
e – Drinking Water Regulations and Health Advisories; USEPA Office of Water, December, 1992.

Table 3-2

GUIDANCE CRITERIA FOR SURFACE WATER
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

Parameter	Maximum Concentration Detected (mg/L)	FEDERAL AMBIENT WATER QUALITY CRITERIA (mg/L)* For the Protection of Aquatic Life: Acute	Chronic	For the Protection of Human Health: (consumption of) Water & Fish	Fish only	KANSAS STATE WATER QUALITY STANDARDS** c For the Protection of Aquatic Life: (mg/L)
Aluminum	12	--	--	--	--	--
Arsenic, pentavalent	0.0044 T	0.85 a	0.048 a	0.0022 b	0.0175 b	--
Arsenic, trivalent	0.0044 T	0.36	0.19	0.0022 b	0.0175 b	--
Barium	0.29	--	--	1	--	--
Bicarbonate	290	--	--	--	--	--
Cadmium	0.0045	0.0039 d	0.0011 d	0.01	--	--
Chloride, inorganic	65	0.019	0.011	--	--	--
Chromium, hexavalent	0.024 T	0.016	0.011	0.05	--	--
Chromium, trivalent	0.024 T	1.7 d	0.21 d	0.17	3.433	--
Copper	0.013	0.018 d	0.012 d	--	--	--
Lead	0.0042	0.082 d	0.0032 d	0.05	--	--
Manganese	0.19	--	--	0.05	0.1	--
Sulfate	106	--	--	--	--	--
Vanadium	0.026	--	--	--	--	--

Boxed areas indicate exceedence of regulatory or guidance criteria

a – Insufficient data to develop criteria. Value presented is lowest observed effect level.
b – Human health criteria for carcinogens reported for three risk levels. Value presented in this table is the 10^{-6} risk level.
c – The State of Kansas has incorporated the Federal AWQC for the protection of aquatic life as the State Water Quality Standards by reference.
d – Hardness Dependent Criteria (100 mg/l used).
T – Valence of metal was not established; concentration listed in table is for total metal(s).

Sources: *Quality Criteria for Water – 1986. EPA 440/5-86.001, 1 May, 1987.
**Kansas Water Quality Standards (KAR 28.16.28), 1 May, 1987.

Table 3-3

NOAA CRITERIA (TBCs) FOR SEDIMENTS
PESTICIDE STORAGE FACILITY AREA
Fort Riley, Kansas

Chemical	Maximum Detected Concentration	ER-L Concentration	ER-M Concentration	ER-L : ER-M Ratio	Overall Apparent Effects Threshold	Degree of Confidence
PESTICIDES (ug/kg):						
Chlordane	67	[0.5]	[6]	12	[2]	Low / Low
DDT	480	[1]	[7]	7	[6]	Low / Low
Dieldrin	56	[0.02]	[8]	400	No	Low / Low
SEMI-VOLATILES (ug/kg):						
Benzo[a]anthracene	160	230	1600	7	550	Low/Moderate
Chrysene	240	400	2800	7	900	Moderate/Moderate
Phenanthrene	360	[225]	1380	6.1	[260]	Moderate/Moderate
METALS (mg/kg):						
Arsenic	3.8	33	85	2.6	50	Low/Moderate
Barium	150	NA	NA	NA	NA	NA
Cadmium	3.3	5	9	1.8	5	High/High
Chromium	25	80	145	1.8	No	Moderate/Moderate
Lead	210	35	110	3.1	300	Moderate/High
Mercury	0.4	[0.15]	1.3	8.7	1	Moderate/High

NSD – Not sufficient data NA – Not available

Boxed values indicate exceedence of TBC criteria (shown here in [brackets])

Source: National Oceanic and Atmospheric Administration, Technical Memorandum, NOS OMA 52, 1990.

Table 3-4

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO BE CONSIDERED (TBC) REQUIREMENTS
Pesticide Storage Facility
Fort Riley, Kansas

TYPE OF ARAR	ARARs	TBC REQUIREMENTS
<u>Location-Specific</u>	Endangered Species Act of 1973 (16 USC 1531-1544)	None Identified
	Fish and Wildlife Coordination Act Requirements (33 CFR 320-330; 40 CFR 6.302)	
	Stormwater Discharge Requirements National Pollutant Discharge Elimination System (CWA 40 CFR 122)	
	Protection of Wetlands (Executive Order 11990)	
	Flood Plain Management (Executive Order 11988 16 USC 661 et. seq. 40 CFR 6.302, Appendix A)	
	Surface Water Use Designations (KAR 28.16.28d)	
<u>Action-Specific</u>		
General Requirements (Applicable to all on-site activities)	Occupational Safety and Health Administration - Hazardous Waste Operations and Emergency Response (OSHA 29 CFR 1910.120)	
No Action	None Identified	None Identified
Institutional Controls	None Identified	None Identified
Institutional Controls and Grading	Ambient Air Quality Standards and Air Pollution Control Regulations (KAR 28.19)	None Identified

Table 3-4, con't

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND TO BE CONSIDERED (TBC) REQUIREMENTS
Pesticide Storage Facility
Fort Riley, Kansas

TYPE OF ARAR	ARARs	TBC REQUIREMENTS
Action-Specific Institutional Controls and Grading (Continued)	Occupational Safety and Health Standards for Air Contaminants (OSHA) (29 CFR 1910.1000)	
	National Ambient Air Quality Standards (NAAQS) (CAA 40 CFR Part 50)	
	National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61)	
Clay Cap and Grading	Ambient Air Quality Standards and Air Pollution Control Regulations (KAR 28.19)	None Identified
	Occupational Safety and Health Standards for Air Contaminants (OSHA) (29 CFR 1910.1000)	
	National Ambient Air Quality Standards (NAAQS) (CAA 40 CFR Part 50)	
	National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61)	
Asphalt Cap and Grading	National Ambient Air Quality Standards (NAAQS) (CAA 40 CFR Part 50)	Standards for Generators of Hazardous Waste (RCRA 40 CFR 262)
	Occupational Safety and Health Standards for Air Contaminants (OSHA) (29 CFR 1910.1000)	
	Ambient Air Quality Standards and Air Pollution Control Regulations (KAR 28.19)	

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND TO BE CONSIDERED (TBC) REQUIREMENTS
Pesticide Storage Facility
Fort Riley, Kansas

TYPE OF ARAR	ARARs	TBC REQUIREMENTS
Action-Specific Asphalt Cap and Grading (Continued)	National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61)	
Removal and Disposal	DOT Rules for Transportation of Hazardous Materials (DOT 40 CFR 107)	Standards for Generators of Hazardous Waste (RCRA 40 CFR 262 Subpart B, C, and F)
	Ambient Air Quality Standards and Air Pollution Control Regulations (KAR 28.19)	Standards Applicable to Transporters of Hazardous Waste (RCRA 40 CFR 263)
	Occupational Safety and Health Standards for Air Contaminants (OSHA) (29 CFR 1910.1000)	Manifesting, Reporting and Recordkeeping Requirements (RCRA) (RCRA 40 CFR 264 Subpart E)
	National Ambient Air Quality Standards (NAAQS) (CAA 40 CFR Part 50)	RCRA Land Disposal Restrictions (RCRA 40 CFR 268)
	National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61)	RCRA Standards for Identification and Listing of Hazardous Waste (RCRA 40 CFR 261)
		State of Kansas Solid Waste Management Regulations (KAR 28.31)
		State of Kansas Hazardous Waste Management Regulations (KAR 28.29 Part II)

TABLE 4-1
SCREENING OF NO ACTION, INSTITUTIONAL AND CONTAINMENT ACTIONS
PESTICIDE STORAGE FACILITY, FORT RILEY, KANSAS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	COST	IMPLEMENTABILITY	FEASIBLE ON-SITE
No Action	None	None	Does not reduce mobility, toxicity, or volume of waste or the potential for contact with media	No Cost	Requires no implementation	Feasible for the site
Institutional Actions	Access Restrictions	Fencing	Protective by limiting direct contact with media	Low Cost	Readily Implemented; most of the fencing already exists, will need to move existing fence.	Feasible for the site
	Monitoring	Ground-water Monitoring	Effective in indentifying the mobility of constituents in the soil	Medium Cost	Readily Implemented	Feasible for the site
	Utility Restrictions	Utility Relocation	Effective in isolating utility lines from areas of concern	Low Cost	Readily Implemented	Feasible for the site, however no utilities cross area of contamination
Containment	Capping	Clay Cap	Reduces mobility of contaminants but does not reduce the volume of contaminated material	Moderate Capital Moderate O&M	Could be implemented to cover small area	Potentially feasible
		Multi-layer Cap (composite)	Reduces mobility of contaminants but does not reduce the volume of contaminated material	Medium to High Capital Moderate O&M	Could be implemented; difficult to tie into surrounding ares.	Potentially feasible; not anticipated to use when other cap covers are as efficient at lower cost.
		Hard Cap	Reduces mobility of contaminants but does not reduce the volume of contaminated material; allows continued use of the area	Moderate Capital Moderate O&M	Could be implemented	Feasible for the area east of the PSF building.
	Surface Controls	Grading/Vegetative Enhancement	Effective in providing soil stability and controlling erosion	Moderate Capital	Easily implemented	Potentially feasible for the site
		Diversion/Collection	Effective in reducing contact with potentially contaminated soil	Moderate Capital Low O&M	Easily implemented	Potentially feasible for the site

TABLE: 4-2
SCREENING OF TREATMENT ACTION TECHNOLOGIES
PESTICIDE STORAGE FACILITY, FORT RILEY, KANSAS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	COST	IMPLEMENTABILITY	FEASIBLE ON-SITE
Treatment	Physical/ Chemical Treatment	Soil Flushing/Washing (in-situ)	Effective in removing heavy metals, halogenated solvents, aromatics, and chlorinated phenols; not suitable for soils with highly variable conditions, high organic content and low permeability; potential to generate soil and ground water contamination	Moderate Capital Moderate O&M	Liquid treatment system required to recover flushing/washing fluid	Feasibility of the technology at the site is questionable. Due to the potential of contaminating the ground water, this action is considered not feasible.
		Soil Flushing/Washing (ex-situ)	Effective in removing heavy metals, halogenated solvents, aromatics, and chlorinated phenols; not suitable for soils with highly variable conditions, high organic content and low permeability; potential to generate soil and ground water contamination	High Capital High O&M	Excavation required and liquid treatment required to recover flushing/washing fluids	Not feasible to be implemented due to variability of soils and low permeability
		Stabilization/ Solidification	Effective in reducing mobility of heavy metals, sulfides, organics; generally not suitable for solid wastes containing more than 20% organics by volume; silt, clay, lignite or other fine particles may limit effectiveness; volume of waste may double as a result of treatment	Low Capital Low O&M	Relatively easy to implement	May be feasible at the site. Increased volume of material will need to be considered along with long-term monitoring of ground water.

RI – Remedial Investigation

TABLE 4-3
SCREENING OF REMOVAL AND DISPOSAL ACTION TECHNOLOGIES
PESTICIDES DISPOSAL FACILITY, FORT RILEY, KANSAS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	COST	IMPLEMENTABILITY	FEASIBLE ON-SITE
Removal and Disposal	Collection/ Removal	Excavation (S)	Effective for the removal of contaminated soil and sediment;	High Capital	Can be costly depending upon the volume of media to be removed; existing buildings and utilities must be considered	Feasible for small areas.
	Disposal	Landfilling (S)	Reduces mobility of waste but not volume or toxicity; increased risk of exposure during transportation	High Capital No O&M	Usually very costly; requires off-site transportation; potential for long-term liability; off-site landfill capacity typically limited	Potentially feasible depending upon the cost of disposal, and amount of material to be disposed.
		Treatment (S) (see previous table)	Reduces toxicity, volume, and/or mobility of the waste	(see previous table)	Relatively easy to implement	Potentially feasible

Media addresses:
S - Soil

18-Mar-93

TABLE 4-4
SUMMARY OF ACTIONS PASSING PRELIMINARY SCREENING
PESTICIDE DISPOSAL FACILITY, FORT RILEY, KANSAS

GENERAL RESPONSE ACTION	MEDIA	REMEDIAL TECHNOLOGY	PROCESS OPTION
Institutional	Soil	Access Restrictions	Fencing
	Soil	Monitoring	Soil Monitoring
	Soil	Utility Restrictions	Utility Relocation
Containment	Soil	Capping	Clay, Hard
	Soil	Surface Controls	Grading
	Soil	Surface Controls	Diversion/Collection
Treatment	Soil	Chemical/Physical	Stabilization/Solidification
Removal/Disposal	Soil	Collection	Excavation
	Soil	Disposal off-site	Landfill

TABLE 5-1
COST PROJECTION FOR ALTERNATIVE 2 (*)
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

ALTERNATIVE 2 – INSTITUTIONAL CONTROLS

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
INSTITUTIONAL ACTIONS				
CAPITAL COST				
FENCING	LF	$15	450	$6,750
SIGNS	# SIGNS	$40	7	$280
SIGNS	# SIGNS	$65	1	$65
UTILITY ISOLATION	$/UTILITY	$500	4	$2,000
CAPITAL COST SUBTOTAL				$9,095
CONTINGENCY @ 20%				$1,819
ENGINEERING AND DESIGN @ 15%				$1,364
TOTAL CAPITAL COST				$12,278
ANNUAL O&M COSTS	$/HOUR	$15.00	260	$3,900
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$49,043

* The cost projections are opinions of cost used for ranking and do not represent a detailed engineering evaluation.

Generally, unit costs have been approximated to the nearest whole dollar amount for this alternative.

TABLE 5-2
COST PROJECTION FOR ALTERNATIVE 3 (*)
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

ALTERNATIVE 3 – INSTITUTIONAL CONTROLS/GRADING

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
	INSTITUTIONAL ACTIONS			
CAPITAL COST				
FENCING	LF	$15	450	$6,750
SIGNS	# SIGNS	$40	7	$280
SIGNS	# SIGNS	$65	1	$65
UTILITY ISOLATION	$/UTILITY	$500	4	$2,000
CAPITAL COST SUBTOTAL				$9,095
CONTINGENCY @ 20%				$1,819
ENGINEERING AND DESIGN @ 15%				$1,364
CAPITAL COST TOTAL – INSTITUTIONAL CONTROLS				$12,278
	GRADING ACTIVITIES			
MOBILIZATION	LUMP SUM			$6,000
CLEAR AND GRUB	LUMP SUM			$3,000
GRADING	$/SY	$2	800	$1,600
STRUCTURAL BACKFILL	$/CY	$3	200	$600
COMPACTION	$/CY	$0.50	200	$100
BERM/BY-PASS DITCH	$/HOUR**	$70	11	$790
DITCH LINING	$/SY	$2	300	$600
WATER-WAY CHANNEL	$/HOUR**	$70	9	$599
RIP-RAP LINING	$/CY	$30	75	$2,250
SILT FENCE	$/LF	$5	350	$1,750
VEGETATION	LUMP SUM			$500
CAPITAL COST SUBTOTAL				$17,789
CONTINGENCY @ 30%				$5,337
ENGINEERING AND DESIGN @ 15%				$2,668
CAPITAL COST TOTAL – GRADING				$25,794
TOTAL CAPITAL COST				$38,072
ANNUAL O&M COSTS	$/HOUR	$15.00	520	$7,800
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$111,602

* The cost projections are opinions of cost used for ranking and do not represent a detailed engineering evaluation.

** $/HOUR is based upon an installation rate of 100 linear feet in an 8 hour requirement.

Generally, unit costs have been approximated to the nearest whole dollar amount for this alternative.

TABLE 5-3
COST PROJECTION FOR ALTERNATIVE 4 (*)
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

ALTERNATIVE 4 – INSTITUTIONAL CONTROLS/GRADING/ASPHALT COVER

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
INSTITUTIONAL ACTIONS				
CAPITAL COST				
FENCING	LF	$15	450	$6,750
SIGNS	# SIGNS	$40	7	$280
SIGNS	# SIGNS	$65	1	$65
UTILITY ISOLATION	$/UTILITY	$500	4	$2,000
CAPITAL COST SUBTOTAL				$9,095
CONTINGENCY @ 20%				$1,819
ENGINEERING AND DESIGN @ 15%				$1,364
CAPITAL COST TOTAL – INSTITUTIONAL CONTROLS				$12,278
GRADING/EROSION CONTROL ACTIVITIES				
MOBILIZATION	LUMP SUM			$6,000
CLEAR AND GRUB	LUMP SUM			$3,000
GRADING	$/SY	$2	800	$1,600
STRUCTURAL BACKFILL	$/CY	$3	350	$1,050
COMPACTION	$/CY	$0.50	350	$175
BERM/BY-PASS DITCH	$/HOUR**	$70	11	$790
DITCH LINING	$/SY	$2	300	$600
WATER-WAY CHANNEL	$/HOUR**	$70	9	$599
RIP-RAP LINING	$/CY	$30	75	$2,250
SILT FENCE	$/LF	$5	350	$1,750
VEGETATION	LUMP SUM			$200
CAPITAL COST SUBTOTAL				$18,014
CONTINGENCY @ 30%				$5,404
ENGINEERING AND DESIGN @ 15%				$2,702
CAPITAL COST TOTAL – GRADING				$26,120
ASPHALT COVER				
MOBILIZATION	LUMP SUM			$4,000
GRADING	$/SY	$2	2200	$4,400
STRUCTURAL BACKFILL	$/CY	$3	1100	$3,300
COMPACTION	$/CY	$0.50	1100	$550
SURFACE TREATMENT	$/SY	$2	2200	$3,300
SEAL COATING	$/SY	$1	2200	$2,200
ASPHALT BERM	$/LF	$2	200	$400
CAPITAL COST SUBTOTAL				$18,150
CONTINGENCY @ 30%				$5,445
ENGINEERING AND DESIGN @ 15%				$2,723
CAPITAL COST TOTAL – ASPHALT COVER				$26,318
TOTAL CAPITAL COST				$64,716
ANNUAL O&M COSTS	$/HOUR	$15.00	520	$7,800
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$138,246

* The cost projections are opinions of cost used for ranking and do not represent a detailed engineering evaluation.

** $/HOUR is based upon an installation rate of 100 linear feet in an 8 hour requirement.

Generally, unit costs have been approximated to the nearest whole dollar amount for this alternative.

TABLE 5-4
COST PROJECTION FOR ALTERNATIVE 5 (*)
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

ALTERNATIVE 5 – INSTITUTIONAL CONTROLS/GRADING/ASPHALT AND CONCRETE COVER

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
INSTITUTIONAL ACTIONS				
CAPITAL COST				
FENCING	LF	$15	450	$6,750
SIGNS	# SIGNS	$40	7	$280
SIGNS	# SIGNS	$65	1	$65
UTILITY ISOLATION	$/UTILITY	$500	4	$2,000
CAPITAL COST SUBTOTAL				$9,095
CONTINGENCY @ 20%				$1,819
ENGINEERING AND DESIGN @ 15%				$1,364
CAPITAL COST TOTAL – INSTITUTIONAL CONTROLS				$12,278
GRADING/EROSION CONTROL ACTIVITIES				
MOBILIZATION	LUMP SUM			$6,000
CLEAR AND GRUB	LUMP SUM			$3,000
BERM/BY-PASS DITCH	$/HOUR**	$70	11	$790
DITCH LINING	$/SY	$1	300	$300
WATER-WAY CHANNEL	$/HOUR**	$70	9	$599
RIP-RAP LINING	$/CY	$30	75	$2,250
SILT FENCE	$/LF	$3	350	$1,050
CAPITAL COST SUBTOTAL				$13,989
CONTINGENCY @ 30%				$4,197
ENGINEERING AND DESIGN @ 15%				$2,098
CAPITAL COST TOTAL – GRADING				$20,284
ASPHALT COVER				
MOBILIZATION	LUMP SUM			$4,000
GRADING	$/SY	$2	1500	$3,000
STRUCTURAL BACKFILL	$/CY	$3	750	$2,250
COMPACTION	$/CY	$0.50	750	$375
SURFACE TREATMENT	$/SY	$2	1500	$3,000
SEAL COATING	$/SY	$1	1500	$1,500
ASPHALT BERM	$/LF	$2	200	$400
CONCRETE COVER				
MOBILIZATION	LUMP SUM			$4,000
GRADING	$/SY	$2	750	$1,500
STRUCTURAL BACKFILL	$/CY	$3	750	$2,250
COMPACTION	$/CY	$0.50	350	$175
CONCRETE	$/CY	$60	350	$21,000
BASE COURSE	$/SY	$3	750	$2,250
BASE	$/SY	$2	750	$1,500
CAPITAL COST SUBTOTAL				$47,200
CONTINGENCY @ 30%				$14,160
ENGINEERING AND DESIGN @ 15%				$7,080
CAPITAL COST TOTAL – ASPHALT/CONCRETE COVER				$68,440
TOTAL CAPITAL COST				$101,002
ANNUAL O&M COSTS	$/HOUR	$15.00	520	$7,800
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$174,532

* The cost projections are opinions of cost used for ranking and do not represent a detailed engineering evaluation.

** $/HOUR is based upon an installation rate of 100 linear feet in an 8 hour requirement.

Generally, unit costs have been approximated to the nearest whole dollar amount for this alternative.

TABLE 5-5A
COST PROJECTION FOR ALTERNATIVE 6 (*)
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

ALTERNATIVE 6A- EXCAVATION/DISPOSAL   BASED ON RCRA CALs

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
	EXCAVATION			
EXCAVATION	$/CY	$3.00	600	$1,800
GRADING	$/SY	$2.00	800	$1,600
STRUCTURAL BACKFILL	$/CY	$3.00	950	$2,850
COMPACTION	$/CY	$0.50	950	$475
BERM/BY-PASS DITCH	$/HOUR**	$70.00	11	$790
DITCH LINING	$/SY	$1.00	300	$300
WATER-WAY CHANNEL	$/HOUR**	$70.00	9	$599
RIP-RAP LINING	$/CY	$30.00	75	$2,250
SILT FENCE	$/LF	$3.00	350	$1,050
CAPITAL COST SUBTOTAL				$11,714
CONTINGENCY @ 30%				$3,514
ENGINEERING AND DESIGN @ 15%				$1,757
CAPITAL COST TOTAL - EXCAVATION				$16,985
	DISPOSAL			
CONFIRMATION TESTING	$/LAYER/AREA	$4,500	6/2	$54,000
TRANSPORTATION	$/LOAD	$1,000	30	$30,000
DISPOSAL	$/CY	$550	600	$330,000
DISPOSAL TESTING	$/LOAD	$1,650	30	$49,500
CAPITAL COST SUBTOTAL				$463,500
CONTINGENCY @ 30%				$139,050
ENGINEERING AND DESIGN @ 15%				$69,525
CAPITAL COST TOTAL - DISPOSAL				$672,075
TOTAL CAPITAL COST				$689,060
ANNUAL O&M COSTS	$/HOUR	$15.00	104	$1,600
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$714,004

* The cost projections are opinions of cost used for ranking and do not represent a detailed engineering evaluation.

** $/HOUR is based upon an installation rate of 100 linear feet in an 8 hour requirement.

Generally, unit costs have been approximated to the nearest whole dollar for this alternative.

Landfill disposal costs are based upon verbal price estimations for the Chem-Met Landfill.

TABLE 5-5 B
COST PROJECTION FOR ALTERNATIVE 6 (*)
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

ALTERNATIVE 6 B-EXCAVATION/DISPOSAL BASED ON FUTURE UTILITY WORKER SCENARIO

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
	EXCAVATION			
EXCAVATION	$/CY	$3.00	350	$1,050
GRADING	$/SY	$2.00	500	$1,000
STRUCTURAL BACKFILL	$/CY	$3.00	650	$1,950
COMPACTION	$/CY	$0.50	650	$325
BERM/BY-PASS DITCH	$/HOUR**	$70.00	11	$790
DITCH LINING	$/SY	$1.00	300	$300
WATER-WAY CHANNEL	$/HOUR**	$70.00	9	$599
RIP-RAP LINING	$/CY	$30.00	75	$2,250
SILT FENCE	$/LF	$3.00	350	$1,050
CAPITAL COST SUBTOTAL				$9,314
CONTINGENCY @ 30%				$2,794
ENGINEERING AND DESIGN @ 15%				$1,397
CAPITAL COST TOTAL - EXCAVATION				$13,505
	DISPOSAL			
CONFIRMATION TESTING	$/LAYER/AREA	$4,500	6/1	$27,000
TRANSPORTATION	$/LOAD	$1,000	18	$18,000
DISPOSAL	$/CY	$550	350	$192,500
DISPOSAL TESTING	$/LOAD	$1,650	18	$29,700
CAPITAL COST SUBTOTAL				$267,200
CONTINGENCY @ 30%				$80,160
ENGINEERING AND DESIGN @ 15%				$40,080
CAPITAL COST TOTAL - DISPOSAL				$387,440
TOTAL CAPITAL COST				$400,945
ANNUAL O&M COSTS	$/HOUR	$15.00	104	$1,600
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$417,384

* The cost projections are opinions of cost used for ranking and do not represent a detailed engineering evaluation.

** $/HOUR is based upon an installation rate of 100 linear feet in an 8 hour requirement.

Generally, unit costs have been approximated to the nearest whole dollar for this alternative.

Landfill disposal costs are based upon verbal price estimations for the Chem-Met Landfill.

TABLE 5-5C
COST PROJECTION FOR ALTERNATIVE 6 (*)
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

ALTERNATIVE 6C-EXCAVATION/DISPOSAL BASED ON FUTURE SITE WORKER SCENARIO

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
	EXCAVATION			
EXCAVATION	$/CY	$3.00	1100	$3,300
GRADING	$/SY	$2.00	1500	$3,000
STRUCTURAL BACKFILL	$/CY	$3.00	1700	$5,100
COMPACTION	$/CY	$0.50	1700	$850
BERM/BY-PASS DITCH	$/HOUR**	$70.00	11	$790
DITCH LINING	$/SY	$1.00	300	$300
WATER-WAY CHANNEL	$/HOUR**	$70.00	9	$599
RIP-RAP LINING	$/CY	$30.00	75	$2,250
SILT FENCE	$/LF	$3.00	350	$1,050
CAPITAL COST SUBTOTAL				$17,239
CONTINGENCY @ 30%				$5,171
ENGINEERING AND DESIGN @ 15%				$2,586
CAPITAL COST TOTAL - EXCAVATION				$24,996
	DISPOSAL			
CONFIRMATION TESTING	$/LAYER/AREA	$4,500	6/2	$54,000
TRANSPORTATION	$/LOAD	$1,000	55	$55,000
DISPOSAL	$/CY	$550	1100	$605,000
DISPOSAL TESTING	$/LOAD	$1,650	55	$90,750
CAPITAL COST SUBTOTAL				$804,750
CONTINGENCY @ 30%				$241,250
ENGINEERING AND DESIGN @ 15%				$120,713
CAPITAL COST TOTAL - DISPOSAL				$1,166,713
TOTAL CAPITAL COST				$1,191,709
ANNUAL O&M COSTS	$/HOUR	$15.00	104	$1,600
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$1,221,502

* The cost projections are opinions of cost used for ranking and do not represent a detailed engineering evaluation.

** $/HOUR is based upon an installation rate of 100 linear feet in an 8 hour requirement.

Generally, unit costs have been approximated to the nearest whole dollar for this alternative.

Landfill disposal costs are based upon verbal price estimations for the Chem-Met Landfill.

TABLE 5-5D
COST PROJECTION FOR ALTERNATIVE 6 (*)
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

ALTERNATIVE 6 D-EXCAVATION/DISPOSAL BASED ON EPA MAX RISK-BASED CONCENTRATIONS

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
	EXCAVATION			
EXCAVATION	$/CY	$3.00	460	$1,380
GRADING	$/SY	$2.00	550	$1,100
STRUCTURAL BACKFILL	$/CY	$3.00	650	$1,950
COMPACTION	$/CY	$0.50	650	$325
BERM/BY-PASS DITCH	$/HOUR**	$70.00	11	$790
DITCH LINING	$/SY	$1.00	300	$300
WATER-WAY CHANNEL	$/HOUR**	$70.00	9	$599
RIP-RAP LINING	$/CY	$30.00	75	$2,250
SILT FENCE	$/LF	$3.00	350	$1,050
CAPITAL COST SUBTOTAL				$9,744
CONTINGENCY @ 30%				$2,923
ENGINEERING AND DESIGN @ 15%				$1,461
CAPITAL COST TOTAL - EXCAVATION				$14,129
	DISPOSAL			
CONFIRMATION TESTING	$/LAYER/AREA	$4,500	6/2	$54,000
TRANSPORTATION	$/LOAD	$1,000	23	$23,000
DISPOSAL	$/CY	$550	460	$253,000
DISPOSAL TESTING	$/LOAD	$1,650	23	$37,950
CAPITAL COST SUBTOTAL				$367,950
CONTINGENCY @ 30%				$110,385
ENGINEERING AND DESIGN @ 15%				$55,193
CAPITAL COST TOTAL - DISPOSAL				$533,528
TOTAL CAPITAL COST				$547,657
ANNUAL O&M COSTS	$/HOUR	$15.00	104	$1,600
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$569,290

* The cost projections are opinions of cost used for ranking and do not represent a detailed engineering evaluation.

** $/HOUR is based upon an installation rate of 100 linear feet in an 8 hour requirement.

Generally, unit costs have been approximated to the nearest whole dollar for this alternative.

Landfill disposal costs are based upon verbal price estimations for the Chem-Met Landfill.

APPENDIX A

Analytical Data - Soils

Positive Hits Table Taken From
Draft Final Remediation Investigation Report
July 19, 1993

TABLE 4-15

POSITIVE ANALYTICAL RESULTS/SURFACE SOILS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSS01 (1-2') 4-8-92	PSFSS02 (6-18") 4-7-92	PSFSS03 (3-12") 4-5-92	PSFSS04 (1-12") 4-6-92
PESTICIDES/PCBs:				
4,4'-DDE, µg/Kg	180	270	94	1800
4,4'-DDT, µg/Kg	670	1000	450	--
Dieldrin, µg/Kg	94	77	--	--
Heptachlor, µg/Kg	--	300	--	--
Methoxychlor, µg/Kg	2400	--	--	--
alpha-Chlordane, µg/Kg	370	1600	29	660
gamma-Chlordane, µg/Kg	380	1600	30	640
SEMI-VOLATILE ORGANICS:				
Benzo[a]anthracene, µg/Kg	--	--	--	160
Chrysene, µg/Kg	--	--	--	450
Fluoranthene, µg/Kg	--	--	--	1300
Phenanthrene, µg/Kg	--	--	--	780
Pyrene, µg/Kg	--	--	--	1000
bis(2-Ethylhexyl)phthalate, µg/Kg	620	--	--	--
VOLATILE ORGANICS:				
Methylene chloride, µg/Kg	16(B2)	24	39(B2)	35(B2)
Toluene, µg/Kg	--	6.0(I2)	--	7.3
TOTAL FURNACE METALS:				
Arsenic, mg/Kg	2.4	16	4.2	4.6
TOTAL ICP METALS:				
Barium, mg/Kg	99	35	130	120
Chromium, mg/Kg	9.3	6.9	7.5	15
Lead, mg/Kg	46	32	540	60
Silver, mg/Kg	--	--	--	0.8
ORGANOPHOSPHORUS PESTICIDES:				
Malathion, µg/kg	419	--	--	--
ACID HERBICIDE:	--	--	--	--
DIOXIN:	--	--	NA	--

B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
Result is estimated.
I2 – Low internal standard response and high surrogate recovery. Result is biased high.
NA – Not analyzed
-- Not detected.

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB01A (2-2.5') 4-6-92	PSFSB01B (4-4.5') 4-6-92	PSFSB02A (2-2.5') 4-7-92	PSFSB02B (4-4.5') 4-7-92	PSFSB03A (2-2.5') 4-5-92	SAMPLE PSFSB03B (4-4.5') 4-6-92	DUPLICATE PSFSB03C (4-4.5') 4-6-92
PESTICIDES/PCBs:							
4,4'-DDD, µg/Kg	--	--	--	--	--	--	--
4,4'-DDE, µg/Kg	--	24(H)	--	--	--	--	--
4,4'-DDT, µg/Kg	16(S)	67(H)	42	--	7700(D1)	4500(D1)	33000(D2)
Dieldrin, µg/Kg	--	27(H)	--	--	--	--	--
Endrin aldehyde, µg/Kg	--	--	--	--	--	--	--
Heptachlor, µg/Kg	--	4.3(H)	45	28	--	--	--
Heptachlor epoxide, µg/Kg	--	--	--	--	--	--	--
Methoxychlor, µg/Kg	58(S)	530(H)	--	--	--	10000(D1)	--
alpha-Chlordane, µg/Kg	22(S)	64(H)	210	160	--	--	1500(D2)
gamma-Chlordane, µg/Kg	24(S)	62(H)	210	160	210(D1)	--	1600(D2)
SEMI-VOLATILE ORGANICS:							
2,4,6-Trichlorophenol, µg/Kg	--	--	--	--	--	--	330
2,4-Dichlorophenol, µg/Kg	--	--	--	--	--	--	2300
2-Methylnaphthalene, µg/Kg	--	--	--	--	--	--	--
Acenaphthene, µg/Kg	--	--	--	--	--	--	--
Anthracene, µg/Kg	--	--	--	--	--	--	--
Benzo[a]anthracene, µg/Kg	--	--	--	--	--	--	--
Benzo[a]pyrene, µg/Kg	--	--	--	--	--	--	--
Benzo[b]fluoranthene, µg/Kg	--	--	--	--	--	--	--
Benzo[k]fluoranthene, µg/Kg	--	--	--	--	--	--	--
Chrysene, µg/Kg	--	--	--	--	--	--	--
Dibenzofuran, µg/Kg	--	--	--	--	--	--	--
Diethylphthalate, µg/Kg	--	--	--	--	--	--	--
Fluoranthene, µg/Kg	--	--	--	--	--	--	--
Fluorene, µg/Kg	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene, µg/Kg	--	--	--	--	--	--	--
Phenanthrene, µg/Kg	--	--	--	--	--	--	--
Pyrene, µg/Kg	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate, µg/Kg	--	690	--	--	--	920	1000
TOTAL MERCURY:							
Mercury, mg/kg	--	--	--	--	--	--	--
VOLATILE ORGANICS:							
Methylene chloride, µg/Kg	17(B2)	14(B2)	19(B2)	16(B2)	29(B2)	22(B2)	23(B2)
Toluene, µg/Kg	--	--	--	--	--	--	--

TABLE 4-18

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB01A (2-2.5') 4-8-92	PSFSB01B (4-4.5') 4-8-92	PSFSB02A (2-2.5') 4-7-92	PSFSB02B (4-4.5') 4-7-92	PSFSB03A (2-2.5') 4-5-92	SAMPLE PSFSB03B (4-4.5') 4-5-92	DUPLICATE PSFSB03C (4-4.5') 4-5-92
TOTAL ICP METALS:							
Barium, mg/Kg	99	73	97	82	89	66	56
Cadmium, mg/Kg	--	--	--	--	--	--	--
Chromium, mg/Kg	8.2	6.7	6.5	8.3	6.9	6.4	5.3
Lead, mg/Kg	4.3	11	13	11	10	4.4	14
Silver, mg/Kg	--	--	--	--	0.8	--	--
TOTAL FURNACE METALS:							
Arsenic, mg/Kg	1.4	1.2	20	4.3	0.8	1.0	1.2
Selenium, mg/Kg	--	--	--	--	--	--	--
ORGANOPHOSPHORUS PESTICIDES:							
RONNEL (FENCHLORPHOS), µg/kg	--	--	--	--	--	--	--
DIOXIN:	NA	NA	NA	NA	NA	--	NA
ACID HERBICIDE:	--	--	--	--	--	--	--

S – Low surrogate recovery. Results are biased low.
H – Holding time exceeded. Results biased low.
D1 – 100X dilution factor. Result is estimated.
D2 – 400X dilution factor. Result is estimated.
B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
-- Not detected
NA – Not analyzed

ıʌdLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB04A (2-2.5') 4-7-92	PSFSB04B (4-4.5') 4-7-92	PSFSB05A (2-2.5') 4-5-92	PSFSB05B (3.5-4.5') 4-6-92	PSFSB06A (2-2.5') 4-7-92	PSFSB06B (4-4.5') 4-7-92	PSFSB7A (2.5-3') 4-7-92
PESTICIDES/PCBs:							
4,4'-DDD, µg/Kg	--	--	--	--	--	--	--
4,4'-DDE, µg/Kg	31	21	110	8.3	--	--	160(S)
4,4'-DDT, µg/Kg	140	96	850	53	--	14	750(S)
Dieldrin, µg/Kg	--	--	200	10	--	--	--
Endrin aldehyde, µg/Kg	--	--	140	--	--	--	--
Heptachlor, µg/Kg	--	--	230	17	--	--	--
Heptachlor epoxide, µg/Kg	--	--	--	6.4	--	--	--
Methoxychlor, µg/Kg	--	--	--	--	--	--	--
alpha-Chlordane, µg/Kg	90	62	790	71	--	3.7	58(S)
gamma-Chlordane, µg/Kg	91	63	790	71	--	4.0	65(S)
SEMI-VOLATILE ORGANICS:							
2,4,6-Trichlorophenol, µg/Kg	--	--	--	--	--	--	--
2,4-Dichlorophenol, µg/Kg	--	--	--	--	--	--	--
2-Methylnaphthalene, µg/Kg	--	--	--	--	--	--	--
Acenaphthene, µg/Kg	--	--	--	--	--	--	--
Anthracene, µg/Kg	--	--	--	--	--	--	--
Benzo[a]anthracene, µg/Kg	--	--	--	--	--	--	390
Benzo[a]pyrene, µg/Kg	--	--	--	--	--	--	300(I)
Benzo[b]fluoranthene, µg/Kg	--	--	--	--	--	--	--
Benzo[k]fluoranthene, µg/Kg	--	--	--	--	--	--	--
Chrysene, µg/Kg	--	--	--	--	--	--	430
Dibenzofuran, µg/Kg	--	--	--	--	--	--	--
Diethylphthalate, µg/Kg	--	--	--	--	--	--	--
Fluoranthene, µg/Kg	--	--	--	--	--	--	740
Fluorene, µg/Kg	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene, µg/Kg	--	--	--	--	--	--	--
Phenanthrene, µg/Kg	--	--	--	--	--	--	370
Pyrene, µg/Kg	--	--	--	--	--	--	560
bis(2-Ethylhexyl)phthalate, µg/Kg	--	--	--	--	--	1200	--
TOTAL MERCURY:							
Mercury, mg/kg	--	--	--	--	--	--	0.1
VOLATILE ORGANICS:							
Methylene chloride, µg/Kg	19(B2)	22	23(B2)	14	18(B2)	17	--
Toluene, µg/Kg	--	9.5	--	--	--	--	--

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB04A (2-2.5') 4-7-92	PSFSB04B (4-4.5') 4-7-92	PSFSB05A (2-2.5') 4-5-92	PSFSB05B (3.5-4.5') 4-5-92	PSFSB06A (2-2.5') 4-7-92	PSFSB06B (4-4.5') 4-7-92	PSFSB7A (2.5-3') 4-7-92
TOTAL ICP METALS:							
Barium, mg/Kg	100	98	100	71	77	39	81
Cadmium, mg/Kg	--	--	--	--	--	--	--
Chromium, mg/Kg	11	6.3	8.3	6.6	5.3	4.6	6.4
Lead, mg/Kg	12	9.9	13	7.5	4.7	4.7	220
Silver, mg/Kg	--	--	--	--	--	--	--
TOTAL FURNACE METALS:							
Arsenic, mg/Kg	6.2	1.9	1.9	1.5	1.6	1.1	4.2
Selenium, mg/Kg	--	--	--	--	--	--	0.3(M2)
ORGANOPHOSPHORUS PESTICIDES:							
RONNEL (FENCHLORPHOS), µg/kg	--	--	--	--	--	--	--
DIOXIN:	NA	NA	--	NA	NA	NA	NA
ACID HERBICIDE:	--	--	--	--	--	--	--

S – Low surrogate recovery. Results are biased low.
B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
I – Low internal standard response. Result is an estimated quantitation.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
-- Not detected
NA – Not analyzed

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB7B (4-4.5') 4-7-92	PSFSB8A (2-2.5') 4-7-92	PSFSB8B (4-4.5') 4-7-92	PSFSB9A (1.5-2.5') 4-7-92	PSFSB9B (4-4.5') 4-7-92	PSFSB10A (1.5-2.5') 4-4-92
<u>PESTICIDES/PCBs:</u>						
4,4'-DDD, μg/Kg	--	--	--	--	--	360
4,4'-DDE, μg/Kg	240(H)	110	20(S)	870(S)	420(S)	180
4,4'-DDT, μg/Kg	2800(H)	440	160(S)	5700(S)	2600(S)	--
Dieldrin, μg/Kg	--	--	--	--	--	--
Endrin aldehyde, μg/Kg	--	--	--	--	--	--
Heptachlor, μg/Kg	--	--	--	--	--	--
Heptachlor epoxide, μg/Kg	--	--	--	--	--	--
Methoxychlor, μg/Kg	--	--	--	--	--	--
alpha-Chlordane, μg/Kg	95(H)	32	5.3(S)	370(S)	190(S)	440
gamma-Chlordane, μg/Kg	99(H)	38	6.3(S)	410(S)	220(S)	450
<u>SEMI-VOLATILE ORGANICS:</u>						
2,4,6-Trichlorophenol, μg/Kg	--	--	--	--	--	--
2,4-Dichlorophenol, μg/Kg	--	--	--	--	--	--
2-Methylnaphthalene, μg/Kg	--	--	--	--	--	--
Acenaphthene, μg/Kg	230	--	--	--	--	--
Anthracene, μg/Kg	760	--	--	300	--	--
Benzo[a]anthracene, μg/Kg	1800(I)	--	--	570	180	620
Benzo[a]pyrene, μg/Kg	1200(I)	--	--	340	--	--
Benzo[b]fluoranthene, μg/Kg	1400(I)	--	--	380	--	--
Benzo[k]fluoranthene, μg/Kg	950(I)	--	--	--	--	--
Chrysene, μg/Kg	1700(I)	--	--	420	110	620
Dibenzofuran, μg/Kg	--	--	--	--	--	--
Diethylphthalate, μg/Kg	--	--	--	--	--	--
Fluoranthene, μg/Kg	3400	--	--	990	180	1200
Fluorene, μg/Kg	270	--	--	--	--	--
Indeno[1,2,3-cd]pyrene, μg/Kg	380(I)	--	--	--	--	--
Phenanthrene, μg/Kg	2700	--	--	990	150	940
Pyrene, μg/Kg	4100(I)	170(I2)	--	870	180	1400
bis(2-Ethylhexyl)phthalate, μg/Kg	--	--	--	420	--	--
<u>TOTAL MERCURY:</u>						
Mercury, mg/kg	0.1	--	--	--	--	--
<u>VOLATILE ORGANICS:</u>						
Methylene chloride, μg/Kg	--	9.5(B2)	13(B2)	15(B2)	14(B2)	31(B2)
Toluene, μg/Kg	--	--	--	--	--	--

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB7B (4-4.5') 4-7-92	PSFSB8A (2-2.5') 4-7-92	PSFSB8B (4-4.5') 4-7-92	PSFSB9A (1.5-2.5') 4-7-92	PSFSB9B (4-4.5') 4-7-92	PSFSB10A (1.5-2.5') 4-4-92
TOTAL ICP METALS:						
Barium, mg/Kg	120	160	130	94	67	84
Cadmium, mg/Kg	--	--	--	0.7	--	--
Chromium, mg/Kg	8.0	4.8	6.5	41	5.6	15
Lead, mg/Kg	310	770	270	240	25	100
Silver, mg/Kg	--	--	--	--	--	--
TOTAL FURNACE METALS:						
Arsenic, mg/Kg	3.2	3.3	2.5	2.3	1.9	5.5
Selenium, mg/Kg	0.2(M2)	--	--	--	--	--
ORGANOPHOSPHORUS PESTICIDES:						
RONNEL (FENCHLORPHOS), µg/kg	--	--	--	--	--	--
DIOXIN:	--	NA	NA	--	NA	--
ACID HERBICIDE:	--	--	--	--	--	--

S – Low surrogate recovery. Results are biased low.
H – Holding time exceeded. Results biased low.
B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
I – Low internal standard response. Result is an estimated quantitation.
I2 – Low internal standard response and high surrogate recovery. Result is biased high.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
-- Not detected
NA – Not analyzed

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	SAMPLE PSFSB10B (3.5-4.5') 4-4-92	DUPLICATE PSFSB10C (3.5-4.5') 4-4-92	PSFSB11A (2-2.5') 4-7-92	PSFSB11B (4-4.5') 4-7-92	PSFSB12A (2-2.5') 4-8-92	PSFSB12B (4-4.5') 4-8-92
PESTICIDES/PCBs:						
4,4'-DDD, µg/Kg	--	25	--	--	430(H)	--
4,4'-DDE, µg/Kg	36	52	26(S)	110(H)	190(H)	170
4,4'-DDT, µg/Kg	57	83	32(S)	150(H)	150(H)	100
Dieldrin, µg/Kg	--	--	--	--	--	--
Endrin aldehyde, µg/Kg	--	--	--	--	--	--
Heptachlor, µg/Kg	--	--	4.7(S)	--	--	--
Heptachlor epoxide, µg/Kg	--	--	--	--	--	--
Methoxychlor, µg/Kg	--	--	80(S)	390(H)	--	--
alpha-Chlordane, µg/Kg	62	75	57(S)	210(H)	370(H)	790
gamma-Chlordane, µg/Kg	60	73	65(S)	220(H)	390(H)	910
SEMI-VOLATILE ORGANICS:						
2,4,6-Trichlorophenol, µg/Kg	--	--	--	--	--	--
2,4-Dichlorophenol, µg/Kg	--	--	--	--	--	--
2-Methylnaphthalene, µg/Kg	170	200	--	--	--	--
Acenaphthene, µg/Kg	--	--	--	--	--	--
Anthracene, µg/Kg	--	--	--	--	--	250
Benzo[a]anthracene, µg/Kg	500	290	--	110	430	950(I2)
Benzo[a]pyrene, µg/Kg	550(I)	--	--	--	270(I)	680(I)
Benzo[b]fluoranthene, µg/Kg	460(I)	--	--	--	--	840(I)
Benzo[k]fluoranthene, µg/Kg	460(I)	--	--	--	--	680(I)
Chrysene, µg/Kg	500	330	--	110	740	1200(I2)
Dibenzofuran, µg/Kg	--	--	--	--	--	--
Diethylphthalate, µg/Kg	--	--	--	--	700	--
Fluoranthene, µg/Kg	500	330	--	160	430	1100
Fluorene, µg/Kg	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene, µg/Kg	--	--	--	--	--	--
Phenanthrene, µg/Kg	420	410	--	--	230	990
Pyrene, µg/Kg	630	330	--	150	940	2700(I2)
bis(2-Ethylhexyl)phthalate, µg/Kg	1400	490	--	--	--	--
TOTAL MERCURY:						
Mercury, mg/kg	--	--	--	--	--	--
VOLATILE ORGANICS:						
Methylene chloride, µg/Kg	75(I)	50(B2)	15(B2)	16(B2)	26(B2)	25(B2)
Toluene, µg/Kg	33(I2)	30(I2)	--	--	8.9	19

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	SAMPLE PSFSB10B (3.5–4.5') 4-4-92	DUPLICATE PSFSB10C (3.5–4.5') 4-4-92	PSFSB11A (2–2.5') 4-7-92	PSFSB11B (4–4.5') 4-7-92	PSFSB12A (2–2.5') 4-8-92	PSFSB12B (4–4.5') 4-8-92
TOTAL ICP METALS:						
Barium, mg/Kg	87	120	68	68	100	66
Cadmium, mg/Kg	5.0	3.2	--	--	--	0.7
Chromium, mg/Kg	8.8	8.6	6.4	6.1	11	15
Lead, mg/Kg	91	120	9.8	14	87	110
Silver, mg/Kg	--	1.1	--	--	--	--
TOTAL FURNACE METALS:						
Arsenic, mg/Kg	66	120	1.4	1.6	6.1	6.0
Selenium, mg/Kg	0.6(M2)	0.6(M2)	--	--	--	--
ORGANOPHOSPHORUS PESTICIDES:						
RONNEL (FENCHLORPHOS), µg/kg	--	--	--	--	--	43.60
DIOXIN:	NA	NA	NA	NA	NA	--
ACID HERBICIDE:	--	--	--	--	--	--

S – Low surrogate recovery. Results are biased low.
H – Holding time exceeded. Results biased low.
B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
I – Low internal standard response. Result is an estimated quantitation.
I2 – Low internal standard response and high surrogate recovery. Result is biased high.
-- – Not detected
NA – Not analyzed

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	SAMPLE PSFSB13A (1.5-2.5') 4-6-92	DUPLICATE PSFSB13C (1.5-2.5') 4-6-92	PSFSB13B (4-4.5') 4-6-92	PSFSB14A (2-2.5') 4-4-92	PSFSB14B (4-4.5') 4-4-92	PSFSB15A (2-2.5') 4-4-92
PESTICIDES/PCBs:						
4,4'-DDD, µg/Kg	--	--	--	--	--	--
4,4'-DDE, µg/Kg	52	150	--	53	--	--
4,4'-DDT, µg/Kg	49	190	12	130	12	--
Dieldrin, µg/Kg	--	--	--	--	--	--
Endrin aldehyde, µg/Kg	--	--	--	--	--	--
Heptachlor, µg/Kg	--	--	--	--	--	--
Heptachlor epoxide, µg/Kg	--	--	--	--	--	--
Methoxychlor, µg/Kg	--	--	--	--	--	--
alpha-Chlordane, µg/Kg	52	180	11	69	4.7	4.7
gamma-Chlordane, µg/Kg	44	160	9.4	66	5.5	4.0
SEMI-VOLATILE ORGANICS:						
2,4,6-Trichlorophenol, µg/Kg	--	--	--	--	--	--
2,4-Dichlorophenol, µg/Kg	--	--	--	--	--	--
2-Methylnaphthalene, µg/Kg	--	--	--	--	--	--
Acenaphthene, µg/Kg	--	--	--	--	--	--
Anthracene, µg/Kg	--	--	--	410	--	--
Benzo[a]anthracene, µg/Kg	--	170	--	1700	330	--
Benzo[a]pyrene, µg/Kg	--	--	--	1300(I)	--	--
Benzo[b]fluoranthene, µg/Kg	--	--	--	1100(I)	--	--
Benzo[k]fluoranthene, µg/Kg	--	--	--	1200(I)	--	--
Chrysene, µg/Kg	130	210	--	1600	290	--
Dibenzofuran, µg/Kg	--	130	--	--	--	--
Diethylphthalate, µg/Kg	--	--	--	--	--	--
Fluoranthene, µg/Kg	--	250	--	2700	530	--
Fluorene, µg/Kg	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene, µg/Kg	--	--	--	--	--	--
Phenanthrene, µg/Kg	260	500	--	1600	250	--
Pyrene, µg/Kg	170	290	140	3400	570	--
bis(2-Ethylhexyl)phthalate, µg/Kg	--	--	--	--	410	--
TOTAL MERCURY:						
Mercury, mg/kg	0.1	0.2	0.6	0.2	--	--
VOLATILE ORGANICS:						
Methylene chloride, µg/Kg	55(B2)	47(B2)	74(I)	43(B2)	36(B2)	26
Toluene, µg/Kg	--	--	--	--	--	19

TABLE 4-18

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	SAMPLE PSFSB13A (1.5-2.5') 4-6-92	DUPLICATE PSFSB13C (1.5-2.5') 4-6-92	PSFSB13B (4-4.5') 4-6-92	PSFSB14A (2-2.5') 4-4-92	PSFSB14B (4-4.5') 4-4-92	PSFSB15A (2-2.5') 4-4-92
TOTAL ICP METALS:						
Barium, mg/Kg	140	160	130	140	100	60
Cadmium, mg/Kg	--	--	--	--	--	--
Chromium, mg/Kg	10	12	8.0	12	8.3	4.5
Lead, mg/Kg	63	110	36	39	140	7.0
Silver, mg/Kg	--	1.2	--	--	--	--
TOTAL FURNACE METALS:						
Arsenic, mg/Kg	12	14	3.6	5.2	3.0	1.6
Selenium, mg/Kg	0.4(M2)	0.3(M2)	--	0.4(M2)	--	--
ORGANOPHOSPHORUS PESTICIDES:						
RONNEL (FENCHLORPHOS), µg/kg	--	--	--	--	--	--
DIOXIN:	NA	NA	NA	NA	NA	NA
ACID HERBICIDE:	--	--	--	--	--	--

B2 - Sample results are less than 10 times the amount detected in method blank. Result is estimated.
M2 - Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
I - Low internal standard response. Result is an estimated quantitation.
I2 - Low internal standard response and high surrogate recovery. Result is biased high.
-- Not detected
NA - Not analyzed

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB15B (4-4.5') 4-4-92	PSFSB16A (1.5-2.5') 4-4-92	PSFSB16B (3.5-4.5') 4-4-92	SAMPLE PSFSB17A (1.5-2.5') 4-6-92	DUPLICATE PSFSB17C (1.5-2.5') 4-6-92	PSFSB17B (4-4.5') 4-6-92
PESTICIDES/PCBs:						
4,4'-DDD, µg/Kg	--	--	--	--	--	--
4,4'-DDE, µg/Kg	--	--	--	370	750	--
4,4'-DDT, µg/Kg	--	310	25	610	1300	25
Dieldrin, µg/Kg	--	--	--	--	--	--
Endrin aldehyde, µg/Kg	--	--	--	--	--	--
Heptachlor, µg/Kg	--	--	--	--	--	--
Heptachlor epoxide, µg/Kg	--	--	--	--	--	--
Methoxychlor, µg/Kg	--	--	--	--	--	--
alpha-Chlordane, µg/Kg	--	66	6.1	280	470	7.9
gamma-Chlordane, µg/Kg	--	70	7.0	280	470	8.2
SEMI-VOLATILE ORGANICS:						
2,4,6-Trichlorophenol, µg/Kg	--	--	--	--	--	--
2,4-Dichlorophenol, µg/Kg	--	--	--	--	--	--
2-Methylnaphthalene, µg/Kg	--	--	--	--	--	--
Acenaphthene, µg/Kg	--	--	--	--	--	--
Anthracene, µg/Kg	--	--	--	200	--	--
Benzo[a]anthracene, µg/Kg	--	--	--	--	230	--
Benzo[a]pyrene, µg/Kg	--	--	--	--	--	--
Benzo[b]fluoranthene, µg/Kg	--	--	--	--	--	--
Benzo[k]fluoranthene, µg/Kg	--	--	--	--	--	--
Chrysene, µg/Kg	--	--	--	200	230	--
Dibenzofuran, µg/Kg	--	--	--	--	--	--
Diethylphthalate, µg/Kg	--	--	--	--	--	--
Fluoranthene, µg/Kg	--	--	--	280	310	--
Fluorene, µg/Kg	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene, µg/Kg	--	--	--	--	--	--
Phenanthrene, µg/Kg	--	--	--	240	230	--
Pyrene, µg/Kg	--	110	--	360	270	--
bis(2-Ethylhexyl)phthalate, µg/Kg	--	960	--	--	--	--
TOTAL MERCURY:						
Mercury, mg/kg	--	--	--	0.3	0.3	--
VOLATILE ORGANICS:						
Methylene chloride, µg/Kg	35(B2)	28(B2)	34(B2)	71	41(B2)	29
Toluene, µg/Kg	38(I2)	6.9	16	12(I2)	7.6	5.9

TABLE 4-18

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB15B (4-4.5') 4-4-92	PSFSB16A (1.5-2.5') 4-4-92	PSFSB16B (3.5-4.5') 4-4-92	SAMPLE PSFSB17A (1.5-2.5') 4-6-92	DUPLICATE PSFSB17C (1.5-2.5') 4-6-92	PSFSB17B (4-4.5') 4-6-92
TOTAL ICP METALS:						
Barium, mg/Kg	130	47	120	150	120	71
Cadmium, mg/Kg	--	--	--	--	--	--
Chromium, mg/Kg	5.5	4.7	8.7	11	10	5.7
Lead, mg/Kg	7.6	18	12	110	60	8.0
Silver, mg/Kg	--	--	--	--	--	--
TOTAL FURNACE METALS:						
Arsenic, mg/Kg	1.5	1.9	1.6	4.1	4.0	0.9
Selenium, mg/Kg	--	--	--	0.2(M2)	0.2(M2)	--
ORGANOPHOSPHORUS PESTICIDES:						
RONNEL (FENCHLORPHOS), µg/kg	--	--	--	--	--	--
DIOXIN:	NA	NA	NA	--	NA	NA
ACID HERBICIDE:	--	--	--	--	--	--

B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
I – Low internal standard response. Result is an estimated quantitation.
I2 – Low internal standard response and high surrogate recovery. Result is biased high.
-- – Not detected
NA – Not analyzed

…LE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB18A (2-2.5') 4-5-92	PSFSB18B (4-4.5') 4-5-92	PSFSB19A (2-2.5') 4-4-92	PSFSB19B (4-4.5') 4-4-92	PSFSB20A (2-2.5') 4-8-92	PSFSB20B (4-4.5') 4-8-92
PESTICIDES/PCBs:						
4,4'-DDD, µg/Kg	--	--	--	--	--	--
4,4'-DDE, µg/Kg	110	22	26	22	--	11(H)
4,4'-DDT, µg/Kg	170	82	50	36	--	26(H)
Dieldrin, µg/Kg	--	--	--	--	--	--
Endrin aldehyde, µg/Kg	--	--	--	--	--	--
Heptachlor, µg/Kg	--	--	--	--	--	--
Heptachlor epoxide, µg/Kg	--	--	--	--	--	--
Methoxychlor, µg/Kg	--	--	--	--	--	--
alpha-Chlordane, µg/Kg	42	16	16	13	5.6(S)	14(H)
gamma-Chlordane, µg/Kg	36	18	15	12	5.4(S)	12(H)
SEMI-VOLATILE ORGANICS:						
2,4,6-Trichlorophenol, µg/Kg	--	--	--	--	--	--
2,4-Dichlorophenol, µg/Kg	--	--	--	--	--	--
2-Methylnaphthalene, µg/Kg	--	--	--	--	--	--
Acenaphthene, µg/Kg	--	--	--	--	--	--
Anthracene, µg/Kg	--	--	--	--	--	--
Benzo[a]anthracene, µg/Kg	160	--	--	--	160	160
Benzo[a]pyrene, µg/Kg	--	--	--	--	--	--
Benzo[b]fluoranthene, µg/Kg	--	--	--	--	--	--
Benzo[k]fluoranthene, µg/Kg	--	--	--	--	--	--
Chrysene, µg/Kg	160	--	120	--	200	200
Dibenzofuran, µg/Kg	--	--	--	--	--	--
Diethylphthalate, µg/Kg	--	--	--	--	510	430
Fluoranthene, µg/Kg	160	--	200	--	310	310
Fluorene, µg/Kg	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene, µg/Kg	--	--	--	--	--	--
Phenanthrene, µg/Kg	--	--	--	--	270	230
Pyrene, µg/Kg	200	--	200	--	310	310
bis(2-Ethylhexyl)phthalate, µg/Kg	--	--	400	--	--	--
TOTAL MERCURY:						
Mercury, mg/kg	--	--	1.3	--	0.2	--
VOLATILE ORGANICS:						
Methylene chloride, µg/Kg	31	31	44	31(B2)	26	15(B2)
Toluene, µg/Kg	--	9.5	34(I)	--	14	--

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSB18A (2-2.5') 4-5-92	PSFSB18B (4-4.5') 4-5-92	PSFSB19A (2-2.5') 4-4-92	PSFSB19B (4-4.5') 4-4-92	PSFSB20A (2-2.5') 4-6-92	PSFSB20B (4-4.5') 4-6-92
TOTAL ICP METALS:						
Barium, mg/Kg	62	110	160	100	69	86
Cadmium, mg/Kg	--	--	--	--	--	--
Chromium, mg/Kg	5.5	6.8	14	6.9	5.6	6.9
Lead, mg/Kg	30	15	38	12	75	69
Silver, mg/Kg	--	--	1.1	--	--	--
TOTAL FURNACE METALS:						
Arsenic, mg/Kg	2.0	1.6	4.0	1.4	3.1	1.9
Selenium, mg/Kg	--	--	--	--	0.2(M2)	--
ORGANOPHOSPHORUS PESTICIDES:						
RONNEL (FENCHLORPHOS), µg/kg	--	--	--	--	--	--
DIOXIN:	NA	NA	NA	NA	NA	NA
ACID HERBICIDE:	--	--	--	--	--	--

S - Low surrogate recovery. Results are biased low.
H - Holding time exceeded. Results biased low.
B2 - Sample results are less than 10 times the amount detected in method blank. Result is estimated.
M2 - Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
-- Not detected
NA - Not analyzed

TABLE 4-17

POSITIVE ANALYTICAL RESULTS/PILOT HOLE
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSF92SB01A (5') 1-24-92	PSF92SB01B (38') 1-24-92
PESTICIDES/PCBs:	--	--
SEMI-VOLATILE ORGANICS:	--	--
VOLATILE ORGANICS:		
Methylene chloride, ug/Kg	21(T)	18(T)
TOTAL FURNACE METALS:		
Arsenic, mg/Kg	1.6	1.2
Selenium, mg/kg	0.2(M2)	--
TOTAL ICP METALS:		
Aluminum, mg/kg	5800	3900
Barium, mg/kg	66	75
Calcium, mg/kg	1600	2400
Chromium, mg/kg	5.2	5.4
Cobalt, mg/kg	3.6	3.4
Copper, mg/kg	3.5	3.6
Iron, mg/kg	5300	5600
Magnesium, mg/kg	970	1400
Manganese, mg/kg	120	130
Nickel, mg/kg	6.5	7.6
Potassium, mg/kg	940	820
Sodium, mg/kg	45	57
Vanadium, mg/kg	13	15
Zinc, mg/kg	14	16
TOTAL MERCURY:	--	--
ORGANOPHOSPHORUS PESTICIDES:	--	--
ACID HERBICIDE:	--	--
DIOXIN:	--	--

M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
T – Sample results are less than 10 times the amount detected in trip blank. Result is estimated.
-- Not detected

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/MONITORING WELL SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	MWSB01A (16-17') 4-28-92	MWSB01B (21-25') 4-28-92	MWSB02A (1-2') 5-5-92	SAMPLE MWSB02B (4-6') 5-5-92	DUPLICATE MWSB02F (4-6') 5-5-92	MWSB02C (8-12') 5-5-92	MWSB02D (14-16') 5-5-92
PESTICIDES/PCBs:							
4,4'-DDE, ug/Kg	--	--	--	--	--	--	--
Dieldrin, ug/Kg	--	--	--	--	--	--	--
alpha-Chlordane, ug/Kg	--	--	73	--	--	--	--
gamma-Chlordane, ug/Kg	--	--	71	--	--	--	--
SEMI-VOLATILE ORGANICS:							
Benzo[a]anthracene, ug/Kg	--	--	600	--	--	--	--
Benzo[a]pyrene, ug/Kg	--	--	680	--	--	--	--
Benzo[b]fluoranthene, ug/Kg	--	--	1000	--	--	--	--
Benzo[ghi]perylene, ug/Kg	--	--	400	--	--	--	--
Chrysene, ug/Kg	--	--	640	--	--	--	--
Fluoranthene, ug/Kg	--	--	1000	--	--	--	--
Indeno[1,2,3-cd]pyrene, ug/Kg	--	--	460	--	--	--	--
Phenanthrene, ug/Kg	--	--	560	--	--	--	--
Pyrene, ug/Kg	--	--	800	--	--	--	--
bis(2-Ethylhexyl)phthalate, ug/Kg	--	--	480	--	--	--	--
VOLATILE ORGANICS:							
Benzene, ug/Kg	6.6	5.9	--	--	--	--	--
Methylene chloride, ug/Kg	62 (B2)	46 (B2)	30	16	17	16	17
TOTAL FURNACE METALS:							
Arsenic, mg/Kg	1.0	2.5	3.7	1.7	1.6	1.7	2.4
Selenium, mg/Kg	--	--	0.2 (M2)	--	--	--	--
TOTAL ICP METALS:							
Barium, mg/Kg	61	120	130	83	60	83	100
Chromium, mg/Kg	6.8	8.7	10	11	7.9	4.8	6.4
Lead, mg/Kg	8.1	10	56	--	4.7	--	--
Silver, mg/Kg	--	--	1.0	0.9	--		1.1
TOTAL MERCURY:							
Mercury, mg/kg	--	--	0.3	--	--	--	--
ORGANOPHOSPHORUS PESTICIDES:	--	--	--	--	--	--	--
ACID HERBICIDES:	--	--	--	--	--	--	--

B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
-- Not detected

TABLE 4-16

POSITIVE ANALYTICAL RESULTS/MONITORING WELL SOIL BORINGS
PESTICIDE STORAGE FACILITY
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	MWSB02E (20-22') 5-5-92	MWSB03A (10-14') 5-2-92	MWSB03B (20-22') 5-2-92	MWSB04A (12-14') 5-4-92	MWSB04B (22-24') 5-4-92	MWSB05A (9-11') 4-29-92	MWSB05B (17-19') 4-29-92
PESTICIDES/PCBs:							
4,4'-DDE, ug/Kg	--	--	--	12	--	--	--
Dieldrin, ug/Kg	--	8.7	--	13	--	--	--
alpha-Chlordane, ug/Kg	--	--	--	15	--	--	--
gamma-Chlordane, ug/Kg	--	5.1	--	18	--	--	--
SEMI-VOLATILE ORGANICS:							
Benzo[a]anthracene, ug/Kg	--	--	--	--	--	110	--
Benzo[a]pyrene, ug/Kg	--	--	--	--	--	--	--
Benzo[b]fluoranthene, ug/Kg	--	--	--	--	--	--	--
Benzo[ghi]perylene, ug/Kg	--	--	--	--	--	--	--
Chrysene, ug/Kg	--	--	--	--	--	110	--
Fluoranthene, ug/Kg	--	--	--	--	--	180	--
Indeno[1,2,3-cd]pyrene, ug/Kg	--	--	--	--	--	--	--
Phenanthrene, ug/Kg	--	--	--	--	--	--	--
Pyrene, ug/Kg	--	--	--	--	--	180	--
bis(2-Ethylhexyl)phthalate, ug/Kg	--	--	--	--	--	--	--
VOLATILE ORGANICS:							
Benzene, ug/Kg	--	--	--	--	--	--	--
Methylene chloride, ug/Kg	11	19	22	21	20	70 (B2)	38 (B2)
TOTAL FURNACE METALS:							
Arsenic, mg/Kg	1.4	2.0	0.5	3.1	0.4	2.8	0.6
Selenium, mg/Kg	--	--	--	--	--	--	--
TOTAL ICP METALS:							
Barium, mg/Kg	72	190	66	60	70	96	44
Chromium, mg/Kg	7.1	11	6.1	20	6.0	10	6.6
Lead, mg/Kg	--	8.5	5.9	56	--	30	5.9
Silver, mg/Kg	1.2	--	--	--	--	--	--
TOTAL MERCURY:							
Mercury, mg/kg	--	--	--	--	--	0.1	--
ORGANOPHOSPHORUS PESTICIDES:	--	--	--	--	--	--	--
ACID HERBICIDES:	--	--	--	--	--	--	--

B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
-- Not detected

APPENDIX B

Pesticide Storage Facility
Site Specific Remediation Goals

Determination of Contaminant Specific Remediation Goals

Contaminant-specific Remediation Goals (RGs) are concentration goals for individual constituents of concern for specific medium and land use combinations at the PSF site. These concentrations are based on risk assessment or risk-based calculations that set the concentration limits for the constituents using carcinogenic and/or noncarcinogenic toxicity values under specific exposure conditions (i.e., the exposure scenarios included in the RI report's baseline risk assessment). Contaminant-specific remediation goals are considered TBC criteria for remediation of site media, in the absence of chemical-specific ARARs. Contaminant-specific RGs are derived to protect human health; no consideration is given to ecological effects when developing the RGs.

Health-based remediation goals are developed following guidance available from USEPA in "Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Parts A and B" (USEPA, 1989a; USEPA, 1991b). This method involves estimating exposure for reasonable scenarios at the PSF site. Exposures to contaminated media are estimated by defining a discrete set of variables that describe the potential exposed population, such as contact rate with contaminated media, exposure frequency, exposure duration, and body weight. Risk-based remediation goals for carcinogenic constituents are based on a total risk of 1×10^{-6}, while remediation goals for noncarcinogenic constituents are based on a hazard index of less than 1.0. The equation is then solved for the concentration of the constituent of concern, yielding a goal concentration that is associated with an "acceptable" risk for a given receptor population.

Tables 1 through 4 are summary tables that compare the calculated RGs for each medium (and each receptor of concern) to the maximum constituent concentrations detected in that particular medium. In addition, available regulatory criteria or guidance values are listed in these tables for comparison. The procedures and methodology used to develop the RGs at the PSF site are depicted in Tables A-1 through A-27. The spreadsheets used to calculate the constituent- and receptor-specific RGs are also located in Attachment A.

For all exposure scenarios, standard default body weights of 70 kg for an adult and 15 kg for a child are used. Standard default exposure values were taken from the "Supplemental Guidance to the Human Health Evaluation Manual" (USEPA, 1991a).

Table 1
REMEDIATION GOALS – GROUND WATER
SUMMARY TABLE
Pesticide Storage Facility
Fort Riley, Kansas

Constituent	Remediation Goals [RGs] (mg/L) [a] Future Adult Resident Non-cancer Effects	Remediation Goals [RGs] (mg/L) [a] Future Adult Resident Cancer Effects	Remediation Goals [RGs] (mg/L) [a] Future Child Resident	"Governing" (Lowest) Remediation Goal (mg/L) [b]	Maximum Detected Concentration (mg/L)	Maximum Detected Background Concentration (mg/L)	Federal Maximum Contaminant Level (mg/L) [c]	Kansas Maximum Contaminant Level (mg/L) [d]	Kansas Action Level (mg/L) [d]	Kansas Notification Level (mg/L) [e]
Aluminum	--	--	--	--	0.27	--	--	--	5	--
Arsenic	0.011**	4.72E-05 **	0.0023**	4.72E-05 **	0.016 (boxed)	--	0.05	0.05	0.05	0.05
Barium	2.6	--	0.55	0.55	0.13	0.1	2 f	1	1	--
Beryllium	0.18	1.98E-05 **	0.039**	1.98E-05 **	0.003 (boxed)	0.0014	0.004 *	--	0.00013	--
Chromium	0.18	--	0.16	0.16	0.012	0.01	0.1 T.,f	0.05	0.05	--
Manganese	0.18	--	0.039	0.039	0.091	0.026	0.2 S	--	0.05	--
Vanadium	0.26	--	0.055	0.055	0.027	0.0083	--	--	--	--

Boxed values indicate an exceedence of the calculated RG, but not an exceedence of federal Maximum Contaminant Levels.

a – Groundwater RGs are calculated based on an unlikely future residential scenario. See text for additional information.
b – The RGs listed for each constituent are the most conservative (lowest) value calculated between all receptors.
c – Maximum Contaminant Levels and Maximum Contaminant Level Goals (40 CFR 141 Subpart B).
d – Kansas Drinking Water Rules (KAR 28.15), Last amended 1 May, 1988.
e – KDHE Memorandum, dated 5 December, 1988; Revised Groundwater Contaminant Cleanup Target Concentrations for Aluminum and Selenium.
f – National Public Drinking Water Rules for 38 Inorganic and Synthetic Organic Chemicals (January, 1990) Phase II Fact Sheet.
* – effective date 01-17-94
** – Indicates maximum detected concentration exceeds the calculated RG, but does not exceed the MCL
S – secondary MCL
T – value is for total chromium

Table 2
REMEDIATION GOALS – SURFACE WATER
SUMMARY TABLE
Pesticide Storage Facility
Fort Riley, Kansas

Constituent	Remediation Goals [RGs] (mg/L) [a]			Governing Remediation Goal (mg/L) [b]	Maximum Detected Concentration (mg/L)	Maximum Detected Background Concentration (mg/L)	Federal Ambient Water Quaity Criteria [AWQC] (mg/L) [c] for the protection of:			
	Site Worker		Current/Future Rcreational Child				Aquatic Life		Human Health (ingestion of:)	
	Current	Future					Acute	Chronic	Water & Fish	Fish only
Aluminum	--	--	--		12	3.9	--	--	--	--
Arsenic	2.67	0.41	20	0.41	0.0044 **	0.004 *	(5+) 0.850[d] (3+) 0.360	0.048[d] 0.190	0.0022[e] 0.0022[e]	0.0175[e] 0.0175[e]
Barium	119,000	18,200	4,690	4,690	0.29	0.25	--	--	1	--
Cadmium	850	130	3	3	0.0045	--	0.0039[f]	0.0011[f]	0.01	--
Chromium	8,500	1,300	1,340	1,300	0.024	0.018 *	(6+) 0.016 (3+) 1.7 [f]	0.011 0.21 [f]	0.05 0.17	-- 3.433
Copper	--	--	--	--	0.013	0.01	0.018 [f]	0.012 [f]	--	--
Lead	--	--	--	--	0.0042	--	0.082 [f]	0.0032 [f]	0.05	--
Manganese	8,500	1,300	335	335	0.19 **	0.1	--	--	0.05	0.1
Vanadium	11,900	1,820	469	469	0.026	0.015	--	--	--	--

a – The RGs listed for each potential receptor are the most conservative (lowest) value calculated between carcinogenic and noncarcinogenic endpoints.
b – The RGs listed for each constituent are the most conservative (lowest) value calculated between all receptors.
c – Quality Criteria for Water, 1986. EPA 440/5–86.001. 1 May, 1987. (Kansas incorporates federal AWQC by reference [KAR 28.16.28 Kansas Water Quality Standards])
d – Insufficient criteria to develop criteria. Value presented is the lowest observed effect level.
e – Human health criteria for carcinogens reported at three risk levels. Value presented here is the 10^{-6} risk level.
f – Hardness dependent criteria (100mg/L used)
* – Indicates a background concentration which exceeds AWQC for the protection of human health (fish and water ingestion)
** – Indicates an exceedence of AWQC for the protection of human health, but NOT an exceedence of site–specific health–based PRGs.

Note: The concentrations of consituents detected in site surface water samples are less than the calculated site–specific and health–based RGs.

Table 3
REMEDIATION GOALS – SEDIMENTS
SUMMARY TABLE
Pesticide Storage Facility
Fort Riley, Kansas

Constituent	Remediation Goals [PRGs], (mg/kg);[a] Site Worker Current	Site Worker Future	Current/Future Recreational Child	Governing Remediation Goals (mg/kg)[b]	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)
Arsenic	5.39E+01	8.06E+00	3.30E+02	8.06E+00	3.80E+00	2.20E+00
Barium	2.45E+06	3.64E+05	7.70E+04	7.70E+04	1.50E+02	8.80E+01
Cadmium	1.75E+04	2.60E+03	5.50E+02	5.50E+02	3.30E+00	2.10E+00
Chromium	1.75E+05	2.60E+04	2.20E+04	2.20E+04	2.50E+01	1.30E+01
Lead	--	--	--	--	2.10E+02	6.00E+01
Mercury	1.05E+04	1.56E+03	3.30E+02	3.30E+02	4.00E-01	--
Chlordane	7.46E+01	1.12E+01	6.60E+01	1.12E+01	6.70E-02	9.40E-03 *
4,4-DDD	4.04E+02	6.04E+01	--	6.04E+01	1.00E-01	--
4,4-DDE	2.85E+02	4.26E+01	--	4.26E+01	2.80E-01	--
4,4-DDT	2.85E+02	4.26E+01	5.50E+02	4.26E+01	4.80E-01	1.10E-01 *
Dieldrin	6.06E+00	9.06E-01	5.50E+01	9.06E-01	5.60E-02	--
Benzo[a]anthracene	8.82E+01	1.32E+01	--	1.32E+01	1.60E-01	--
Chrysene	3.34E+02	5.00E+02	--	3.34E+02	2.40E-01	--
Phenanthrene	--	--	--	--	3.60E-01	--

a – The RGs listed for each potential receptor are the most conservative (lowest) value calculated between carcinogenic and noncarcinogenic endpoints for that receptor.
b – The RGs listed for each constituent are the most conservative (lowest) value calculated between all receptors.
* – The organic contamination present in sediment "background" samples may be the result of site activities. Therefore, background samples will only be used to attempt to establish background concentrations for metals constituents.

Note: The concentrations of constituents detected in site sediment samples are less than the calculated site-specific health-based RGs.

Table 4
REMEDIATION GOALS – SOILS
SUMMARY TABLE
Pesticide Storage Facility
Fort Riley, Kansas

Constituent	"Governing" Remediation Goals [RGs] (mg/kg) [a]								Proposed RCRA Soil Action Levels [b] (mg/kg)	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)
	Site Worker		Utility Worker		Landscaper		Const. Worker	Recreat. Child			
	Current	Future	Current	Future	Current	Future	Future	Current & Future			
Pesticides:											
Chlordane	2.25E-01 *	1.72E-01 *	1.09E+02	5.43E+00	4.40E+01	1.09E+01	6.79E+00	6.34E+01	5.00E-01 *	3.20E+00 T	7.50E-01 T,e
4,4'-DDD	1.22E+00	9.29E-01	5.88E+02	2.94E+01	2.38E+02	5.89E+01	3.68E+01	--	3.00E+00	4.30E-01	ND
4,4'-DDE	8.62E-01 *	6.56E-01 *	4.15E+02	2.08E+01	1.68E+02	4.15E+01	2.60E+01	--	2.00E+00	1.80E+00	6.70E-01 e
4,4'-DDT	8.62E-01 *	6.56E-01 *	4.15E+02	2.08E+01 *	1.68E+02	4.15E+01	2.60E+01 *	5.28E+02	2.00E+00 *	3.30E+01	9.40E-02 e
Dieldrin	1.83E-02 *	1.39E-02 *	8.82E+00	4.41E-01	3.57E+00	8.83E-01	5.51E-01	5.28E+01	4.00E-02 *	2.00E-01	2.70E-02 e
Endrin aldehyde	3.09E+01	2.35E+01	1.50E+04	7.59E+02	6.19E+03	1.52E+03	3.76E+01	3.17E+02	2.00E+01 f	1.40E-02	ND
Heptachlor	6.51E-02 *	4.96E-02 *	3.14E+01	1.57E+00	1.27E+01	3.14E+00	1.96E+00	5.28E+02	2.00E-01 *	3.00E-01	ND
Heptachlor epoxide	3.22E-02	2.45E-02	1.55E+01	7.76E-01	6.28E+00	1.55E+00	9.70E-01	1.37E+01	8.00E-02	5.40E-03	4.00E-03 e
Malathion	2.06E+03	1.57E+03	1.00E+05	5.06E+03	4.13E+05	1.02E+05	2.51E+03	2.11E+04	NA	4.19E-01	ND
Methoxychlor	5.15E+02	3.92E+02	2.50E+05	1.26E+04	1.03E+05	2.54E+04	6.26E+02	5.28E+03	NA	1.00E+01	2.40E+00 e
Semi-Volatile Compounds:											
Anthracene	3.09E+04	2.35E+04	1.50E+07	7.59E+05	6.19E+06	1.52E+06	3.76E+04	3.17E+05	NA	7.60E-01	ND
Benzo[a]anthracene	2.76E-01 *	2.10E-01 *	1.33E+02	6.66E+00	5.39E+01	1.33E+01	8.32E+00	--	NA	6.00E-01	ND
Benzo[a]pyrene	4.01E-02 *	3.06E-02 *	1.93E+01	9.67E-01	7.83E+00	1.94E+00	1.21E+00 *	--	NA	1.30E+00	ND
Benzo[b]fluoranthene	2.87E-01 *	2.19E-01 *	1.38E+02	6.92E+00	5.60E+01	1.38E+01	8.65E+00	--	NA	1.40E+00	ND
Benzo[k]fluoranthene	6.10E-01 *	4.65E-01 *	2.94E+02	1.47E+01	1.19E+02	2.94E+01	1.84E+01	--	NA	1.20E+00	ND
Chrysene	1.01E+01	7.69E+00	4.87E+03	2.43E+02	1.97E+03	4.87E+02	3.04E+02	--	NA	1.70E+00	ND
Dibenzofuran	--	--	--	--	--	--	--	--	NA	1.30E-01	ND
Indeno[1,2,3-cd]pyrene	1.72E-01 *	1.31E-01 *	8.30E+01	4.15E+00	3.36E+01	8.31E+00	5.19E+00	--	NA	4.80E-01	ND
2-Methylnaphthalene	--	--	--	--	--	--	--	--	NA	2.00E-01	ND
Phenanthrene	--	--	--	--	--	--	--	--	NA	2.70E+00	ND
Metals:											
Arsenic	1.63E-01 *	1.24E-01 *	7.84E+01 *	3.92E+00 *	3.17E+01 *	7.85E+00 *	4.90E+00 *	3.17E+02	8.00E+01	1.20E+02	2.40E+00
Barium	7.04E+03	5.37E+03	3.50E+06	1.77E+05	1.44E+06	3.53E+05	8.62E+03	7.38E+04	4.00E+03	1.90E+02	9.90E+01
Cadmium	9.90E+02	7.79E+02	5.00E+04	2.53E+03	2.06E+04	5.08E+03	4.03E+04	1.06E+03	4.00E+01	5.00E+00	ND
Chromium	1.47E+02	1.16E+02	9.60E+04	4.80E+03	1.03E+05	2.54E+04	6.00E+03	5.28E+03	4.00E+02 d	4.10E+01	9.30E+00
Lead	--	--	--	--	--	--	--	--	5E+02 to 1E+03 c	7.70E+02	4.60E+01
Mercury	3.09E+01	2.35E+01	1.50E+04	7.59E+02	6.19E+03	1.52E+03	3.76E+01	3.17E+02	2.00E+02	1.30E+00	ND

a – "Governing" RGs listed for each potential receptor are the most conservative (i.e., lowest) values calculated for a given receptor, using both carcinogenic and noncarcinogenic endpoints.
b – RCRA Action Levels – Federal Register, Volume 55, Nuber 145, 27 July, 1990. Pages 30798 – 30884. Corrective Action for Solid Waste Management Facilities, Proposed Rule.
c – Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites. Memorandum from H. Longest and B. Diamond to EPA Regions. OSWER Directive No. 9355.4-02.
d – Value is for hexavalent chromium.
e – Constituent detected in "background" sample(s), but presence may be the result of site activities; background samples used for metals only.
f – Value is for endrin
-- RG not calculated; toxicity values not available for this constituent.
* – Indicates an exceedence by the constituent's maximum detected concentration.

ATTACHMENT A

REMEDIATION GOAL CALCULATIONS

Table A-1
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF GROUND WATER EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * IR_W * EF * ED}{RfD_O * BW * AT * 365 \text{ days/yr}} + \frac{C * EF * ET * ED * SA * PC * 10^{-3} \text{ L/cm}^3}{RfD_O * BW * AT * 365 \text{ days/yr}}$$

$$C \text{ (mg/L)} = \frac{THI * BW * AT * 365 \text{ days/yr}}{EF * ED * (1/RfD_O) * [IR_W + (ET * SA * PC * 10^{-3} \text{ L/cm}^3)]}$$

(risk-based)

PLEASE NOTE: This equation does not contain an inhalation component (only metals were detected in ground water samples)

	Parameter		Definition	Adult	Child
where:	C	=	chemical concentration in ground water (mg/L)		
	THI	=	target hazard index (unitless)	1	1
	RfD_O	=	oral chronic reference dose (mg/kg-day)	chemical specific	chemical specific
	IR_W	=	daily water ingestion rate (L/day)	2 [a]	2 [a,b]
	SA	=	surface area of exposed skin (cm^2/day)	19,400 [b]	8,660 [b]
	PC	=	permeability constant (cm/hr)	0.001 (metals) [c]	0.001 (metals) [c]
	ET	=	exposure time (hrs/day)	0.2 [c]	0.2 [c]
	EF	=	exposure frequency (days/yr)	350 [a]	350 [a]
	ED	=	exposure duration (yrs)	30 [a]	6 [a]
	BW	=	body weight (kg)	70 [a]	15 [a]
	AT	=	averaging time (yrs)	30 [a]	6 [a]

REDUCED EQUATIONS: GROUND WATER – NONCARCINOGENIC EFFECTS

ADULT RECEPTOR

Risk-based RG (mg/L; THI = 1)

$$= \frac{1 * 70 \text{ kg} * 30 \text{ yrs} * 365 \text{ days/yr}}{350 \text{ days/yr} * 30 \text{ yr} * (1/RfD_O) * [\,2 \text{ L/day} + (0.2 \text{ hr} * 19{,}400 \text{ cm}^2\text{/day} * 0.001 \text{ cm/hr} * 10^{-3} \text{ L/cm}^3)]}$$

Risk-based RG (mg/L; THI = 1) = 36.5 RfD_O

CHILD RECEPTOR

Risk-based RG (mg/L; THI = 1)

$$= \frac{1 * 15 \text{ kg} * 6 \text{ yrs} * 365 \text{ days/yr}}{350 \text{ days/yr} * 6 \text{ yr} * (1/RfD_O) * [\,2 \text{ L/day} + (0.2 \text{ hr} * 8{,}660 \text{ cm}^2\text{/day} * 0.001 \text{ cm/hr} * 10^{-3} \text{ L/cm}^3)]}$$

Risk-based RG (mg/L; THI = 1) = 7.8 RfD_O

a – USEPA, 1991
b – USEPA, 1989b
c – USEPA, 1992

Table A-2
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF GROUND WATER EXPOSURES – CARCINOGENIC EFFECTS

$$TR = \frac{SF_O * C * IR_W * EF * ED}{BW * AT * 365\ days/yr} + \frac{SF_O * C * EF * ET * ED * SA * PC * 10^{-3}\ L/cm^3}{BW * AT * 365\ days/yr}$$

C (mg/L) (risk-based) =

$$C = \frac{TR * BW * AT * 365\ days/yr}{EF * ED * SF_O * [IR_W + (ET * SA * PC * 10^{-3}\ L/cm^3)]}$$

PLEASE NOTE: This equation does not contain an inhalation component (only metals were detected in ground water samples)

where:

Parameter		Definition	Value Used
C	=	chemical concentration in ground water (mg/L)	
TR	=	target excess individual lifetime cancer risk (unitless)	10^{-6}
RfD_O	=	oral chronic reference dose (mg/kg-day)	chemical specific
IR_W	=	daily water ingestion rate (L/day)	2 [a]
SA	=	surface area of exposed skin (cm^2/day)	19,400 [b]
PC	=	permeability constant (cm/hr)	0.001 (metals) [c]
ET	=	exposure time (hrs/day)	0.2 [c]
EF	=	exposure frequency (days/yr)	350 [a]
ED	=	exposure duration (yrs)	30 [a]
BW	=	body weight (kg)	70 [a]
AT	=	averaging time (yrs)	70 [a]

REDUCED EQUATIONS: GROUND WATER – CARCINOGENIC EFFECTS

ADULT RECEPTOR

Risk-based RG (mg/L; TR = 10^{-6}) =

$$\frac{10^{-6} * 70\ kg * 70\ yrs * 365\ days/yr}{350\ days/yr * 30\ yr * SF_O * [\ 2\ L/day + (0.2\ hr * 19{,}400\ cm^2/day * 0.001\ cm/hr * 10^{-3}\ L/cm^3)]}$$

Risk-based RG (mg/L; TR = 10^{-6}) = $\frac{8.5 \times 10^{-5}}{SF_O}$

NOTE: Carcinogenic RGs are not calculated for children.
Carcinogenesis is based on chronic exposures lasting > 7 years, and the child in the residential scenario is 6 yrs of age.

a – USEPA, 1991
b – USEPA, 1989b
c – USEPA, 1992

TABLE A-3
REMEDIATION GOALS – GROUND WATER (ADULT RECEPTOR)
Pesticide Storage Facility
Fort Riley, Kansas

RESIDENTIAL ADULT

Constituent	Reference Dose (oral) (mg/kg-day)	Remediation Goal (mg/L) Non-cancer Effects	Cancer Slope Factor (oral) (mg/kg-day)$^{-1}$	Remediation Goal (mg/L) Carcinogenic Effects	Federal Maximum Contaminant Level (mg/L) [a]	Kansas Maximum Contaminant Level (mg/L) [b]	Kansas Action Level (mg/L) [c]	Kansas Notification Level (mg/L) [c]	Governing Remediation Goal (mg/L)	Maximum Detected Concentration (mg/L)
Aluminum	--	--	--	--	--	--	5	--	--	2.70E-01
Arsenic	3.00E-04	1.09E-02	1.80E+00	4.72E-05	0.05	0.05	0.05	0.05	4.72E-05	1.60E-02
Barium	7.00E-02	2.56E+00	--	--	2 d	1	1	--	2.56E+00	1.30E-01
Beryllium	5.00E-03	1.82E-01	4.30E+00	1.98E-05	0.004 *	--	0.00013	--	1.98E-05	3.00E-03
Chromium	5.00E-03	1.82E-01	--	--	0.1 T d	0.05	0.05	--	1.82E-01	1.20E-02
Manganese	5.00E-03 w	1.82E-01	--	--	0.2 S	--	0.05	--	1.82E-01	9.10E-02
Vanadium	7.00E-03 p	2.56E-01	--	--	--	--	--	--	2.56E-01	2.70E-02

p – IRIS lists toxicity value as pending; value used here is obtained from HEAST (1992).
w – IRIS value for constituent in water.
* – effective date 1-17/94
s – secondary MCL
T – value is for total chromium
a – Maximum Contaminant Levels and Maximum Contaminant Level Goals (40CFR 141 Subpart B)
b – Kansas Drinking Water Rules (KAR 28.15), 1 May, 1988
c – KDHE Memorandum, 5 December, 1988; Revised Groundwater Contaminant Cleanup Target Concentrations for Aluminum and Selenium
d – National Public Drinking Water Rules for 38 Inorganic and Synthetic Organic Chemicals (January 1990), Phase II Fact SHeet
e – Drinking Water Regulations and Health Advisories; USEPA Office of Water, December 1992

TABLE A-4
REMEDIATION GOALS – GROUND WATER (CHILD RECEPTOR)
Pesticide Storage Facility
Fort Riley, Kansas

RESIDENTIAL CHILD

Constituent	Subchronic Reference Dose (oral) (mg/kg-day)	Remediation Goal (mg/L) Non-cancer Effects	Cancer Slope Factor (oral) (mg/kg-day)$^{-1}$	Remediation Goal (mg/L) Carcinogenic Effects	Federal Maximum Contaminant Level (mg/L) [a]	Kansas Maximum Contaminant Level (mg/L) [b]	Kansas Action Level (mg/L) [c]	Kansas Notification Level (mg/L) [c]	Governing Remediation Goal (mg/L)	Maximum Detected Concentration (mg/L)
Aluminum	--	--	--	--	--	--	5	--	--	2.70E-01
Arsenic	3.00E-04	2.34E-03	1.80E+00	--	0.05	0.05	0.05	0.05	2.34E-03	1.60E-02
Barium	7.00E-02	5.46E-01	--	--	2 d	1	1	--	5.46E-01	1.30E-01
Beryllium	5.00E-03	3.90E-02	4.30E+00	--	0.004 *	--	0.00013	--	3.90E-02	3.00E-03
Chromium	2.00E-02	1.56E-01	--	--	0.1 T,d	0.05	0.05	--	1.56E-01	1.20E-02
Manganese	5.00E-03 w	3.90E-02	--	--	0.2 S	--	0.05	--	3.90E-02	9.10E-02
Vanadium	7.00E-03 p	5.46E-02	--	--	--	--	--	--	5.46E-02	2.70E-02

p – IRIS lists toxicity value as pending; value listed here is obtained from HEAST (1992).
w – IRIS value for constituent in water.
* – effective date 1-17-94
s – secondary MCL
T – value is for total chromium
a – Maximum Contaminant Levels and Maximum Contaminant Level Goals (40 CFR 141 Subpart B)
b – Kansas Drinking Water Rules (KAR 28.15), 1 May, 1988
c – KDHE Memorandum, 5 December, 1988; Revised Groundwater Contaminat Cleanup Target Concentrations for Aluminum and Selenium
d – National Public Drinking Water Rules for 38 Inorganic and Synthetic Organic Chemicals, Phase II Fact Sheet; January, 1990.
e – Drinking Water Regulations and Health Advisories; USEPA Office of Water, December, 1992

Table A-5
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF OCCUPATIONAL SURFACE WATER EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * EF * ET * ED * SA * PC * 10^{-3}\ L/cm^3}{RfD_O * BW * AT * 365\ days/yr}$$

$$C\ (mg/L)\ (risk\text{-}based) = \frac{THI * BW * AT * 365\ days/yr}{(1/RfD_O) * EF * ED * ET * SA * PC * 10^{-3}\ L/cm^3)]}$$

PLEASE NOTE: This equation does not contain an inhalation or an oral component. Only metals were detected in the samples, and the surface water is too shallow for incidental ingestion.

	Parameter		Definition	Current Exposure	Future Exposure
where:	C	=	chemical concentration in ground water (mg/L)		
	THI	=	target hazard index (unitless)	1	1
	RfD_O	=	oral chronic reference dose (mg/kg-day)	chemical specific	chemical specific
	SA	=	surface area of exposed skin (cm^2/day)	6,170 [a]	6,170 [a]
	PC	=	permeability constant (cm/hr)	0.001 (metals) [b]	0.001 (metals) [b]
	ET	=	exposure time (hrs/day)	8 [c,d]	8 [c,d]
	EF	=	exposure frequency (days/yr)	0.3 [c]	2
	ED	=	exposure duration (yrs)	25 [d]	25 [d]
	BW	=	body weight (kg)	70 [d]	70 [d]
	AT	=	averaging time (yrs)	25 [d]	25 [d]

REDUCED EQUATION: OCCUPATIONAL SURFACE WATER – NONCARCINOGENIC EFFECTS

CURRENT SITE WORKER

$$\text{Risk-based RG (mg/L; THI = 1)} = \frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{0.3\ days/yr * 25\ yr * (1/RfD_O) * 8\ hr * 6{,}170\ cm^2/day * 0.001\ cm/hr * 10^{-3}\ L/cm^3)]}$$

Risk-based RG (mg/L; THI = 1) = $1.7 \times 10^6\ RfD_O$

FUTURE SITE WORKER

$$\text{Risk-based RG (mg/L; THI = 1)} = \frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{2\ days/yr * 25\ yr * (1/RfD_O) * 8\ hr * 6{,}170\ cm^2/day * 0.001\ cm/hr * 10^{-3}\ L/cm^3)]}$$

Risk-based RG (mg/L; THI = 1) = $2.6 \times 10^5\ RfD_O$

a – USEPA, 1989b
b – Of the metals detected in site surface water, only cadmium, chromium and lead have chemical specific PC values. Chromium and cadmium have the same PC value as the default PC value for metals (0.001 cm^2/hr). Lead's PC value differs but there is no toxicity value for lead so a chemical-specific RG cannot be calculated. Therefore, for simplicity, the default PC value is used in calculating surface water RGs; USEPA, 1992.
c – DEH, 1992a
d – USEPA, 1991

Table A-6
PRELIMINARY REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF OCCUPATIONAL SURFACE WATER EXPOSURES – CARCINOGENIC EFFECTS

$$TR = \frac{SF_O * C * EF * ET * ED * SA * PC * 10^{-3}\ L/cm^3}{BW * AT * 365\ days/yr}$$

$$C\ (mg/L)\ (risk\text{-}based) = \frac{TR * BW * AT * 365\ days/yr}{EF * ED * SF_O * ET * SA * PC * 10^{-3}\ L/cm^3}$$

PLEASE NOTE: This equation does not contain an inhalation or an oral component. Only metals were detected in the samples, and the surface water is too shallow for incidental ingestion.

where:

Parameter		Definition	Current Exposure	Future Exposure
C	=	chemical concentration in ground water (mg/L)		
TR	=	target excess individual lifetime cancer risk (unitless)	10^{-6}	10^{-6}
RfD_O	=	oral chronic reference dose (mg/kg-day)	chemical specific	chemical specific
SA	=	surface area of exposed skin (cm^2/day)	6,170 [a]	6,170 [a]
PC	=	permeability constant (cm/hr)	0.001 (metals) [b]	0.001 (metals) [b]
ET	=	exposure time (hrs/day)	8 [c,d]	8 [c,d]
EF	=	exposure frequency (days/yr)	0.3 [c]	2
ED	=	exposure duration (yrs)	25 [d]	25 [d]
BW	=	body weight (kg)	70 [d]	70 [d]
AT	=	averaging time (yrs)	70 [d]	70 [d]

REDUCED EQUATION: OCCUPATIONAL SURFACE WATER – CARCINOGENIC EFFECTS

CURRENT SITE WORKER

$$\text{Risk-based RG } (mg/L;\ TR = 10^{-6}) = \frac{10^{-6} * 70\ kg * 70\ yrs * 365\ days/yr}{0.3\ days/yr * 25\ yr * SF_O * 8\ hr * 6{,}170\ cm^2/day * 0.001\ cm/hr * 10^{-3}\ L/cm^3)]}$$

$$\text{Risk-based RG } (mg/L;\ TR = 10^{-6}) = \frac{4.8}{SF_O}$$

FUTURE SITE WORKER

$$\text{Risk-based RG } (mg/L;\ TR = 10^{-6}) = \frac{10^{-6} * 70\ kg * 70\ yrs * 365\ days/yr}{2\ days/yr * 25\ yr * SF_O * 8\ hr * 6{,}170\ cm^2/day * 0.001\ cm/hr * 10^{-3}\ L/cm^3)]}$$

$$\text{Risk-based RG } (mg/L;\ TR = 10^{-6}) = \frac{0.72}{SF_O}$$

a – USEPA, 1989b
b – Of the metals detected in site surface water, only cadmium, chromium and lead have chemical specific PC values. Chromium and cadmium have the same PC value as the default PC value for metals (0.001 cm^2/hr). Lead's PC value differs but there is no toxicity value for lead so a chemical-specific RG cannot be calculated. Therefore, for simplicity, the default PC value is used in calculating surface water RGs; USEPA, 1992.
c – DEH, 1992a
d – USEPA, 1991

Table A–7
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF RECREATIONAL SURFACE WATER EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * EF * ET * ED * SA * PC * 10^{-3}\ L/cm^3}{RfD_O * BW * AT * 365\ days/yr}$$

$$C\ (mg/L)\ (risk-based) = \frac{THI * BW * AT * 365\ days/yr}{(1/RfD_O) * EF * ED * ET * SA * PC * 10^{-3}\ L/cm^3)]}$$

PLEASE NOTE: This equation does not contain an inhalation or an oral component. Only metals were detected in the samples, and the surface water is too shallow for incidental ingestion.

	Parameter		Definition	Recreational Child
where:	C	=	chemical concentration in ground water (mg/L)	
	THI	=	target hazard index (unitless)	1
	RfD_O	=	oral chronic reference dose (mg/kg–day)	chemical specific
	SA	=	surface area of exposed skin (cm^2/day)	4,490 [a]
	PC	=	permeability constant (cm/hr)	0.001 (metals) [b]
	ET	=	exposure time (hrs/day)	2.6 [b]
	EF	=	exposure frequency (days/yr)	7 [b]
	ED	=	exposure duration (yrs)	6 [c]
	BW	=	body weight (kg)	15 [c]
	AT	=	averaging time (yrs)	6 [c]

REDUCED EQUATION: RECREATIONAL SURFACE WATER – NONCARCINOGENIC EFFECTS

RECREATIONAL CHILD

$$\text{Risk-based RG (mg/L; THI = 1)} = \frac{1 * 15\ kg * 6\ yrs * 365\ days/yr}{7\ days/yr * 6\ yr * (1/RfD_O) * 2.6\ hr * 4{,}490\ cm^2/day * 0.001\ cm/hr * 10^{-3}\ L/cm^3)]}$$

$$\text{Risk-based RG (mg/L; THI = 1)} = 6.7 \times 10^{4}\ RfD_O$$

a – USEPA, 1989b
b – Of the metals detected in site surface water, only cadmium, chromium and lead have chemical specific PC values. Chromium and cadmium have the same PC value as the default PC value for metals (0.001 cm^2/hr). Lead's PC value differs but there is no toxicity value for lead so a chemical–specific RG cannot be calculated. Therefore, for simplicity, the default PC value is used in calculating surface water RGs; USEPA, 1992.
c – USEPA, 1991

TABLE A-8
REMEDIATION GOALS – SURFACE WATER (SITE WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT SITE WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Remediation Goals (mg/L) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Remediation Goals (mg/L) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/L)	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)	Federal Ambient Water Quality Criteria [AWQC], (mg/L) [a] for the protection of: Aquatic Life – Acute	Aquatic Life – Chronic	Human Health (ingestion of:) Water & Fish	Human Health (ingestion of:) Fish only
Aluminum	--	--	--	--	--	1.20E+01	3.90E+00	--	--	--	--
Arsenic	0.0003	510	1.8	2.67	2.67	4.40E-03	4.00E-03	(5+) 0.850[b] (3+) 0.360	0.048[b] 0.190	0.0022[c] 0.0022[c]	0.0175[c] 0.0175[c]
Barium	0.07	119000	--	--	119000	2.90E-01	2.50E-01	--	--	1	--
Cadmium	0.0005 w	850	--	--	850	4.50E-03	--	0.0039[d]	0.0011[d]	0.01	--
Chromium	0.005	8500	--	--	8500	2.40E-02	1.80E-02	(6+) 0.016 (3+) 1.7 [d]	0.011 0.21[d]	0.05 0.17	-- 3.433
Copper	--	--	--	--	--	1.30E-02	1.00E-02	0.018[d]	0.012[d]	--	--
Lead	--	--	--	--	--	4.20E-03	--	0.082[d]	0.0032[d]	0.05	--
Manganese	0.005 w	8500	--	--	8500	1.90E-01	1.00E-01	--	--	0.05	0.1
Vanadium	0.007 p	11900	--	--	11900	5.60E-01	1.50E-02	--	--	--	--

p – IRIS lists toxicity value as pending; value used here is obtained from HEAST (1992).
w – IRIS value is for constituent in water.
a – Quality Criteria for Water, 1986. EPA 440/5-86/001. (Kansas incorporates AWQC by reference [KAR 28.16.28 Kansas Water Quality Standards])
b – Insufficient data to develop criteria. Value presented is the lowest observed effect level.
c – Human health criteria for carcinogens reported at three risk levels. Value presented here is the 10^{-6} level.
d – Hardness dependent criteria (100 mg/L used)

TABLE A-9
PRELIMINARY REMEDIATION GOALS – SURFACE WATER (SITE WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE SITE WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Remediation Goals (mg/L) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Remediation Goals (mg/L) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/L)	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)	Federal Ambient Water Quality Criteria [AWQC], (mg/L) [a] for the protection of: Aquatic Life – Acute	Aquatic Life – Chronic	Human Health (Ingestion of:) Water & Fish	Human Health (Ingestion of:) Fish only
Aluminum	--	--	--	--	--	1.20E+01	3.90E+00	--	--	--	--
Arsenic	0.0003	78	1.8	0.41	0.41	4.40E-03	4.00E-03	(5+) 0.850[b]	0.048[b]	0.0022[c]	0.0175[c]
								(3+) 0.360	0.190	0.0022[c]	0.0175[c]
Barium	0.07	18200	--	--	18200	2.90E-01	2.50E-01	--	--	1	--
Cadmium	0.0005 w	130	--	--	130	4.50E-03	--	0.0039[d]	0.0011[d]	0.01	--
Chromium	0.005	1300	--	--	1300	2.40E-02	1.80E-02	(6+) 0.016	0.011	0.05	--
								(3+) 1.7[d]	0.21[d]	0.17	3.433
Copper	--	--	--	--	--	1.30E-02	1.00E-02	0.018[d]	0.012[d]	--	--
Lead	--	--	--	--	--	4.20E-03	--	0.082[d]	0.0032[d]	0.05	--
Manganese	0.005 w	1300	--	--	1300	1.90E-01	1.00E-01	--	--	0.05	0.1
Vanadium	0.007 p	1820	--	--	1820	5.60E-01	1.50E-02	--	--	--	--

p – IRIS lists toxicity value as pending; value used here is obtained from HEAST (1992).
w – IRIS value is for constituent in water.
a – Quality Criteria for Water, 1986. EPA 440/5-86/001. (Kansas incorporates AWQC by reference [KAR 28.16.28 Kansas Water Quality Standards])
b – Insufficient data to develop criteria. Value presented is the lowest observed effect level.
c – Human health criteria for carcinogens reported at three risk levels. Value presented here is the 10^{-6} level.
d – Hardness dependent criteria (100 mg/L used)

TABLE A-10
PRELIMINARY REMEDIATION GOALS – SURFACE WATER (RECREATIONAL RECEPTORS)
Pesticide Storage Facility
Fort Riley, Kansas

RECREATIONAL CHILD

Constituent	Subchronic Reference Dose (oral) (mg/kg–day)	Preliminary Remediation Goals (mg/L) Non–cancer Effects	Cancer Slope Factor (oral) $(mg/kg–day)^{-1}$	Preliminary Remediation Goals (mg/L) Carcinogenic Effects	Governing Preliminary Remediation Goal (mg/L)	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)	Federal Ambient Water Quality Criteria (mg/L) [a] for the protection of: Aquatic Life		Human Health (ingestion of:)	
								Acute	Chronic	Water & Fish	Fish only
Aluminum	--	--	--	--	--	1.20E+01	3.90E+00	--	--	--	--
Arsenic	0.0003	20	1.8	--	20	4.40E-03	4.00E-03	(5+) 0.850[d] (3+) 0.360	0.048[d] 0.190	0.0022[e] 0.0022[e]	0.0175[e] 0.0175[e]
Barium	0.07	4690	--	--	4690	2.90E-01	2.50E-01	--	--	1	--
Cadmium	0.00005	3	--	--	3	4.50E-03	--	0.0039[f]	0.0011[f]	0.01	--
Chromium	0.020	1340	--	--	1340	2.40E-02	1.80E-02	(6+) 0.016 (3+) 1.7[f]	0.011 0.21[f]	0.05 0.17	-- 3.433
Copper	--	--	--	--	--	1.30E-02	1.00E-02	0.018[f]	0.012[f]	--	--
Lead	--	--	--	--	--	4.20E-03	--	0.082[f]	0.0032[f]	0.05	--
Manganese	0.005 w	335	--	--	335	1.90E-01	1.00E-01	--	--	0.05	0.1
Vanadium	0.007 p	469	--	--	469	5.60E-01	1.50E-02	--	--	--	--

p – IRIS lists value as pending; value used here is obtained from HEAST (1992).
w – IRIS value for constituent in water.
a – Quality Criteria for Water, 1986. EPA / 44015-86-001. (Kansas incorporates AWQC by reference [KAR 28.16.28 Kansas Water Quality Standards]).

Table A-11
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF OCCUPATIONAL SEDIMENT EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * IR_{SED} * EF * ED * 10^{-6}\ kg/mg}{RfD_O * BW * AT * 365\ days/yr} + \frac{C * EF * ED * AF * ABS * SA * 10^{-6}\ kg/mg}{RfD_O * BW * AT * 365\ days/yr}$$

C (mg/kg) (risk-based) =

$$C = \frac{THI * BW * AT * 365\ days/yr}{[(1/RfD_O) * EF * ED * 10^{-6}\ kg/mg] * [IR_{SED} + (AF * ABS * SA)]}$$

where:

Parameter		Definition	Current Exposure	Future Exposure
C	=	chemical concentration in sediment (mg/kg)		
THI	=	target hazard index (unitless)	1	1
RfD_O	=	oral chronic reference dose (mg/kg-day)	chemical specific	chemical specific
IR_{SED}	=	daily sediment ingestion rate (mg/day)	480 [a]	480 [a]
SA	=	surface area of exposed skin (cm^2/day)	1,980 [b]	1,980 [b]
AF	=	soil to skin adherence factor (mg/cm^2)	1 [c]	1 [c]
ABS	=	absorption factor (unitless)	100%	100%
EF	=	exposure frequency (days/yr)	0.3 [d]	2
ED	=	exposure duration (yrs)	25 [a]	25 [a]
BW	=	body weight (kg)	70 [a]	70 [a]
AT	=	averaging time (yrs)	25 [a]	25 [a]

REDUCED EQUATIONS: OCCUPATIONAL SEDIMENT – NONCARCINOGENIC EFFECTS

CURRENT SITE WORKER

Risk-based RG (mg/kg; THI = 1) =

$$\frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{[0.3\ days/yr * 25\ yr * 10^{-6}\ kg/mg * (1/RfD_O)] * [480\ mg/day + (1\ mg/cm^2 * 1 * 1{,}980\ cm^2/day)]}$$

Risk-based RG (mg/kg; THI = 1)	= $3.5 \times 10^{7}\ RfD_O$

FUTURE SITE WORKER

Risk-based RG (mg/kg; THI = 1) =

$$\frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{[2\ days/yr * 25\ yr * 10^{-6}\ kg/mg * (1/RfD_O)] * [480\ mg/day + (1\ mg/cm^2 * 1 * 1{,}980\ cm^2/day)]}$$

Risk-based RG (mg/kg; THI = 1)	= $5.2 \times 10^{6}\ RfD_O$

a – USEPA, 1991
b – USEPA, 1989b
c – USEPA, 1992
d – DEH, 1992a

Table A-12
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF OCCUPATIONAL SEDIMENT EXPOSURES – CARCINOGENIC EFFECTS

$$TR = \frac{SF_O * C * IR_{SED} * EF * ED * 10^{-6}\ kg/mg}{BW * AT * 365\ days/yr} + \frac{SF_O * C * EF * ED * AF * ABS * SA * 10^{-6}\ kg/mg}{BW * AT * 365\ days/yr}$$

C (mg/kg) (risk-based) =

$$C = \frac{TR * BW * AT * 365\ days/yr}{[SF_O * EF * ED * 10^{-6}\ kg/mg] * [IR_{SED} + (AF * ABS * SA)]}$$

where:

Parameter		Definition	Current Exposure	Future Exposure
C	=	chemical concentration in sediment (mg/kg)		
TR	=	target excess individual lifetime cancer risk (unitless)	10^{-6}	10^{-6}
SF_O	=	oral cancer slope factor $(mg/kg-day)^{-1}$	chemical specific	chemical specific
IR_{SED}	=	daily sediment ingestion rate (mg/day)	480 [a]	480 [a]
SA	=	surface area of exposed skin (cm^2/day)	1,980 [b]	1,980 [b]
AF	=	soil to skin adherence factor (mg/cm^2)	1 [c]	1 [c]
ABS	=	absorption factor (unitless)	100%	100%
EF	=	exposure frequency (days/yr)	0.3 [d]	2
ED	=	exposure duration (yrs)	25 [a]	25 [a]
BW	=	body weight (kg)	70 [a]	70 [a]
AT	=	averaging time (yrs)	70 [a]	70 [a]

REDUCED EQUATIONS: OCCUPATIONAL SEDIMENT – CARCINOGENIC EFFECTS

CURRENT SITE WORKER

Risk-based RG (mg/kg; TR = 10^{-6})

$$= \frac{10^{-6} * 70\ kg * 70\ yrs * 365\ days/yr}{[0.3\ days/yr * 25\ yr * 10^{-6}\ kg/mg * SF_O] * [480\ mg/day + (1\ mg/cm^2 * 1 * 1{,}980\ cm^2/day)]}$$

Risk-based RG (mg/kgL; TR = 10^{-6}) $= \frac{97}{SF_O}$

FUTURE SITE WORKER

Risk-based RG (mg/kg; TR = 10^{-6})

$$= \frac{10^{-6} * 70\ kg * 70\ yrs * 365\ days/yr}{[2\ days/yr * 25\ yr * 10^{-6}\ kg/mg * SF_O] * [480\ mg/day + (1\ mg/cm^2 * 1 * 1{,}980\ cm^2/day)]}$$

Risk-based RG (mg/kg; TR = 10^{-6}) $= \frac{14.5}{SF_O}$

a – USEPA, 1991
b – USEPA, 1989b
c – USEPA, 1992
d – DEH, 1992a

Table A-13
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF RECREATIONAL SEDIMENT EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * IR_{SED} * EF * ED * 10^{-6}\ kg/mg}{RfD_O * BW * AT * 365\ days/yr} + \frac{C * EF * ED * ET * AF * ABS * SA * 10^{-6}\ kg/mg}{RfD_O * BW * AT * 365\ days/yr}$$

C (mg/kg) = (risk-based)

$$C = \frac{THI * BW * AT * 365\ days/yr}{[(1/RfD_O) * EF * ED * 10^{-6}\ kg/mg] * [IR_{SED} + (ET * AF * ABS * SA)]}$$

where:

Parameter		Definition	Child
C	=	chemical concentration in sediment (mg/kg)	
THI	=	target hazard index (unitless)	1
RfD_O	=	oral chronic reference dose (mg/kg-day)	chemical specific
IR_{SED}	=	daily sediment ingestion rate (mg/day)	200 [a]
SA	=	surface area of exposed skin (cm^2/day)	4,490 [b]
AF	=	soil to skin adherence factor (mg/cm^2)	1 [c]
ABS	=	absorption factor (unitless)	100%
EF	=	exposure frequency (days/yr)	7 [c]
ET	=	exposure time (hrs/day)	2.6 [c]
ED	=	exposure duration (yrs)	6 [a]
BW	=	body weight (kg)	15 [a]
AT	=	averaging time (yrs)	6 [a]

REDUCED EQUATIONS: RECREATIONAL SEDIMENT – NONCARCINOGENIC EFFECTS

CHILD RECEPTOR

Risk-based RG (mg/kg; THI = 1) =

$$\frac{1 * 15\ kg * 6\ yrs * 365\ days/yr}{[7\ days/yr * 6\ yr * 10^{-6}\ kg/mg * (1/RfD_O)] * [200\ mg/day + ([2.6\ hr/day/24\ hrs/day] * 1\ mg/cm^2 * 1 * 4{,}490\ cm^2/day)]}$$

Risk-based RG (mg/kg; THI = 1) = $1.1 \times 10^{6}\ RfD_O$

a – USEPA, 1991
b – USEPA, 1989b
c – USEPA, 1992

Table A-14
REMEDIATION GOALS - SEDIMENTS (SITE WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT SITE WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goals (mg/kg)	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)
Arsenic	3.00E-04	1.05E+04	1.80E+00	5.39E+01	5.39E+01	3.80E+00	4.00E+00
Barium	7.00E-02	2.45E+06	--	--	2.45E+06	1.50E+02	1.50E+02
Cadmium	5.00E-04	1.75E+04	--	--	1.75E+04	3.30E+00	3.00E+00
Chromium	5.00E-03	1.75E+05	--	--	1.75E+05	2.50E+01	2.50E+01
Lead	--	--	--	--	--	2.10E+02	2.10E+02
Mercury	3.00E-04 p	1.05E+04	--	--	1.05E+04	4.00E-01	4.00E-01
Chlordane	6.00E-05	2.10E+03	1.30E+00	7.46E+01	7.46E+01	6.70E-02	6.70E-02
4,4-DDD	--	--	2.40E-01	4.04E+02	4.04E+02	1.00E-01	--
4,4-DDE	--	--	3.40E-01	2.85E+02	2.85E+02	2.80E-01	--
4,4-DDT	5.00E-04	1.75E+04	3.40E-01	2.85E+02	2.85E+02	4.80E-01	4.80E-01
Dieldrin	5.00E-05	1.75E+03	1.60E+01	6.06E+00	6.06E+00	5.60E-02	5.60E-02
Benzo[a]anthracene	--	--	1.10E+00	8.82E+01	8.82E+01	1.60E-01	1.60E-01
Chrysene	--	--	2.90E-02	3.34E+03	3.34E+03	2.40E-01	2.40E-01
Phenanthrene	--	--	--	--	--	3.60E-01	3.60E-01

p - IRIS lists toxicity value as pending; value used here is obtained from HEAST (1992).

Table A-15
REMEDIATION GOALS - SEDIMENTS (SITE WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE SITE WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goals (mg/kg)	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)
Arsenic	3.00E-04	1.56E+03	1.80E+00	8.06E+00	8.06E+00	3.80E+00	4.00E+00
Barium	7.00E-02	3.64E+05	--	--	3.64E+05	1.50E+02	1.50E+02
Cadmium	5.00E-04	2.60E+03	--	--	2.60E+03	3.30E+00	3.00E+00
Chromium	5.00E-03	2.60E+04	--	--	2.60E+04	2.50E+01	2.50E+01
Lead	--	--	--	--	--	2.10E+02	2.10E+02
Mercury	3.00E-04 p	1.56E+03	--	--	1.56E+03	4.00E-01	4.00E-01
Chlordane	6.00E-05	3.12E+02	1.30E+00	1.12E+01	1.12E+01	6.70E-02	6.70E-02
4,4-DDD	--	--	2.40E-01	6.04E+01	6.04E+01	1.00E-01	--
4,4-DDE	--	--	3.40E-01	4.26E+01	4.26E+01	2.80E-01	--
4,4-DDT	5.00E-04	2.60E+03	3.40E-01	4.26E+01	4.26E+01	4.80E-01	4.80E-01
Dieldrin	5.00E-05	2.60E+02	1.60E+01	9.06E-01	9.06E-01	5.60E-02	5.60E-02
Benzo[a]anthracene	--	--	1.10E+00	1.32E+01	1.32E+01	1.60E-01	1.60E-01
Chrysene	--	--	2.90E-02	5.00E+02	5.00E+02	2.40E-01	2.40E-01
Phenanthrene	--	--	--	--	--	3.60E-01	3.60E-01

p - IRIS lists toxicity value as pending; value used here is obtained from HEAST (1992).

Table A-16
PRELIMINARY REMEDIATION GOALS – SEDIMENTS (RECREATIONAL RECEPTOR)
Pesticide Storage Facility
Fort Riley, Kansas

RECREATIONAL CHILD

Constituent	Subchronic Reference Dose (oral) (mg/kg-day)	Preliminary Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Preliminary Remediation Goals (mg/kg) Carcinogenic Effects	Governing Preliminary Remediation Goals (mg/kg)	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)
Arsenic	3.00E-04	3.30E+02	1.80E+00	--	3.30E+02	3.80E+00	4.00E+00
Barium	7.00E-02	7.70E+04	--	--	7.70E+04	1.50E+02	1.50E+02
Cadmium	5.00E-04	5.50E+02	--	--	5.50E+02	3.30E+00	3.00E+00
Chromium	2.00E-02	2.20E+04	--	--	2.20E+04	2.50E+01	2.50E+01
Lead	--	--	--	--	--	2.10E+02	2.10E+02
Mercury	3.00E-04 p	3.30E+02	--	--	3.30E+02	4.00E-01	4.00E-01
Chlordane	6.00E-05	6.60E+01	1.30E+00	--	6.60E+01	6.70E-02	6.70E-02
4,4-DDD	--	--	2.40E-01	--	--	1.00E-01	--
4,4-DDE	--	--	3.40E-01	--	--	2.80E-01	--
4,4-DDT	5.00E-04	5.50E+02	3.40E-01	--	5.50E+02	4.80E-01	4.80E-01
Dieldrin	5.00E-05	5.50E+01	1.60E+01	--	5.50E+01	5.60E-02	5.60E-02
Benzo[a]anthracene	--	--	1.10E+00	--	--	1.60E-01	1.60E-01
Chrysene	--	--	2.90E-02	--	--	2.40E-01	2.40E-01
Phenanthrene	--	--	--	--	--	3.60E-01	3.60E-01

p – IRIS lists toxicity value as pending; value used here is obtained from HEAST (1992).

Table A–17
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF COMMERCIAL/INDUSTRIAL SOIL EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * 10^{-6}\,kg/mg * IR_{SOIL} * EF * ED}{RfD_O * BW * AT * 365\,days/yr} + \frac{C * EF * ED * AF * ABS * SA * 10^{-6}\,kg/mg}{RfD_O * BW * AT * 365\,days/yr} + \frac{C * EF * ET * ED * IR_{AIR} * 1/PEF}{RfD_I * BW * AT * 365\,days/yr}$$

C (mg/kg) (risk–based) =

$$C = \frac{THI * BW * AT * 365\,days/yr}{EF * ED * [(1/RfD_O * 10^{-6}\,kg/mg * IR_{SOIL}) + (1/RfD_O * ET * AF * ABS * SA * 10^{-6}\,kg/mg) + (1/RfD_I * IR_{AIR} * ET * 1/PEF)]}$$

where:

Parameter		Definition
C	=	chemical concentration in soil (mg/kg)
THI	=	target hazard index (unitless)
RfD_O	=	oral chronic reference dose (mg/kg–day)
IR_{SOIL}	=	daily soil ingestion rate (mg/day)
SA	=	surface area of exposed skin (cm^2/day)
AF	=	soil to skin adherence factor (mg/cm^2)
ABS	=	absorption factor (unitless)

Parameter		Definition
IR_{AIR}	=	inhalation rate (m^3/day)
RfD_I	=	inhalation chronic reference dose (mg/kg–day)
PEF	=	particulate emission factor (m^3/kg)
ET	=	dermal soil exposure time (hrs/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yrs)
BW	=	body weight (kg)
AT	=	averaging time (yrs)

Current Exposure

	Site Worker	Utility	Landscaper
THI	1	1	1
SF_O	*** chemical specific ***		
EF	250 [a]	0.3 [e]	2 [e,g]
ED	25 [b]	25 [b]	25 [b]
ET	6.25 [a]	8 [e]	1 [g]
IR_{SOIL}	50 [b]	480 [b]	480 [b]
AF	1 [c]	1 [c]	1 [c]
ABS	100%	100%	100%
SA	3,600 [d]	3,600 [d]	3,600 [d]
SF_I	*** chemical specific ***		
IR_{AIR}	2.5 [d]	2.5 [d]	2.5 [d]
PEF	*** 3.26×10^{9} [f] ***		
BW	70 [b]	70 [b]	70 [b]
AT	25 [b]	25 [b]	25 [b]

Future Exposure

	Site Worker	Utility	Landscaper	Construction Worker
THI	1	1	1	1
SF_O	*** chemical specific ***			
EF	250 [a]	1.12 [h]	8 [i]	120 [j]
ED	25 [b]	25 [b]	25 [b]	1 [j]
ET	8 [a]	8 [e,h]	1 [g]	8 [j]
IR_{SOIL}	50 [b]	480 [b]	480 [b]	480 [b]
AF	1 [c]	1 [c]	1 [c]	1 [c]
ABS	100%	100%	100%	100%
SA	3,600 [d]	3,600 [d]	3,600 [d]	3,600 [d]
SF_I	*** chemical specific ***			
IR_{AIR}	2.5 [d]	2.5 [d]	2.5 [d]	2.5 [d]
PEF	*** 3.26×10^{9} [f] ***			
BW	70 [b]	70 [b]	70 [b]	70 [b]
AT	25 [b]	25 [b]	25 [b]	1 [j]

a – DEH, 1993c
b – USEPA, 1991
c – USEPA, 1992
d – USEPA, 1989b
e – DEH, 1992a
f – USEPA, 1991a
g – DEH, 1993d
h – DEH, 1993n; DEH, 1993o
i – DOC, 1993
j – DEH, 1993l; DEH, 1993m

Table A-17 (continued)
REDUCED EQUATIONS: COMMERCIAL/INDUSTRIAL SOIL – NONCARCINOGENIC EFFECTS

CURRENT SITE WORKER

Risk-based RG (mg/kg; THI = 1)

$$= \frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{250\ days/yr * 25\ yr * [(1/RfD_o) * 10^{-6}\ kg/mg * 50\ mg/day) + (1/RfD_o * \{6.25\ hr/day / 24\ hr/day\} * 1\ mg/cm^2 * 1 * 3600\ cm^2/day * 10^{-6}\ kg/mg) + (1/RfD_i * 2.5\ m^3/hr * 6.25\ hr/day * (1/3.26 \times 10^9\ m^3/kg))]}$$

Risk-based RG (mg/kg; THI = 1)

$$= \frac{102}{(9.9 \times 10^{-4}/RfD_o) + (4.8 \times 10^{-8}/RfD_i)}$$

FUTURE SITE WORKER

Risk-based RG (mg/kg; THI = 1)

$$= \frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{250\ days/yr * 25\ yr * [(1/RfD_o) * 10^{-6}\ kg/mg * 50\ mg/day) + (1/RfD_o * \{8\ hr/day / 24\ hr/day\} * 1\ mg/cm^2 * 1 * 3600\ cm^2 * 10^{-6}\ kg/mg) + (1/RfD_i * 2.5\ m^3/hr * 8\ hr/day * (1/3.26 \times 10^9\ m^3/kg))]}$$

Risk-based RG (mg/kg; THI = 1)

$$= \frac{102}{(1.3 \times 10^{-3}/RfD_o) + (6.1 \times 10^{-8}/RfD_i)}$$

CURRENT UTILITY WORKER

Risk-based RG (mg/kg; THI = 1)

$$= \frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{0.3\ days/yr * 25\ yr * [(1/RfD_o) * 10^{-6}\ kg/mg * 480\ mg/day) + (1/RfD_o * \{8\ hr/day/24\ hr/day\} * 1\ mg/cm^2 * 1 * 3{,}600\ cm^2/day * 10^{-6}\ kg/mg) + (1/RfD_i * 2.5\ m^3/hr * 8\ hr/day * (1/3.26 \times 10^9\ m^3/kg))]}$$

Risk-based RG (mg/kg; THI = 1)

$$= \frac{8.5 \times 10^4}{(1.7 \times 10^{-3}/RfD_o) + (6.1 \times 10^{-8}/RfD_i)}$$

FUTURE UTILITY WORKER

Risk-based RG (mg/kg; THI = 1)

$$= \frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{1.12\ days/yr * 25\ yr * [(1/RfD_o) * 10^{-6}\ kg/mg * 480\ mg/day) + (1/RfD_o * \{8\ hr/day/24\ hr/day\} * 1\ mg/cm^2 * 1 * 3{,}600\ cm^2/day * 10^{-6}\ kg/mg) + (1/RfD_i * 2.5\ m^3/hr * 8\ hr/day * (1/3.26 \times 10^9\ m^3/kg))]}$$

Risk-based RG (mg/kg; THI = 1)

$$= \frac{2.1 \times 10^4}{(1.7 \times 10^{-3}/RfD_o) + (6.1 \times 10^{-8}/RfD_i)}$$

Table A-17 (continued)
REDUCED EQUATIONS: COMMERCIAL/INDUSTRIAL SOIL – NONCARCINOGENIC EFFECTS

CURRENT LANDSCAPER

Risk-based RG (mg/kg; THI = 1)

$$= \frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{2\ days/yr * 25\ yr * [(1/RfD_O) * 10^{-6}\ kg/mg * 480\ mg/day) + (1/RfD_O * \{1\ hr/day/24\ hr/day\} * 1\ mg/cm^2 * 1 * 3{,}600\ cm^2/day * 10^{-6}\ kg/mg) + (1/RfD_I * 2.5\ m^3/hr * 1\ hr/day * (1/3.26 \times 10^9\ m^3/kg))]}$$

Risk-based RG (mg/kg; THI = 1)

$$= \frac{1.3 \times 10^4}{(6.3 \times 10^{-4}/RfD_O) + (7.7 \times 10^{-9}/RfD_I)}$$

FUTURE LANDSCAPER

Risk-based RG (mg/kg; THI = 1)

$$= \frac{1 * 70\ kg * 25\ yrs * 365\ days/yr}{8\ days/yr * 25\ yr * [(1/RfD_O) * 10^{-6}\ kg/mg * 480\ mg/day) + (1/RfD_O * \{1\ hr/day/24\ hr/day\} * 1\ mg/cm^2 * 1 * 3{,}600\ cm^2/day * 10^{-6}\ kg/mg) + (1/RfD_I * 2.5\ m^3/hr * 1\ hr/day * (1/3.26 \times 10^9\ m^3/kg))]}$$

Risk-based RG (mg/kg; THI = 1)

$$= \frac{3.2 \times 10^3}{(6.3 \times 10^{-4}/RfD_O) + (7.7 \times 10^{-9}/RfD_I)}$$

FUTURE CONSTRUCTION WORKER

Risk-based RG (mg/kg; THI = 1)

$$= \frac{1 * 70\ kg * 1\ yr * 365\ days/yr}{120\ days/yr * 1\ yr * [(1/RfD_O) * 10^{-6}\ kg/mg * 480\ mg/day) + (1/RfD_O * \{8\ hr/day/24\ hr/day\} * 1\ mg/cm^2 * 1 * 3{,}600\ cm^2/day * 10^{-6}\ kg/mg) + (1/RfD_I * 2.5\ m^3/hr * 8\ hr/day * (1/3.26 \times 10^9\ m^3/kg))]}$$

Risk-based RG (mg/kg; THI = 1)

$$= \frac{213}{(1.7 \times 10^{-3}/RfD_O) + (6.1 \times 10^{-9}/RfD_I)}$$

Table A-18
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF COMMERCIAL/INDUSTRIAL SOIL EXPOSURES – CARCINOGENIC EFFECTS

$$TR = \frac{SF_O * C * 10^{-6}\ kg/mg * IR_{SOIL} * EF * ED}{BW * AT * 365\ days/yr} + \frac{SF_O * C * ED * AF * ABS * SA * 10^{-6}\ kg/mg}{BW * AT * 365\ days/yr} + \frac{SF_I * C * EF * ET * ED * IR_{AIR} * 1/PEF}{BW * AT * 365\ days/yr}$$

C (mg/kg) (risk-based) =

$$C = \frac{TR * BW * AT * 365\ days/yr}{EF * ED * [(SF_O * 10^{-6}\ mg/kg * IR_{SOIL}) + (SF_O * AF * ABS * SA * 10^{-6}\ mg/kg * ET) + (SF_I * ET * IR_{AIR} * 1/PEF)]}$$

where:

Parameter		Definition
C	=	chemical concentration in soil (mg/kg)
TR	=	target excess individual lifetime cancer risk (unitless)
SF_O	=	oral cancer slope factor $(mg/kg-day)^{-1}$
IR_{SOIL}	=	daily soil ingestion rate (mg/day)
SA	=	surface area of exposed skin (cm^2/day)
AF	=	soil to skin adherence factor (mg/cm^2)
ABS	=	absorption factor (unitless)
IR_{AIR}	=	inhalation rate (m^3/day)
SF_I	=	inhalation cancer slope factor $(mg/kg-day)^{-1}$
PEF	=	particulate emission factor (m^3/kg)
ET	=	dermal soil exposure time (hrs/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yrs)
BW	=	body weight (kg)
AT	=	averaging time (yrs)

Current Exposure

	Site Worker	Utility	Landscaper
TR	10^{-6}	10^{-6}	10^{-6}
SF_O	*** chemical specific ***		
EF	250 [a]	0.3 [e]	2 [e,g]
ED	25 [b]	25 [b]	25 [b]
ET	6.25 [e]	8 [e]	1 [g]
IR_{SOIL}	50 [b]	480 [b]	480 [b]
AF	1 [c]	1 [c]	1 [c]
ABS	100%	100%	100%
SA	3,600 [d]	3,600 [d]	3,600 [d]
SF_I	*** chemical specific ***		
IR_{AIR}	2.5 [d]	2.5 [d]	2.5 [d]
PEF	*** 3.26×10^{8} [f] ***		
BW	70 [b]	70 [b]	70 [b]
AT	70 [b]	70 [b]	70 [b]

Future Exposure

	Site Worker	Utility	Landscaper	Construction Worker
TR	10^{-6}	10^{-6}	10^{-6}	10^{-6}
SF_O	*** chemical specific ***			
EF	250 [a]	1.12 [h]	8 [i]	120 [b]
ED	25 [b]	25 [b]	25 [b]	1 [j]
ET	8 [b]	8 [e,h]	1 [g]	8 [j]
IR_{SOIL}	50 [e]	480 [b]	480 [b]	480 [b]
AF	1	1 [c]	1 [c]	1 [c]
ABS	100%	100%	100%	100%
SA	3,600 [d]	3,600 [d]	3,600 [d]	3,600 [d]
SF_I	*** chemical specific ***			
IR_{AIR}	2.5 [d]	2.5 [d]	2.5 [d]	2.5 [d]
PEF	*** 3.26×10^{8} [f] ***			
BW	70 [b]	70 [b]	70 [b]	70 [b]
AT	70 [b]	70 [b]	70 [b]	70 [b]

a – DEH, 1993c
b – USEPA, 1991
c – USEPA, 1992
d – USEPA, 1989b
e – DEH, 1992a
f – USEPA, 1991a
g – DEH, 1993d
h – DEH, 1993n; DEH, 1993o
i – DOC, 1993
j – DEH, 1993l; DEH, 1993m

Table A–18 (continued)
REDUCED EQUATIONS: COMMERCIAL/INDUSTRIAL SOIL – CARCINOGENIC EFFECTS

CURRENT SITE WORKER

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{250\ \text{days/yr} * 25\ \text{yr} * [(SF_o * 10^{-6}\ \text{kg/mg} * 50\ \text{mg/day}) + (SF_o * 1\ \text{mg/cm}^2 * 1 * 3600\ \text{cm}^2/\text{day} * \{6.25\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3/\text{hr} * 6.25\ \text{hr/day} * (1/3.26 \times 10^{8}\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{2.9 \times 10^{-4}}{(9.9 \times 10^{-4}\ SF_o) + (4.8 \times 10^{-9}\ SF_i)}$$

FUTURE SITE WORKER

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{250\ \text{days/yr} * 25\ \text{yr} * [(SF_o * 10^{-6}\ \text{kg/mg} * 50\ \text{mg/day}) + (SF_o * 1\ \text{mg/cm}^2 * 1 * 3600\ \text{cm}^2/\text{day} * \{8\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3/\text{hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{9}\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{2.9 \times 10^{-4}}{(1.3 \times 10^{-3}\ SF_o) + (6.1 \times 10^{-9}\ SF_i)}$$

CURRENT UTILITY WORKER

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{0.3\ \text{days/yr} * 25\ \text{yr} * [(SF_o * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (SF_o * 1\ \text{mg/cm}^2 * 1 * 3{,}600\ \text{cm}^2/\text{day} * \{8\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3/\text{hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{9}\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{2.4 \times 10^{-1}}{(1.7 \times 10^{-3}\ SF_o) + (6.1 \times 10^{-9}\ SF_i)}$$

FUTURE UTILITY WORKER

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{1.12\ \text{days/yr} * 25\ \text{yr} * [(SF_o * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (SF_o * 1\ \text{mg/cm}^2 * 1 * 3{,}600\ \text{cm}^2/\text{day} * \{8\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3/\text{hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{9}\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{6.4 \times 10^{-2}}{(1.7 \times 10^{-3}\ SF_o) + (6.1 \times 10^{-9}\ SF_i)}$$

Table A-18 (continued)
REDUCED EQUATIONS: COMMERCIAL/INDUSTRIAL SOIL – CARCINOGENIC EFFECTS

CURRENT LANDSCAPER

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{2\ \text{days/yr} * 25\ \text{yr} * [(SF_O * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (SF_O * 1\ \text{mg/cm}^2 * 1 * 3{,}600\ \text{cm}^2/\text{day} * \{1\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3/\text{hr} * 1\ \text{hr/day} * (1/3.26 \times 10^{9}\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{3.6 \times 10^{-2}}{(6.3 \times 10^{-4}\ SF_O) + (7.7 \times 10^{-9}\ SF_i)}$$

FUTURE LANDSCAPER

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{8\ \text{days/yr} * 25\ \text{yr} * [(SF_O * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (SF_O * 1\ \text{mg/cm}^2 * 1 * 3{,}600\ \text{cm}^2/\text{day} * \{1\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3/\text{hr} * 1\ \text{hr/day} * (1/3.26 \times 10^{9}\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{8.9 \times 10^{-3}}{(6.3\ 10^{-4}\ SF_O) + (7.7 \times 10^{-9}\ SF_i)}$$

FUTURE CONSTRUCTION WORKER

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{120\ \text{days/yr} * 1\ \text{yr} * [(SF_O * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (SF_O * 1\ \text{mg/cm}^2 * 1 * 3{,}600\ \text{cm}^2/\text{day} * \{8\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3/\text{hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{9}\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; TR} = 10^{-6}) = \frac{1.5 \times 10^{-2}}{(1.7\ 10^{-3}\ SF_O) + (6.1 \times 10^{-8}\ SF_i)}$$

Table A-19
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF RECREATIONAL SOIL EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * 10^{-6}\ kg/mg * IR_{SOIL} * EF_R * ED}{RfD_O * BW * AT * 365\ days/yr} + \frac{C * EF_D * ED * ET_D * AF * ABS * SA * 10^{-6}\ kg/mg}{RfD_O * BW * AT * 365\ days/yr} + \frac{C * EF_R * ED * IR_{AIR} * 1/PEF}{RfD_I * BW * AT * 365\ days/yr}$$

C (mg/kg) (risk-based) =

$$C = \frac{THI * BW * AT * 365\ days/yr}{EF * ED * [(1/RfD_O * 10^{-6}\ kg/mg * IR_{SOIL}) + (1/RfD_O * ET_D * AF * ABS * SA * 10^{-6}\ kg/mg) + (1/RfD * IR_{AIR} * 1/PEF)]}$$

where:

Parameter		Definition	Child
C	=	chemical concentration in soil (mg/kg)	
THI	=	target hazard index (unitless)	1
RfD_O	=	oral chronic reference dose (mg/kg-day)	chemical specific
IR_{SOIL}	=	daily soil ingestion rate (mg/day)	200 [a]
SA	=	surface area of exposed skin (cm^2)	5,025 [b]
AF	=	soil to skin adherence factor (mg/cm^2)	1 [c]
ABS	=	absorption factor (unitless)	100 %
IR_{AIR}	=	inhalation rate (m^3/day)	0.83 [a,b]
RfD_I	=	inhalation chronic reference dose (mg/kg-day)	chemical specific
PEF	=	particulate emission factor (m^3/kg)	3.26×10^9 [d]
ET_D	=	dermal soil exposure time (hr/day)	2.6 [a,e]
EF	=	exposure frequency (days/yr)	7 [a,e]
ED	=	exposure duration (yrs)	6 [c]
BW	=	body weight (kg)	15 [a]
AT	=	averaging time (yrs)	6 [c]

REDUCED EQUATION: RECREATIONAL SOIL – NONCARCINOGENIC EFFECTS

CHILD RECEPTOR

Risk-based RG (mg/kg; THI = 1) =

$$\frac{1 * 15\ kg * 6\ yrs * 365\ days/yr}{7\ day/yr * 6\ yr * [(1/RfD_O * 10^{-6}\ kg/mg * 200\ mg/day) + (1/RfD_O * [2.6\ hr/day / 24\ hr/day] * 1\ mg/cm^2 * 1 * 5{,}025\ cm^2 * 10^{-6}\ kg/mg) + (1/RfD_I * 0.83\ m^3/day * (1/3.26 \times 10^9\ m^3/kg))]}$$

Risk-based RG (mg/kg; THI = 1) =

$$\frac{782}{(7.4 \times 10^{-4}/RfD_O) + (2.5 \times 10^{-9}/RfD_I)}$$

a – USEPA, 1991
b – USEPA, 1989b
c – USEPA, 1992
d – USEPA, 1991a
e – USEPA, 1993a

Table A-20
REMEDIATION GOALS – SOILS (SITE WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT SITE WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Reference Dose (inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (inhalation) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/kg)
Pesticides:							
Chlordane	6.00E-05	--	6.18E+00	1.30E+00	1.30E+00	2.25E-01	2.25E-01
4,4'-DDD	--	--	--	2.40E-01	--	1.22E+00	1.22E+00
4,4'-DDE	--	--	--	3.40E-01	--	8.62E-01	8.62E-01
4,4'-DDT	5.00E-04	--	5.15E+01	3.40E-01	3.40E-01	8.62E-01	8.62E-01
Dieldrin	5.00E-05	--	5.15E+00	1.60E+01	1.60E+01	1.83E-02	1.83E-02
Endrin aldehyde	3.00E-04	--	3.09E+01	--	--	--	3.09E+01
Heptachlor	5.00E-04	--	5.15E+01	4.50E+00	4.60E+00	6.51E-02	6.51E-02
Heptachlor epoxide	1.30E-05	--	1.34E+00	9.10E+00	9.10E+00	3.22E-02	3.22E-02
Malathion	2.00E-02	--	2.06E+03	--	--	--	2.06E+03
Methoxychlor	5.00E-03	--	5.15E+02	--	--	--	5.15E+02
Semi-Volatile Compounds:							
Anthracene	3.00E-01	--	3.09E+04	--	--	--	3.09E+04
Benzo[a]anthracene	--	--	--	1.06E+00	--	2.76E-01	2.76E-01
Benzo[a]pyrene	--	--	--	7.30E+00	--	4.01E-02	4.01E-02
Benzo[b]fluoranthene	--	--	--	1.02E+00	--	2.87E-01	2.87E-01
Benzo[k]fluoranthene	--	--	--	4.80E-01	--	6.10E-01	6.10E-01
Chrysene	--	--	--	2.90E-02	--	1.01E+01	1.01E+01
Dibenzofuran	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	--	--	--	1.70E+00	--	1.72E-01	1.72E-01
2-Methylnaphthalene	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--
Metals:							
Arsenic	3.00E-04	--	3.09E+01	1.80E+00	1.50E+01	1.63E-01	1.63E-01
Barium	7.00E-02	p 1.40E-04	7.04E+03	--	--	--	7.04E+03
Cadmium	1.00E-03	--	1.03E+02	--	6.10E+00	9.90E+02	9.90E+02
Chromium	5.00E-03	--	5.15E+02	--	4.10E+01	1.47E+02	1.47E+02
Lead	--	--	--	--	--	--	--
Mercury	p 3.00E-04	--	3.09E+01	--	--	--	3.09E+01

p – IRIS lists toxicity value as pending; value listed here is obtained from HEAST (1992).

Table A-21
REMEDIATION GOALS - SOILS (UTILITY WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT UTILITY WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Reference Dose (Inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (Inhalation) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/kg)
Pesticides:							
Chlordane	6.00E-05	--	3.00E+03	1.30E+00	1.30E+00	1.09E+02	1.09E+02
4,4'-DDD	--	--	--	2.40E-01	--	5.88E+02	5.88E+02
4,4'-DDE	--	--	--	3.40E-01	--	4.15E+02	4.15E+02
4,4'-DDT	5.00E-04	--	2.50E+04	3.40E-01	3.40E-01	4.15E+02	4.15E+02
Dieldrin	5.00E-05	--	2.50E+03	1.60E+01	1.60E+01	8.82E+00	8.82E+00
Endrin aldehyde	3.00E-04	--	1.50E+04	--	--	--	1.50E+04
Heptachlor	5.00E-04	--	2.50E+04	4.50E+00	4.60E+00	3.14E+01	3.14E+01
Heptachlor epoxide	1.30E-05	--	6.50E+02	9.10E+00	9.10E+00	1.55E+01	1.55E+01
Malathion	2.00E-03	--	1.00E+05	--	--	--	1.00E+05
Methoxychlor	5.00E-03	--	2.50E+05	--	--	--	2.50E+05
Semi-Volatile Compounds:							
Anthracene	3.00E-01	--	1.50E+07	--	--	--	1.50E+07
Benzo[a]anthracene	--	--	--	1.06E+00	--	1.33E+02	1.33E+02
Benzo[a]pyrene	--	--	--	7.30E+00	--	1.93E+01	1.93E+01
Benzo[b]fluoranthene	--	--	--	1.02E+00	--	1.38E+02	1.38E+02
Benzo[k]fluoranthene	--	--	--	4.80E-01	--	2.94E+02	2.94E+02
Chrysene	--	--	--	2.90E-02	--	4.87E+03	4.87E+03
Dibenzofuran	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	--	--	--	1.70E+00	--	8.30E+01	8.30E+01
2-Methylnaphthalene	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--
Metals:							
Arsenic	3.00E-04	--	1.50E+04	1.80E+00	1.50E+01	7.84E+01	7.84E+01
Barium	7.00E-02	p 1.40E-04	3.50E+06	--	--	--	3.50E+06
Cadmium	1.00E-03	--	5.00E+04	--	6.10E+00	6.45E+05	5.00E+04
Chromium	5.00E-03	--	2.50E+05	--	4.10E+01	9.60E+04	9.60E+04
Lead	--	--	--	--	--	--	--
Mercury	p 3.00E-04	--	1.50E+04	--	--	--	1.50E+04

p - IRIS lists toxicity value as pending; value listed here is fronm HEAST (1992).

Table A-22
REMEDIATION GOALS - SOILS (LANDSCAPER)
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT LANDSCAPER

Constituent	Reference Dose (oral) (mg/kg-day)	Reference Dose (inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (inhalation) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/kg)
Pesticides:							
Chlordane	6.00E-05	--	1.24E+03	1.30E+00	1.30E+00	4.40E+01	4.40E+01
4,4'-DDD	--	--	--	2.40E-01	--	2.38E+02	2.38E+02
4,4'-DDE	--	--	--	3.40E-01	--	1.68E+02	1.68E+02
4,4'-DDT	5.00E-04	--	1.03E+04	3.40E-01	3.40E-01	1.68E+02	1.68E+02
Dieldrin	5.00E-05	--	1.03E+03	1.60E+01	1.60E+01	3.57E+00	3.57E+00
Endrin aldehyde	3.00E-04	--	6.19E+03	--	--	--	6.19E+03
Heptachlor	5.00E-04	--	1.03E+04	4.50E+00	4.60E+00	1.27E+01	1.27E+01
Heptachlor epoxide	1.30E-05	--	2.68E+02	9.10E+00	9.10E+00	6.28E+00	6.28E+00
Malathion	2.00E-02	--	4.13E+05	--	--	--	4.13E+05
Methoxychlor	5.00E-03	--	1.03E+05	--	--	--	1.03E+05
Semi-Volatile Compounds:							
Anthracene	3.00E-01	--	6.19E+06	--	--	--	6.19E+06
Benzo[a]anthracene	--	--	--	1.06E+00	--	5.39E+01	5.39E+01
Benzo[a]pyrene	--	--	--	7.30E+00	--	7.83E+00	7.83E+00
Benzo[b]fluoranthene	--	--	--	1.02E+00	--	5.60E+01	5.60E+01
Benzo[k]fluoranthene	--	--	--	4.80E-01	--	1.19E+02	1.19E+02
Chrysene	--	--	--	2.90E-02	--	1.97E+03	1.97E+03
Dibenzofuran	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	--	--	--	1.70E+00	--	3.36E+01	3.36E+01
2-Methylnaphthalene	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--
Metals:							
Arsenic	3.00E-04	--	6.19E+03	1.80E+00	1.50E+01	3.17E+01	3.17E+01
Barium	7.00E-02	p 1.40E-04	1.44E+06	--	--	--	1.44E+06
Cadmium	1.00E-03	--	2.06E+04	--	6.10E+00	7.66E+05	2.06E+04
Chromium	5.00E-03	--	1.03E+05	--	4.10E+01	1.14E+05	1.03E+05
Lead	--	--	--	--	--	--	--
Mercury	p 3.00E-04	--	6.19E+03	--	--	--	6.19E+03

p - IRIS lists toxicity value as pending; value lsited here is obtained from HEAST (1992).

Table A-23
REMEDIATION GOALS – SOILS (SITE WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE SITE WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Reference Dose (inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (inhalation) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/kg)
Pesticides:							
Chlordane	6.00E-05	--	4.71E+00	1.30E+00	1.30E+00	1.72E-01	1.72E-01
4,4'-DDD	--	--	--	2.40E-01	--	9.29E-01	9.29E-01
4,4'-DDE	--	--	--	3.40E-01	--	6.56E-01	6.56E-01
4,4'-DDT	5.00E-04	--	3.92E+01	3.40E-01	3.40E-01	6.56E-01	6.56E-01
Dieldrin	5.00E-05	--	3.92E+00	1.60E+01	1.60E+01	1.39E-02	1.39E-02
Endrin aldehyde	3.00E-04	--	2.35E+01	--	--	--	2.35E+01
Heptachlor	5.00E-04	--	3.92E+01	4.50E+00	4.60E+00	4.96E-02	4.96E-02
Heptachlor epoxide	1.30E-05	--	1.02E+00	9.10E+00	9.10E+00	2.45E-02	2.45E-02
Malathion	2.00E-02	--	1.57E+03	--	--	--	1.57E+03
Methoxychlor	5.00E-03	--	3.92E+02	--	--	--	3.92E+02
Semi-Volatile Compounds:							
Anthracene	3.00E-01	--	2.35E+04	--	--	--	2.35E+04
Benzo[a]anthracene	--	--	--	1.06E+00	--	2.10E-01	2.10E-01
Benzo[a]pyrene	--	--	--	7.30E+00	--	3.06E-02	3.06E-02
Benzo[b]fluoranthene	--	--	--	1.02E+00	--	2.19E-01	2.19E-01
Benzo[k]fluoranthene	--	--	--	4.80E-01	--	4.65E-01	4.65E-01
Chrysene	--	--	--	2.90E-02	--	7.69E+00	7.69E+00
Dibenzofuran	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	--	--	--	1.70E+00	--	1.31E-01	1.31E-01
2-Methylnaphthalene	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--
Metals:							
Arsenic	3.00E-04	--	2.35E+01	1.80E+00	1.50E+01	1.24E-01	1.24E-01
Barium	7.00E-02	p 1.40E-04	5.37E+03	--	--	--	5.37E+03
Cadmium	1.00E-03	--	7.85E+01	--	6.10E+00	7.79E+02	7.79E+02
Chromium	5.00E-03	--	3.92E+02	--	4.10E+01	1.16E+02	1.16E+02
Lead	--	--	--	--	--	--	--
Mercury	p 3.00E-04	--	2.35E+01	--	--	--	2.35E+01

p – IRIS lists toxicity value as pending; value listed here is obtained from HEAST (1992).

Table A-24
REMEDIATION GOALS - SOILS (UTILITY WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE UTILITY WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Reference Dose (inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (inhalation) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/kg)
Pesticides:							
Chlordane	6.00E-05	--	1.52E+02	1.30E+00	1.30E+00	5.43E+00	5.43E+00
4,4'-DDD	--	--	--	2.40E-01	--	2.94E+01	2.94E+01
4,4'-DDE	--	--	--	3.40E-01	--	2.08E+01	2.08E+01
4,4'-DDT	5.00E-04	--	1.26E+03	3.40E-01	3.40E-01	2.08E+01	2.08E+01
Dieldrin	5.00E-05	--	1.26E+02	1.60E+01	1.60E+01	4.41E-01	4.41E-01
Endrin aldehyde	3.00E-04	--	7.59E+02	--	--	--	7.59E+02
Heptachlor	5.00E-04	--	1.26E+03	4.50E+00	4.60E+00	1.57E+00	1.57E+00
Heptachlor epoxide	1.30E-05	--	3.29E+01	9.10E+00	9.10E+00	7.76E-01	7.76E-01
Malathion	2.00E-03	--	5.06E+03	--	--	--	5.06E+03
Methoxychlor	5.00E-03	--	1.26E+04	--	--	--	1.26E+04
Semi-Volatile Compounds:							
Anthracene	3.00E-01	--	7.59E+05	--	--	--	7.59E+05
Benzo[a]anthracene	--	--	--	1.06E+00	--	6.66E+00	6.66E+00
Benzo[a]pyrene	--	--	--	7.30E+00	--	9.67E-01	9.67E-01
Benzo[b]fluoranthene	--	--	--	1.02E+00	--	6.92E+00	6.92E+00
Benzo[k]fluoranthene	--	--	--	4.80E-01	--	1.47E+01	1.47E+01
Chrysene	--	--	--	2.90E-02	--	2.43E+02	2.43E+02
Dibenzofuran	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	--	--	--	1.70E+00	--	4.15E+00	4.15E+00
2-Methylnaphthalene	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--
Metals:							
Arsenic	3.00E-04	--	7.59E+02	1.80E+00	1.50E+01	3.92E+00	3.92E+00
Barium	7.00E-02	p 1.40E-04	1.77E+05	--	--	--	1.77E+05
Cadmium	1.00E-03	--	2.53E+03	--	6.10E+00	3.22E+04	2.53E+03
Chromium	5.00E-03	--	1.26E+04	--	4.10E+01	4.80E+03	4.80E+03
Lead	--	--	--	--	--	--	--
Mercury	p 3.00E-04	--	7.59E+02	--	--	--	7.59E+02

p - IRIS lists toxicity value as pending; value listed here is fronm HEAST (1992).

Table A-25
REMEDIATION GOALS - SOILS (LANDSCAPER)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE LANDSCAPER

Constituent	Reference Dose (oral) (mg/kg-day)	Reference Dose (inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (inhalation) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/kg)
Pesticides:							
Chlordane	6.00E-05	--	3.05E+02	1.30E+00	1.30E+00	1.09E+01	1.09E+01
4,4'-DDD	--	--	--	2.40E-01	--	5.89E+01	5.89E+01
4,4'-DDE	--	--	--	3.40E-01	--	4.15E+01	4.15E+01
4,4'-DDT	5.00E-04	--	2.54E+03	3.40E-01	3.40E-01	4.15E+01	4.15E+01
Dieldrin	5.00E-05	--	2.54E+02	1.60E+01	1.60E+01	8.83E-01	8.83E-01
Endrin aldehyde	3.00E-04	--	1.52E+03	--	--	--	1.52E+03
Heptachlor	5.00E-04	--	2.54E+03	4.50E+00	4.60E+00	3.14E+00	3.14E+00
Heptachlor epoxide	1.30E-05	--	6.60E+01	9.10E+00	9.10E+00	1.55E+00	1.55E+00
Malathion	2.00E-02	--	1.02E+05	--	--	--	1.02E+05
Methoxychlor	5.00E-03	--	2.54E+04	--	--	--	2.54E+04
Semi-Volatile Compounds:							
Anthracene	3.00E-01	--	1.52E+06	--	--	--	1.52E+06
Benzo[a]anthracene	--	--	--	1.06E+00	--	1.33E+01	1.33E+01
Benzo[a]pyrene	--	--	--	7.30E+00	--	1.94E+00	1.94E+00
Benzo[b]fluoranthene	--	--	--	1.02E+00	--	1.38E+01	1.38E+01
Benzo[k]fluoranthene	--	--	--	4.80E-01	--	2.94E+01	2.94E+01
Chrysene	--	--	--	2.90E-02	--	4.87E+02	4.87E+02
Dibenzofuran	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	--	--	--	1.70E+00	--	8.31E+00	8.31E+00
2-Methylnaphthalene	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--
Metals:							
Arsenic	3.00E-04	--	1.52E+03	1.80E+00	1.50E+01	7.85E+00	7.85E+00
Barium	7.00E-02	p 1.40E-04	3.53E+05	--	--	--	3.53E+05
Cadmium	1.00E-03	--	5.08E+03	--	6.10E+00	1.89E+05	5.08E+03
Chromium	5.00E-03	--	2.54E+04	--	4.10E+01	2.82E+04	2.54E+04
Lead	--	--	--	--	--	--	--
Mercury	p 3.00E-04	--	1.52E+03	--	--	--	1.52E+03

p - IRIS lists toxicity value as pending; value isited here is obtained from HEAST (1992).

Table A-26
REMEDIATION GOALS – SOILS (CONSTRUCTION WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE CONSTRUCTION WORKER

Constituent	Reference Dose (oral) (mg/kg-day)	Reference Dose (inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (inhalation) $(mg/kg-day)^{-1}$	Remediation Goals (mg/kg) Carcinogenic Effects	Governing (Lowest) Remediation Goal (mg/kg)
Pesticides:							
Chlordane	6.00E-05	--	7.52E+00	1.30E+00	1.30E+00	6.79E+00	6.79E+00
4,4'-DDD	--	--	--	2.40E-01	--	3.68E+01	3.68E+01
4,4'-DDE	--	--	--	3.40E-01	--	2.60E+01	2.60E+01
4,4'-DDT	5.00E-04	--	6.26E+01	3.40E-01	3.40E-01	2.60E+01	2.60E+01
Dieldrin	5.00E-05	--	6.26E+00	1.60E+01	1.60E+01	5.51E-01	5.51E-01
Endrin aldehyde	3.00E-04	--	3.76E+01	--	--	--	3.76E+01
Heptachlor	5.00E-04	--	6.26E+01	4.50E+00	4.60E+00	1.96E+00	1.96E+00
Heptachlor epoxide	1.30E-05	--	1.63E+00	9.10E+00	9.10E+00	9.70E-01	9.70E-01
Malathion	2.00E-02	--	2.51E+03	--	--	--	2.51E+03
Methoxychlor	5.00E-03	--	6.26E+02	--	--	--	6.26E+02
Semi-Volatile Compounds:							
Anthracene	3.00E-01	--	3.76E+04	--	--	--	3.76E+04
Benzo[a]anthracene	--	--	--	1.06E+00	--	8.32E+00	8.32E+00
Benzo[a]pyrene	--	--	--	7.30E+00	--	1.21E+00	1.21E+00
Benzo[b]fluoranthene	--	--	--	1.02E+00	--	8.65E+00	8.65E+00
Benzo[k]fluoranthene	--	--	--	4.80E-01	--	1.84E+01	1.84E+01
Chrysene	--	--	--	2.90E-02	--	3.04E+02	3.04E+02
Dibenzofuran	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	--	--	--	1.70E+00	--	5.19E+00	5.19E+00
2-Methylnaphthalene	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--
Metals:							
Arsenic	3.00E-04	--	3.76E+01	1.80E+00	1.50E+01	4.90E+00	4.90E+00
Barium	7.00E-02	p 1.40E-04	8.62E+03	--	--	--	8.62E+03
Cadmium	1.00E-03	--	1.25E+02	--	6.10E+00	4.03E+04	4.03E+04
Chromium	5.00E-03	--	6.26E+02	--	4.10E+01	6.00E+03	6.00E+03
Lead	--	--	--	--	--	--	--
Mercury	p 3.00E-04	--	3.76E+01	--	--	--	3.76E+01

p – IRIS lists toxicity value as pending; value listed here is obtained from HEAST (1992).

Table A-27
REMEDIATION GOALS – SOILS (RECREATIONAL CHILD)
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT AND FUTURE RECREATIONAL CHILD

Constituent		Subchronic Reference Dose (Oral) (mg/kg-day)		Subchronic Reference Dose (Inhalation) (mg/kg-day)	Current and Future Remediation Goals (mg/kg) Non-cancer Effects
Pesticides:					
Chlordane		6.00E-05		--	6.34E+01
4,4'-DDD		--		--	--
4,4'-DDE		--		--	--
4,4'-DDT		5.00E-04		--	5.28E+02
Dieldrin		5.00E-05		--	5.28E+01
Endrin aldehyde		3.00E-04		--	3.17E+02
Heptachlor		5.00E-04		--	5.28E+02
Heptachlor epoxide		1.30E-05		--	1.37E+01
Malathion		2.00E-02		--	2.11E+04
Methoxychlor		5.00E-03		--	5.28E+03
Semi-Volatile Compounds:					
Anthracene		3.00E-01		--	3.17E+05
Benzo[a]anthracene		--		--	--
Benzo[a]pyrene		--		--	--
Benzo[b]fluoranthene		--		--	--
Benzo[k]fluoranthene		--		--	--
Chrysene		--		--	--
Dibenzofuran		--		--	--
Indeno[1,2,3-cd]pyrene		--		--	--
2-Methylnaphthalene		--		--	--
Phenanthrene		--		--	--
Metals:					
Arsenic		3.00E-04		--	3.17E+02
Barium		7.00E-02	p	1.40E-04	7.38E+04
Cadmium		1.00E-03		--	1.06E+03
Chromium		5.00E-03		--	5.28E+03
Lead		--		--	--
Mercury	p	3.00E-04		--	3.17E+02

p – IRIS lists toxicity value as pending; value lsited here is obtained from HEAST (1992).

APPENDIX C

Risk-Based Concentration Table
Second Quarter 1993
United States Environmental Protection Agency
Region III
May 10, 1993

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region III
841 Chestnut Street
Philadelphia, Pennsylvania 19107

May 10, 1993

SUBJECT: Risk-Based Concentration Table, Second Quarter 1993

FROM: Roy L. Smith, Ph.D., Senior Toxicologist
Technical Support Section (3HW13)

TO: RBC Table mailing list

Attached is the EPA Region III risk-based concentration table, which has been distributed quarterly to all interested EPA offices and private parties since 1991. If you are not currently on the mailing list, but would like to be, please call Anna Poulton (215-597-3179) and give her your name, address, and phone and FAX numbers.

The table contains reference doses and carcinogenic potency slopes (obtained from IRIS through April 1993, HEAST through November 1992, OHEA-Cincinnati, and other EPA sources) for nearly 600 chemicals. These toxicity constants have been combined with "standard" exposure scenarios to calculate chemical concentrations corresponding to fixed levels of risk (*i.e.*, a hazard quotient of 1, or lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration) in water, air, fish tissue, and soil.

The Region III toxicologists use this table as a risk-based screen for Superfund sites, and as a desk reference for emergencies and other requests for immediate information. The table also provides a useful benchmark for evaluating preliminary site investigation data and contractor-prepared preliminary remediation goals. The table has no official status as either regulation or guidance, and should be used only as a predictor of generic single-contaminant health risk estimates. *The table is specifically not intended as (1) a stand-alone decision-making tool, (2) a substitute for EPA guidance for preparing baseline risk assessments, (3) a source of site-specific cleanup levels, or (4) a rule to determine if a waste is hazardous under RCRA.* In general, chemical concentrations above the levels in the table suggest a need for a closer look by a toxicologist, but should not be used as the sole basis for taking any action.

The toxicity information in the table has been assembled by hand, and (despite extensive checking and several years' use) may contain errors. It's advisable to cross-check before relying on any numbers in the table. If you find any errors, please send me a note.

This update of the table reflects an important philosophical change. Previous versions estimated exposures to carcinogens on the basis of 30 years of adult exposure. Now the calculations for three media have been changed to reflect 30 years of combined childhood and adult exposure, using age-integrated estimates of body weight and contact rates. This has lowered risk-based concentrations for carcinogens in tap water by 6%, in ambient air by 8%, and in residential soil by 30%. Risk-based concentrations for fish tissue continue to assume adult exposure because of uncertainties about fish consumption rates for children. As part of this conversion, the variable names table was expanded and modernized to reflect current EPA conventions.

The table now reflects revised carcinogenic potency slopes for bromodichloromethane and chlorobenzilate, reference doses for 1,4-dithiane, manganese, and Aroclor 1016, and a reference concentration for 1,4-dichlorobenzene. These revisions have caused some risk-based concentrations for these substances to change.

Attachments

Risk-Based Concentration Table
Background Information

General: Separate carcinogenic and non-carcinogenic risk-based concentrations were calculated for each compound for each pathway. The concentration in the table is the lower of the two, rounded to two significant figures. All calculations for non-carcinogens used an averaging time equal to the exposure duration times 365 days per year. The following terms and values were used in the calculations:

Exposure variables	Value	Name
1-General:		
Carcinogenic potency slope oral (kg-d/mg):	*	CPSo
Carcinogenic potency slope inhaled (kg-d/mg):	*	CPSI
Reference dose oral (mg/kg/d):	*	RfDo
Reference dose inhaled (mg/kg/d):	*	RfDi
Target cancer risk:	1e-06	TR
Target hazard quotient:	1	THQ
Body weight, adult (kg):	70	BWa
Body weight, age 1-6 (kg):	15	BWc
Body weight, age adjusted (kg):	59	BWall
Averaging time carcinogens (d):	25550	ATc
Averaging time non-carcinogens (d):	ED*365	ATn
Air inhaled, adult (m3/d):	20	IRAa
Air inhaled, age 1-6 (m3/d):	12	IRAc
Air inhaled, age-adjusted (m3/d):	18	IRAall
Tap water ingested, adult (L/d):	2	IRWa
Tap water ingested, age 1-6 (L/d):	1	IRWc
Tap water ingested, age-adjusted (L/d):	1.8	IRWall
Fish ingested (g/d):	54	IRF
Soil ingestion - adult (mg/d):	100	IRSa
Soil ingestion - age 1-6 (mg/d):	200	IRSc
Soil ingestion - age adjusted (mg/d):	120	IRSall

Exposure variables	Value	Name
2-Residential:		
Exposure frequency (d/y):	350	EFr
Exposure duration, age adjusted (y):	30	EDall
Exposure duration, age 1-6 (y):	6	EDc
Volatilization factor (L/m3):	1	VF
3-Occupational:		
Exposure frequency (d/y):	250	EFo
Exposure duration (y):	25	EDo
* = Contaminant-specific toxicity parameters		

The priority among sources of toxicological constants was as follows: (1) IRIS, (2) HEAST, (3) HEAST alternative method, (4) ECAO-Cincinnati, (5) withdrawn from IRIS, (6) withdrawn from HEAST, and (7) other EPA documents. Each source was used only if numbers from higher-priority sources were unavailable.

Algorithms:

1. Residential water use (µg/L). Volatilization terms were calculated only for compounds with "y" in the "Volatile" column. Compounds having a Henry's Law constant greater than 10^{-5} were considered volatile. The list may be incomplete, but is unlikely to include false positives. The equations and the volatilization factor (VF, above) were obtained from the draft RAGS IB. Oral potency slopes and reference doses were used for both oral and inhaled exposures for volatile compounds lacking inhalation values. Inhaled potency slopes were substituted for unavailable oral potency slopes only for volatile compounds; inhaled RfDs were substituted for unavailable oral RfDs for both volatile and non-volatile compounds.

a. Carcinogens: Calculations were based on combined childhood and adult exposure.

$$\frac{TR \cdot BWall \cdot ATc \cdot 1000\frac{\mu g}{mg}}{EFr \cdot EDall \cdot ([VF \cdot IRAall \cdot CPSi] + [IRWall \cdot CPSo])}$$

b. Non-carcinogens: Calculations were based on adult exposure.

$$\frac{THQ \cdot BWa \cdot ATn \cdot 1000\frac{\mu g}{mg}}{EFr \cdot EDall \cdot \left(\frac{VF \cdot IRAa}{RfDi} + \frac{IRWa}{RfDo}\right)}$$

2. Air ($\mu g/m^3$). Oral potency slopes and references were used where inhalation values were not available.

a. Carcinogens: Calculations were based on combined childhood and adult exposure.

$$\frac{TR \cdot BWall \cdot ATc \cdot 1000\frac{\mu g}{mg}}{EFr \cdot EDall \cdot IRAall \cdot CPSi}$$

b. Non-carcinogens: Calculations were based on adult exposure.

$$\frac{THQ \cdot RfDi \cdot BWa \cdot ATn \cdot 1000\frac{\mu g}{mg}}{EFr \cdot EDall \cdot IRAa}$$

3. Fish (mg/kg):

a. Carcinogens: Calculations were based on adult exposure.

$$\frac{TR \cdot BWa \cdot ATc}{EFr \cdot EDall \cdot \frac{IRF}{1000\frac{g}{kg}} \cdot CPSo}$$

b. Non-carcinogens: Calculations were based on adult exposure.

$$\frac{THQ \cdot RfDo \cdot BWa \cdot ATn}{EFr \cdot EDall \cdot \frac{IRF}{1000\frac{g}{kg}}}$$

4. Soil commercial/industrial (mg/kg): The default exposure assumption that only 50% of incidental soil ingestion occurs at work has been omitted. Calculations were based on adult occupational exposure.

a. Carcinogens:

$$\frac{TR \cdot BWa \cdot ATc}{EFo \cdot EDo \cdot \frac{IRSa}{10^6 \frac{mg}{kg}} \cdot CPSo}$$

b. Non-carcinogens:

$$\frac{THQ \cdot RfDo \cdot BWa \cdot ATn}{EFo \cdot EDo \cdot \frac{IRSa}{10^6 \frac{mg}{kg}}}$$

5. Soil residential (mg/kg):

a. Carcinogens: Calculations were based on combined childhood and adult exposure.

$$\frac{TR \cdot BWall \cdot ATc}{EFr \cdot EDall \cdot \frac{IRSall}{10^6 \frac{mg}{kg}} \cdot CPSo}$$

b. Non-carcinogens: Calculations were based on childhood exposure only.

$$\frac{THQ \cdot RfDo \cdot BWc \cdot ATn}{EFr \cdot EDc \cdot \frac{IRSc}{10^6 \frac{mg}{kg}}}$$

Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Acephate	4.00e-03 i		8.70e-03 i			9.2	0.92	0.36	330	140
Acetaldehyde		2.57e-03 i		7.70e-03 i		94	1			
Acetone	1.00e-01 i					3700	370	140	100000	7800
Acetone cyanohydrin	7.00e-02 h	2.86e-03 a				2600	10	95	72000	5500
Acetonitrile	6.00e-03 i	1.43e-02 a				220	52	8.1	6100	470
Acetophenone	1.00e-01 i	5.71e-06 y			y	0.042	0.021	140	100000	7800
Acifluorfen	1.30e-02 i					470	47	18	13000	1000
Acrolein	2.00e-02 h	5.71e-06 i				730	0.021	27	20000	1600
Acrylamide	2.00e-04 i		4.50e+00 i	4.55e+00 i		0.018	0.0018	0.0007	0.64	0.27
Acrylic acid	8.00e-02 i	8.57e-05 i				2900	0.31	110	82000	6300
Acrylonitrile		5.71e-04 i	5.40e-01 i	2.38e-01 i		0.15	0.034	0.0058	5.3	2.2
Alachlor	1.00e-02 i		8.00e-02 h			1	0.1	0.039	36	15
Alar	1.50e-01 i					5500	550	200	150000	12000
Aldicarb	2.00e-04 i					7.3	0.73	0.27	200	16
Aldicarb sulfone	3.00e-04 x					11	1.1	0.41	310	23
Aldrin	3.00e-05 i		1.70e+01 i	1.72e+01 i		0.0047	0.00047	0.00019	0.17	0.07
Ally	2.50e-01 i					9100	910	340	260000	20000
Allyl alcohol	5.00e-03 i					180	18	6.8	5100	390
Allyl chloride	5.00e-02 h	2.86e-04 i				1800	1	68	51000	3900
Aluminum	2.90e+00 o					110000	11000	3900	3000000	230000
Aluminum phosphide	4.00e-04 i					15	1.5	0.54	410	31
Amdro	3.00e-04 i					11	1.1	0.41	310	23
Ametryn	9.00e-03 i					330	33	12	9200	700
m-Aminophenol	7.00e-02 h					2600	260	95	72000	5500
4-Aminopyridine	2.00e-05 h					0.73	0.073	0.027	20	1.6
Amitraz	2.50e-03 i					91	9.1	3.4	2600	200
Ammonia		2.86e-02 i				1000	100			
Ammonium sulfamate	2.00e-01 i					7300	730	270	200000	16000
Aniline		2.86e-04 i	5.70e-03 i			10	1	0.55	500	210
Antimony and compounds	4.00e-04 i					15	1.5	0.54	410	31
Antimony pentoxide	5.00e-04 h					18	1.8	0.68	510	39
Antimony potassium tartrate	9.00e-04 h					33	3.3	1.2	920	70
Antimony tetroxide	4.00e-04 h					15	1.5	0.54	410	31
Antimony trioxide	4.00e-04 h					15	1.5	0.54	410	31
Apollo	1.30e-02 i					470	47	18	13000	1000
Aramite	5.00e-02 h		2.50e-02 i	2.49e-02 i		3.2	0.32	0.13	110	48
Arsenic	3.00e-04 i					11	1.1	0.41	310	23
Arsenic (as carcinogen)			1.75e+00 i	1.51e+01 i		0.046	0.00053	0.0018	1.6	0.68
Assure	9.00e-03 i					330	33	12	9200	700

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Asulam	5.00e-02 i					1800	180	68	51000	3900
Atrazine	5.00e-03 i		2.22e-01 h			0.36	0.036	0.014	13	5.4
Avermectin B1	4.00e-04 i					15	1.5	0.54	410	31
Azobenzene			1.10e-01 i	1.09e-01 i		0.73	0.074	0.029	26	11
Barium and compounds	7.00e-02 i	1.43e-04 a				2600	0.52	95	72000	5500
Baygon	4.00e-03 i					150	15	5.4	4100	310
Bayleton	3.00e-02 i					1100	110	41	31000	2300
Baythroid	2.50e-02 i					910	91	34	26000	2000
Benefin	3.00e-01 i					11000	1100	410	310000	23000
Benomyl	5.00e-02 i					1800	180	68	51000	3900
Bentazon	2.50e-03 i					91	9.1	3.4	2600	200
Benzaldehyde	1.00e-01 i				y	610	370	140	100000	7800
Benzene		5.71e-05 e	2.90e-02 i	2.91e-02 i	y	0.35	0.21	0.11	99	41
Benzidine	3.00e-03 i		2.30e+02 i	2.35e+02 i		0.00035	0.000034	0.000014	0.012	0.0052
Benzoic acid	4.00e+00 i					150000	15000	5400	4100000	310000
Benzotrichloride			1.30e+01 i			0.0061	0.00061	0.00024	0.22	0.092
Benzyl alcohol	3.00e-01 h					11000	1100	410	310000	23000
Benzyl chloride			1.70e-01 i		y	0.078	0.047	0.019	17	7
Beryllium and compounds	5.00e-03 i		4.30e+00 i	8.40e+00 i		0.019	0.00095	0.00073	0.67	0.28
Bidrin	1.00e-04 i					3.7	0.37	0.14	100	7.8
Biphenthrin (Talstar)	1.50e-02 i					550	55	20	15000	1200
1,1-Biphenyl	5.00e-02 i					1800	180	68	51000	3900
Bis(2-chloroethyl)ether			1.10e+00 i	1.16e+00 i	y	0.012	0.0069	0.0029	2.6	1.1
Bis(2-chloroisopropyl)ether	4.00e-02 i		7.00e-02 h	3.50e-02 h	y	0.33	0.23	0.045	41	17
Bis(chloromethyl)ether			2.20e+02 i	2.17e+02 i	y	0.000061	0.000037	0.000014	0.013	0.0054
Bis(2-chloro-1-methylethyl)ether			7.00e-02 y	7.00e-02 y		1.1	0.11	0.045	41	17
Bis(2-ethylhexyl)phthalate (DEHP)	2.00e-02 i		1.40e-02 i			5.7	0.57	0.23	200	85
Bisphenol A	5.00e-02 i					1800	180	68	51000	3900
Boron	9.00e-02 i	5.71e-03 h				3300	21	120	92000	7000
Boron trifluoride		2.00e-04 h				7.3	0.73			
Bromodichloromethane	2.00e-02 i		6.20e-02 i		y	0.21	0.13	0.051	46	19
Bromoethene				1.10e-01 h	y	0.12	0.073			
Bromoform (tribromomethane)	2.00e-02 i		7.90e-03 i	3.85e-03 i	y	2.9	2.1	0.4	360	150
Bromomethane	1.40e-03 i	1.43e-03 i			y	8.7	5.2	1.9	1400	110
4-Bromophenyl phenyl ether	5.80e-02 o					2100	210	78	59000	4500
Bromophos	5.00e-03 h					180	18	6.8	5100	390
Bromoxynil	2.00e-02 i					730	73	27	20000	1600
Bromoxynil octanoate	2.00e-02 i					730	73	27	20000	1600
1,3-Butadiene				9.80e-01 i	y	0.014	0.0081			

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	V O C	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
1-Butanol	1.00e-01 i					3700	370	140	100000	7800
Butylate	5.00e-02 i					1800	180	68	51000	3900
Butyl benzyl phthalate	2.00e-01 i					7300	730	270	200000	16000
Butylphthalyl butylglycolate	1.00e+00 i					37000	3700	1400	1000000	78000
Cacodylic acid	3.00e-03 h					110	11	4.1	3100	230
Cadmium and compounds	5.00e-04 i			6.30e+00 i		18	0.0013	0.68	510	39
Caprolactam	5.00e-01 i					18000	1800	680	510000	39000
Captafol	2.00e-03 i		8.60e-03 h			9.3	0.93	0.37	330	140
Captan	1.30e-01 i		3.50e-03 h			23	2.3	0.9	820	340
Carbaryl	1.00e-01 i					3700	370	140	100000	7800
Carbazole			2.00e-02 h			4	0.4	0.16	140	60
Carbofuran	5.00e-03 i					180	18	6.8	5100	390
Carbon disulfide	1.00e-01 i	2.86e-03 h			y	21	10	140	100000	7800
Carbon tetrachloride	7.00e-04 i	5.71e-04 e	1.30e-01 i	5.25e-02 i	y	0.2	0.15	0.024	22	9.2
Carbosulfan	1.00e-02 i					370	37	14	10000	780
Carboxin	1.00e-01 i					3700	370	140	100000	7800
Chloral	2.00e-03 i					73	7.3	2.7	2000	160
Chloramben	1.50e-02 i					550	55	20	15000	1200
Chloranil			4.03e-01 h			0.2	0.02	0.0078	7.1	3
Chlordane	6.00e-05 i		1.30e+00 i	1.30e+00 i		0.061	0.0062	0.0024	2.2	0.92
Chlorimuron-ethyl	2.00e-02 i					730	73	27	20000	1600
Chlorine dioxide		5.71e-05 i				2.1	0.21			
Chloroacetaldehyde	6.90e-03 o					250	25	9.3	7100	540
Chloroacetic acid	2.00e-03 h					73	7.3	2.7	2000	160
2-Chloroacetophenone		8.57e-06 i				0.31	0.031			
4-Chloroaniline	4.00e-03 i					150	15	5.4	4100	310
Chlorobenzene	2.00e-02 i	5.71e-03 a			y	39	21	27	20000	1600
Chlorobenzilate	2.00e-02 i		2.70e-01 h	2.70e-01 h		0.3	0.03	0.012	11	4.4
p-Chlorobenzoic acid	2.00e-01 h					7300	730	270	200000	16000
4-Chlorobenzotrifluoride	2.00e-02 h					730	73	27	20000	1600
2-Chloro-1,3-butadiene	7.00e-03 h	2.86e-02 a			y	110	100	9.5	7200	550
1-Chlorobutane	4.00e-01 h				y	2400	1500	540	410000	31000
2-Chloroethyl vinyl ether	2.50e-02 o				y	150	91	34	26000	2000
Chloroform	1.00e-02 i		6.10e-03 i	8.05e-02 i	y	0.2	0.099	0.52	470	200
Chloromethane			1.30e-02 h	6.30e-03 h	y	1.8	1.3	0.24	220	92
4-Chloro-2-methylaniline			5.80e-01 h			0.14	0.014	0.0054	4.9	2.1
4-Chloro-2,2-methylaniline hydrochloride			4.60e-01 h			0.17	0.017	0.0069	6.2	2.6
beta-Chloronaphthalene	8.00e-02 i					2900	290	110	82000	6300

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o-Chloronitrobenzene			2.50e-02 h		y	0.53	0.32	0.13	110	48
p-Chloronitrobenzene			1.80e-02 h		y	0.74	0.44	0.18	160	66
2-Chlorophenol	5.00e-03 i					180	18	6.8	5100	390
2-Chloropropane		2.86e-02 h			y	170	100			
Chlorothalonil	1.50e-02 i		1.10e-02 h			7.3	0.73	0.29	260	110
o-Chlorotoluene	2.00e-02 i				y	120	73	27	20000	1600
Chlorpropham	2.00e-01 i					7300	730	270	200000	16000
Chlorpyrifos	3.00e-03 i					110	11	4.1	3100	230
Chlorpyrifos-methyl	1.00e-02 h					370	37	14	10000	780
Chlorsulfuron	5.00e-02 i					1800	180	68	51000	3900
Chlorthiophos	8.00e-04 h					29	2.9	1.1	820	63
Chromium III and compounds	1.00e+00 i	5.71e-07 y				37000	0.0021	1400	1000000	78000
Chromium VI and compounds	5.00e-03 i			4.20e+01 i		180	0.00019	6.8	5100	390
Coal tars				2.20e+00 h			0.0036			
Coke Oven Emissions				2.17e+00 i			0.0037			
Copper and compounds	3.71e-02 h					1400	140	50	38000	2900
Crotonaldehyde	1.00e-02 x		1.90e+00 h	1.90e+00 y		0.042	0.0042	0.0017	1.5	0.63
Cumene	4.00e-02 i	2.57e-03 h				1500	9.4	54	41000	3100
Cyanazine	2.00e-03 h					73	7.3	2.7	2000	160
Cyanides										
Barium cyanide	1.00e-01 h					3700	370	140	100000	7800
Copper cyanide	5.00e-03 i					180	18	6.8	5100	390
Calcium cyanide	4.00e-02 i					1500	150	54	41000	3100
Cyanogen	4.00e-02 i					1500	150	54	41000	3100
Cyanogen bromide	9.00e-02 i					3300	330	120	92000	7000
Cyanogen chloride	5.00e-02 i					1800	180	68	51000	3900
Free cyanide	2.00e-02 i					730	73	27	20000	1600
Hydrogen cyanide	2.00e-02 i					730	73	27	20000	1600
Potassium cyanide	5.00e-02 i					1800	180	68	51000	3900
Potassium silver cyanide	2.00e-01 i					7300	730	270	200000	16000
Silver cyanide	1.00e-01 i					3700	370	140	100000	7800
Sodium cyanide	4.00e-02 i					1500	150	54	41000	3100
Zinc cyanide	5.00e-02 i					1800	180	68	51000	3900
Cyclohexanone	5.00e+00 i				y	30000	18000	6800	5100000	390000
Cyclohexlamine	2.00e-01 i					7300	730	270	200000	16000
Cyhalothrin/Karate	5.00e-03 i					180	18	6.8	5100	390
Cypermethrin	1.00e-02 i					370	37	14	10000	780
Cyromazine	7.50e-03 i					270	27	10	7700	590
Dacthal	5.00e-01 i					18000	1800	680	510000	39000

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Dalapon	3.00e-02 i					1100	110	41	31000	2300
Danitol	5.00e-04 i					18	1.8	0.68	510	39
DDD			2.40e-01 i			0.33	0.033	0.013	12	5
DDE			3.40e-01 i			0.23	0.023	0.0093	8.4	3.5
DDT	5.00e-04 i		3.40e-01 i	3.40e-01 i		0.23	0.023	0.0093	8.4	3.5
Decabromodiphenyl ether	1.00e-02 i				y	61	37	14	10000	780
Demeton	4.00e-05 i					1.5	0.15	0.054	41	3.1
Diallate			6.10e-02 h		y	0.22	0.13	0.052	47	20
Diazinon	9.00e-04 h					33	3.3	1.2	920	70
1,4-Dibromobenzene	1.00e-02 i				y	61	37	14	10000	780
Dibromochloromethane	2.00e-02 i		8.40e-02 i		y	0.16	0.095	0.038	34	14
1,2-Dibromo-3-chloropropane		5.71e-05 i	1.40e+00 h	2.40e-03 h	y	0.056	0.21	0.0023	2	0.85
1,2-Dibromoethane			8.50e+01 i	7.70e-01 i	y	0.0009	0.01	0.000037	0.034	0.014
Di-n-butyl phthalate	1.00e-01 i					3700	370	140	100000	7800
Dicamba	3.00e-02 i					1100	110	41	31000	2300
1,2-Dichlorobenzene	9.00e-02 i	5.71e-02 a			y	370	210	120	92000	7000
1,3-Dichlorobenzene	8.90e-02 o				y	540	320	120	91000	7000
1,4-Dichlorobenzene		2.29e-01 h	2.40e-02 h		y	0.55	0.33	0.13	120	50
3,3'-Dichlorobenzidine			4.50e-01 i			0.18	0.018	0.007	6.4	2.7
1,4-Dichloro-2-butene				9.30e+00 h	y	0.0014	0.00086			
Dichlorodifluoromethane	2.00e-01 i	5.71e-02 a			y	390	210	270	200000	16000
1,1-Dichloroethane	1.00e-01 h	1.43e-01 a			y	810	520	140	100000	7800
1,2-Dichloroethane (EDC)		2.86e-03 e	9.10e-02 i	9.10e-02 i	y	0.15	0.088	0.035	31	13
1,1-Dichloroethylene	9.00e-03 i		6.00e-01 i	1.75e-01 i	y	0.054	0.046	0.0053	4.8	2
1,2-Dichloroethylene (cis)	1.00e-02 h				y	61	37	14	10000	780
1,2-Dichloroethylene (trans)	2.00e-02 i				y	120	73	27	20000	1600
1,2-Dichloroethylene (mixture)	9.00e-03 h				y	55	33	12	9200	700
2,4-Dichlorophenol	3.00e-03 i					110	11	4.1	3100	230
4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	8.00e-03 i					290	29	11	8200	630
2,4-Dichlorophenoxyacetic Acid (2,4-D)	1.00e-02 i				y	61	37	14	10000	780
1,2-Dichloropropane		1.14e-03 i	6.80e-02 h		y	0.2	0.12	0.046	42	18
1,3-Dichloropropene	3.00e-04 i	5.71e-03 i	1.80e-01 h	1.30e-01 h	y	0.096	0.061	0.018	16	6.6
2,3-Dichloropropanol	3.00e-03 i					110	11	4.1	3100	230
Dichlorvos	8.00e-04 x		2.90e-01 i			0.28	0.028	0.011	9.9	4.1
Dicofol			4.40e-01 x			0.18	0.018	0.0072	6.5	2.7
Dicyclopentadiene	3.00e-02 h	5.71e-05 a			y	0.42	0.21	41	31000	2300
Dieldrin	5.00e-05 i		1.60e+01 i	1.61e+01 i		0.005	0.0005	0.0002	0.18	0.075

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Diethylene glycol, monobutyl ether		5.71e-03 h				210	21			
Diethylene glycol, monoethyl ether	2.00e+00 h					73000	7300	2700	2000000	160000
Diethylformamide	1.10e-02 h					400	40	15	11000	860
Di(2-ethylhexyl)adipate	6.00e-01 i		1.20e-03 i			66	6.6	2.6	2400	1000
Diethyl phthalate	8.00e-01 i					29000	2900	1100	820000	63000
Diethylstilbestrol			4.70e+03 h			0.000017	0.0000017	0.00000067	0.00061	0.00025
Difenzoquat (Avenge)	8.00e-02 i					2900	290	110	82000	6300
Diflubenzuron	2.00e-02 i					730	73	27	20000	1600
Diisopropyl methylphosphonate (DIMP)	8.00e-02 i					2900	290	110	82000	6300
Dimethipin	2.00e-02 i					730	73	27	20000	1600
Dimethoate	2.00e-04 i					7.3	0.73	0.27	200	16
3,3'-Dimethoxybenzidine			1.40e-02 h			5.7	0.57	0.23	200	85
Dimethylamine		5.71e-06 x				0.21	0.021			
N-N-Dimethylaniline	2.00e-03 i					73	7.3	2.7	2000	160
2,4-Dimethylaniline			7.50e-01 h			0.11	0.011	0.0042	3.8	1.6
2,4-Dimethylaniline hydrochloride			5.80e-01 h			0.14	0.014	0.0054	4.9	2.1
3,3'-Dimethylbenzidine			9.20e+00 h			0.0087	0.00087	0.00034	0.31	0.13
1,1-Dimethylhydrazine			2.60e+00 h	3.50e+00 h		0.031	0.0023	0.0012	1.1	0.46
1,2-Dimethylhydrazine			3.70e+01 h	3.70e+01 h		0.0022	0.00022	0.000085	0.077	0.032
N,N-Dimethylformamide	1.00e-01 h	8.57e-03 i				3700	31	140	100000	7800
2,4-Dimethylphenol	2.00e-02 i					730	73	27	20000	1600
2,6-Dimethylphenol	6.00e-04 i					22	2.2	0.81	610	47
3,4-Dimethylphenol	1.00e-03 i					37	3.7	1.4	1000	78
Dimethyl phthalate	1.00e+01 h					370000	37000	14000	10000000	780000
Dimethyl terephthalate	1.00e-01 i					3700	370	140	100000	7800
4,6-Dinitro-o-cyclohexyl phenol	2.00e-03 i					73	7.3	2.7	2000	160
1,2-Dinitrobenzene	4.00e-04 h					15	1.5	0.54	410	31
1,3-Dinitrobenzene	1.00e-04 i					3.7	0.37	0.14	100	7.8
1,4-Dinitrobenzene	4.00e-04 h					15	1.5	0.54	410	31
2,4-Dinitrophenol	2.00e-03 i					73	7.3	2.7	2000	160
Dinitrotoluene mixture			6.80e-01 i			0.12	0.012	0.0046	4.2	1.8
2,4-Dinitrotoluene	2.00e-03 i		i			73	7.3	2.7	2000	160
2,6-Dinitrotoluene			6.80e-01 i			0.12	0.012	0.0046	4.2	1.8
Dinoseb	1.00e-03 i					37	3.7	1.4	1000	78
di-n-Octyl phthalate	2.00e-02 h					730	73	27	20000	1600
1,4-Dioxane			1.10e-02 i			7.3	0.73	0.29	260	110
Diphenamid	3.00e-02 i					1100	110	41	31000	2300
Diphenylamine	2.50e-02 i					910	91	34	26000	2000

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
1,2-Diphenylhydrazine			8.00e-01 i	7.70e-01 i		0.1	0.01	0.0039	3.6	1.5
Diquat	2.20e-03 i					80	8	3	2200	170
Direct black 38			8.60e+00 h			0.0093	0.00093	0.00037	0.33	0.14
Direct blue 6			8.10e+00 h			0.0098	0.00098	0.00039	0.35	0.15
Direct brown 35			9.30e+00 h			0.0086	0.00086	0.00034	0.31	0.13
Disulfoton	4.00e-05 i					1.5	0.15	0.054	41	3.1
Diuron	2.00e-03 i					73	7.3	2.7	2000	160
1,4-Dithiane	1.00e-02 i					370	37	14	10000	780
Dodine	4.00e-03 i					150	15	5.4	4100	310
Endosulfan	5.00e-05 x					1.8	0.18	0.068	51	3.9
Endothall	2.00e-02 i					730	73	27	20000	1600
Endrin	3.00e-04 i					11	1.1	0.41	310	23
Epichlorohydrin	2.00e-03 h	2.86e-04 i	9.90e-03 i	4.20e-03 i		8.1	1	0.32	290	120
1,2-Epoxybutane		5.71e-03 i				210	21			
EPTC (S-Ethyl dipropylthiocarbamate)	2.50e-02 i					910	91	34	26000	2000
Ethephon (2-chloroethyl phosphonic acid)	5.00e-03 i					180	18	6.8	5100	390
Ethion	5.00e-04 i					18	1.8	0.68	510	39
2-Ethoxyethanol	4.00e-01 h	5.71e-02 i				15000	210	540	410000	31000
2-Ethoxyethanol acetate	3.00e-01 a					11000	1100	410	310000	23000
Ethyl acetate	9.00e-01 i					33000	3300	1200	920000	70000
Ethyl acrylate			4.80e-02 h			1.7	0.17	0.066	60	25
Ethylbenzene	1.00e-01 i	2.86e-01 i			y	1300	1000	140	100000	7800
Ethylene cyanohydrin	3.00e-01 h					11000	1100	410	310000	23000
Ethylene diamine	2.00e-02 h					730	73	27	20000	1600
Ethylene glycol	2.00e+00 i					73000	7300	2700	2000000	160000
Ethylene glycol, monobutyl ether		5.71e-03 h				210	21			
Ethylene oxide			1.02e+00 h	3.50e-01 h		0.078	0.023	0.0031	2.8	1.2
Ethylene thiourea (ETU)	8.00e-05 i		6.00e-01 h			0.13	0.013	0.0053	4.8	2
Ethyl chloride	2.00e-02 e	2.86e+00 i			y	710	10000	27	20000	1600
Ethyl ether	2.00e-01 i				y	1200	730	270	200000	16000
Ethyl methacrylate	9.00e-02 h					3300	330	120	92000	7000
Ethyl p-nitrophenyl phenylphosphorothioate	1.00e-05 i					0.37	0.037	0.014	10	0.78
Ethylnitrosourea			1.40e+02 h			0.00057	0.000057	0.000023	0.02	0.0085
Ethylphthalyl ethyl glycolate	3.00e+00 i					110000	11000	4100	3100000	230000
Express	8.00e-03 i					290	29	11	8200	630
Fenamiphos	2.50e-04 i					9.1	0.91	0.34	260	20

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Fluometuron	1.30e-02 i					470	47	18	13000	1000
Fluoride	6.00e-02 i					2200	220	81	61000	4700
Fluoridone	8.00e-02 i					2900	290	110	82000	6300
Flurprimidol	2.00e-02 i					730	73	27	20000	1600
Flutolanil	6.00e-02 i					2200	220	81	61000	4700
Fluvalinate	1.00e-02 i					370	37	14	10000	780
Folpet	1.00e-01 i		3.50e-03 i			23	2.3	0.9	820	340
Fomesafen			1.90e-01 i			0.42	0.042	0.017	15	6.3
Fonofos	2.00e-03 i					73	7.3	2.7	2000	160
Formaldehyde	2.00e-01 i			4.55e-02 i		7300	0.18	270	200000	16000
Formic Acid	2.00e+00 h					73000	7300	2700	2000000	160000
Fosetyl-al	3.00e+00 i					110000	11000	4100	3100000	230000
Furan	1.00e-03 i					37	3.7	1.4	1000	78
Furazolidone			3.80e+00 h			0.021	0.0021	0.00083	0.75	0.31
Furfural	3.00e-03 i	1.43e-02 a				110	52	4.1	3100	230
Furium			5.00e+01 h			0.0016	0.00016	0.000063	0.057	0.024
Furmecyclox			3.00e-02 i			2.7	0.27	0.11	95	40
Glufosinate-ammonium	4.00e-04 i					15	1.5	0.54	410	31
Glycidaldehyde	4.00e-04 i	2.86e-04 h				15	1	0.54	410	31
Glyphosate	1.00e-01 i					3700	370	140	100000	7800
Haloxyfop-methyl	5.00e-05 i					1.8	0.18	0.068	51	3.9
Harmony	1.30e-02 i					470	47	18	13000	1000
Heptachlor	5.00e-04 i		4.50e+00 i	4.55e+00 i	y	0.0029	0.0018	0.0007	0.64	0.27
Heptachlor epoxide	1.30e-05 i		9.10e+00 i	9.10e+00 i	y	0.0015	0.00088	0.00035	0.31	0.13
Hexabromobenzene	2.00e-03 i				y	12	7.3	2.7	2000	160
Hexachlorobenzene	8.00e-04 i		1.60e+00 i	1.61e+00 i	y	0.0083	0.005	0.002	1.8	0.75
Hexachlorobutadiene	2.00e-03 i		7.80e-02 i	7.70e-02 i	y	0.17	0.1	0.04	37	15
HCH (alpha)			6.30e+00 i	6.30e+00 i		0.013	0.0013	0.0005	0.45	0.19
HCH (beta)			1.80e+00 i	1.80e+00 i		0.044	0.0044	0.0018	1.6	0.66
HCH (gamma) Lindane	3.00e-04 i		1.30e+00 h			0.061	0.0061	0.0024	2.2	0.92
HCH-technical			1.80e+00 i	1.79e+00 i		0.044	0.0045	0.0018	1.6	0.66
Hexachlorocyclopentadiene	7.00e-03 i	2.00e-05 h			y	0.15	0.073	9.5	7200	550
Hexachlorodibenzo-p-dioxin mixture (HxCDD)			6.20e+03 i	4.55e+03 i		0.000013	0.0000018	0.00000051	0.00046	0.00019
Hexachloroethane	1.00e-03 i		1.40e-02 i	1.40e-02 i	y	0.95	0.57	0.23	200	78
Hexachlorophene	3.00e-04 i					11	1.1	0.41	310	23
n-Hexane	6.00e-02 h	5.71e-02 i			y	350	210	81	61000	4700
Hexazinone	3.30e-02 i					1200	120	45	34000	2600
Hydrazine, hydrazine sulfate			3.00e+00 i	1.72e+01 i		0.027	0.00047	0.0011	0.95	0.4

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Hydrogen chloride		2.00e-03 i				73	7.3			
Hydrogen sulfide	3.00e-03 i	2.57e-04 i				110	0.94	4.1	3100	230
p-Hydroquinone	4.00e-02 h					1500	150	54	41000	3100
Imazalil	1.30e-02 i					470	47	18	13000	1000
Imazaquin	2.50e-01 i					9100	910	340	260000	20000
Iprodione	4.00e-02 i					1500	150	54	41000	3100
Isobutanol	3.00e-01 i				y	1800	1100	410	310000	23000
Isophorone	2.00e-01 i		9.50e-04 i			84	8.4	3.3	3000	1300
Isopropalin	1.50e-02 i					550	55	20	15000	1200
Isopropyl methyl phosphonic acid (IMPA)	1.00e-01 i					3700	370	140	100000	7800
Isoxaben	5.00e-02 i					1800	180	68	51000	3900
Kepone			1.80e+01 e			0.0044	0.00044	0.00018	0.16	0.066
Lactofen	2.00e-03 i					73	7.3	2.7	2000	160
Lead (tetraethyl)	1.00e-07 i					0.0037	0.00037	0.00014	0.1	0.0078
Linuron	2.00e-03 i					73	7.3	2.7	2000	160
Lithium	2.00e-02 e					730	73	27	20000	1600
Londax	2.00e-01 i					7300	730	270	200000	16000
Malathion	2.00e-02 i					730	73	27	20000	1600
Maleic anhydride	1.00e-01 i					3700	370	140	100000	7800
Maleic hydrazide	5.00e-01 i					18000	1800	680	510000	39000
Malononitrile	2.00e-05 h					0.73	0.073	0.027	20	1.6
Mancozeb	3.00e-02 h					1100	110	41	31000	2300
Maneb	5.00e-03 i					180	18	6.8	5100	390
Manganese and compounds	5.00e-03 i	1.14e-04 i				180	0.42	6.8	5100	390
Mephosfolan	9.00e-05 h					3.3	0.33	0.12	92	7
Mepiquat	3.00e-02 i					1100	110	41	31000	2300
Mercury and compounds (methyl)	3.00e-04 i					11	1.1	0.41	310	23
Mercury and compounds (inorganic)	3.00e-04 h	8.57e-05 h				11	0.31	0.41	310	23
Merphos	3.00e-05 i					1.1	0.11	0.041	31	2.3
Merphos oxide	3.00e-05 i					1.1	0.11	0.041	31	2.3
Metalaxyl	6.00e-02 i					2200	220	81	61000	4700
Methacrylonitrile	1.00e-04 i	2.00e-04 a				3.7	0.73	0.14	100	7.8
Methamidophos	5.00e-05 i					1.8	0.18	0.068	51	3.9
Methanol	5.00e-01 i					18000	1800	680	510000	39000
Methidathion	1.00e-03 i					37	3.7	1.4	1000	78
Methomyl	2.50e-02 i					910	91	34	26000	2000
Methoxychlor	5.00e-03 i					180	18	6.8	5100	390

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2-Methoxyethanol	4.00e-03 h	5.71e-03 i				150	21	5.4	4100	310
2-Methoxyethanol acetate	2.00e-03 a					73	7.3	2.7	2000	160
2-Methoxy-5-nitroaniline			4.60e-02 h			1.7	0.17	0.069	62	26
Methyl acetate	1.00e+00 h					37000	3700	1400	1000000	78000
Methyl acrylate	3.00e-02 a					1100	110	41	31000	2300
2-Methylaniline (o-toluidine)			2.40e-01 h			0.33	0.033	0.013	12	5
2-Methylaniline hydrochloride			1.80e-01 h			0.44	0.044	0.018	16	6.6
Methyl chlorocarbonate	1.00e+00 x					37000	3700	1400	1000000	78000
2-Methyl-4-chlorophenoxyacetic acid	5.00e-04 i					18	1.8	0.68	510	39
4-(2-Methyl-4-chlorophenoxy) butyric acid (MCPB)	1.00e-02 i					370	37	14	10000	780
2-(2-Methyl-4-chlorophenoxy) propionic acid	1.00e-03 i					37	3.7	1.4	1000	78
2-(2-Methyl-1,4-chlorophenoxy) propionic acid (MCPP)	1.00e-03 i					37	3.7	1.4	1000	78
Methylcyclohexane		8.57e-01 h				31000	3100			
4,4'-Methylenediphenyl isocyanate		5.71e-06 h			y	0.035	0.021			
4,4'-Methylenebisbenzeneamine			2.50e-01 h			0.32	0.032	0.013	11	4.8
4,4'-Methylene bis(2-chloroaniline)	7.00e-04 h		1.30e-01 h	1.30e-01 h		0.61	0.061	0.024	22	9.2
4,4'-Methylene bis(N,N'-dimethyl)aniline			4.60e-02 i			1.7	0.17	0.069	62	26
Methylene bromide	1.00e-02 a				y	61	37	14	10000	780
Methylene chloride	6.00e-02 i	8.57e-01 h	7.50e-03 i	1.65e-03 i	y	5.1	4.8	0.42	380	160
Methyl ethyl ketone	5.00e-02 h	2.86e-01 i				1800	1000	68	51000	3900
Methyl hydrazine			1.10e+00 h			0.073	0.0073	0.0029	2.6	1.1
Methyl isobutyl ketone	5.00e-02 h	2.29e-02 a				1800	83	68	51000	3900
Methyl methacrylate	8.00e-02 h					2900	290	110	82000	6300
2-Methyl-5-nitroaniline			3.30e-02 h			2.4	0.24	0.096	87	36
Methyl parathion	2.50e-04 i					9.1	0.91	0.34	260	20
2-Methylphenol (o-cresol)	5.00e-02 i					1800	180	68	51000	3900
3-Methylphenol (m-cresol)	5.00e-02 i					1800	180	68	51000	3900
4-Methylphenol (p-cresol)	5.00e-03 h					180	18	6.8	5100	390
Methyl styrene (mixture)	6.00e-03 a	1.14e-02 a			y	60	42	8.1	6100	470
Methyl styrene (alpha)	7.00e-02 a				y	430	260	95	72000	5500
Methyl tertbutyl ether (MTBE)	5.00e-03 e	1.43e-01 i			y	160	520	6.8	5100	390
Metolaclor (Dual)	1.50e-01 i					5500	550	200	150000	12000
Metribuzin	2.50e-02 i					910	91	34	26000	2000
Mirex	2.00e-04 i		1.80e+00 h			0.044	0.0044	0.0018	1.6	0.66
Molinate	2.00e-03 i					73	7.3	2.7	2000	160

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Molybdenum	5.00e-03 i					180	18	6.8	5100	390
Monochloramine	1.00e-01 i					3700	370	140	100000	7800
Naled	2.00e-03 i					73	7.3	2.7	2000	160
Napropamide	1.00e-01 i					3700	370	140	100000	7800
Nickel and compounds	2.00e-02 i					730	73	27	20000	1600
Nickel refinery dust				8.40e-01 i			0.0095			
Nickel subsulfide				1.70e+00 i			0.0047			
Nitrapyrin	1.50e-03 x					55	5.5	2	1500	120
Nitrate	1.60e+00 i					58000	5800	2200	1600000	130000
Nitric Oxide	1.00e-01 i					3700	370	140	100000	7800
Nitrite	1.00e-01 i					3700	370	140	100000	7800
2-Nitroaniline	6.00e-05 h	5.71e-05 h				2.2	0.21	0.081	61	4.7
3-Nitroaniline	3.00e-03 o					110	11	4.1	3100	230
4-Nitroaniline	3.00e-03 o					110	11	4.1	3100	230
Nitrobenzene	5.00e-04 i	5.71e-04 a			y	3.4	2.1	0.68	510	39
Nitrofurantoin	7.00e-02 h					2600	260	95	72000	5500
Nitrofurazone			1.50e+00 h	9.40e+00 h		0.053	0.00085	0.0021	1.9	0.8
Nitrogen dioxide	1.00e+00 i					37000	3700	1400	1000000	78000
Nitroguanidine	1.00e-01 i					3700	370	140	100000	7800
4-Nitrophenol	6.20e-02 o					2300	230	84	63000	4800
2-Nitropropane		5.71e-03 i		9.40e+00 h		210	0.00085			
N-Nitrosodi-n-butylamine			5.40e+00 i	5.60e+00 i		0.015	0.0014	0.00058	0.53	0.22
N-Nitrosodiethanolamine			2.80e+00 i			0.028	0.0028	0.0011	1	0.43
N-Nitrosodiethylamine			1.50e+02 i	1.51e+02 i		0.00053	0.000053	0.000021	0.019	0.008
N-Nitrosodimethylamine			5.10e+01 i	4.90e+01 i		0.0016	0.00016	0.000062	0.056	0.023
N-Nitrosodiphenylamine			4.90e-03 i			16	1.6	0.64	580	240
N-Nitroso di-n-propylamine			7.00e+00 i			0.011	0.0011	0.00045	0.41	0.17
N-Nitroso-N-methylethylamine			2.20e+01 i			0.0036	0.00036	0.00014	0.13	0.054
N-Nitrosopyrrolidine			2.10e+00 i	2.14e+00 i		0.038	0.0037	0.0015	1.4	0.57
m-Nitrotoluene	1.00e-02 h				y	61	37	14	10000	780
p-Nitrotoluene	1.00e-02 h				y	61	37	14	10000	780
Norflurazon	4.00e-02 i					1500	150	54	41000	3100
NuStar	7.00e-04 i					26	2.6	0.95	720	55
Octabromodiphenyl ether	3.00e-03 i					110	11	4.1	3100	230
Octahydro-1357-tetranitro-1357-tetrazocine (HMX)	5.00e-02 i					1800	180	68	51000	3900
Octamethylpyrophosphoramide	2.00e-03 h					73	7.3	2.7	2000	160
Oryzalin	5.00e-02 i					1800	180	68	51000	3900
Oxadiazon	5.00e-03 i					180	18	6.8	5100	390

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Oxamyl	2.50e-02 i					910	91	34	26000	2000
Oxyfluorfen	3.00e-03 i					110	11	4.1	3100	230
Paclobutrazol	1.30e-02 i					470	47	18	13000	1000
Paraquat	4.50e-03 i					160	16	6.1	4600	350
Parathion	6.00e-03 h					220	22	8.1	6100	470
Pebulate	5.00e-02 h					1800	180	68	51000	3900
Pendimethalin	4.00e-02 i					1500	150	54	41000	3100
Pentabromo-6-chloro cyclohexane			2.30e-02 h			3.5	0.35	0.14	120	52
Pentabromodiphenyl ether	2.00e-03 i					73	7.3	2.7	2000	160
Pentachlorobenzene	8.00e-04 i				y	4.9	2.9	1.1	820	63
Pentachloronitrobenzene	3.00e-03 i		2.60e-01 h		y	0.051	0.031	0.012	11	4.6
Pentachlorophenol	3.00e-02 i		1.20e-01 i			0.66	0.066	0.026	24	10
Permethrin	5.00e-02 i					1800	180	68	51000	3900
Phenmedipham	2.50e-01 i					9100	910	340	260000	20000
Phenol	6.00e-01 i					22000	2200	810	610000	47000
m-Phenylenediamine	6.00e-03 i					220	22	8.1	6100	470
p-Phenylenediamine	1.90e-01 h					6900	690	260	190000	15000
Phenylmercuric acetate	8.00e-05 i					2.9	0.29	0.11	82	6.3
Phenylphenol			1.94e-03 h			41	4.1	1.6	1500	620
Phorate	2.00e-04 h					7.3	0.73	0.27	200	16
Phosmet	2.00e-02 i					730	73	27	20000	1600
Phosphine	3.00e-04 i	8.57e-06 h				11	0.031	0.41	310	23
Phosphorus (white)	2.00e-05 i					0.73	0.073	0.027	20	1.6
p-Phthalic acid	1.00e+00 h					37000	3700	1400	1000000	78000
Phthalic anhydride	2.00e+00 i	3.43e-01 h				73000	1300	2700	2000000	160000
Picloram	7.00e-02 i					2600	260	95	72000	5500
Pirimiphos-methyl	1.00e-02 i					370	37	14	10000	780
Polybrominated biphenyls	7.00e-06 h		8.90e+00 h			0.009	0.0009	0.00035	0.32	0.13
Polychlorinated biphenyls (PCBs)			7.70e+00 i			0.01	0.001	0.00041	0.37	0.16
Aroclor 1016	7.00e-03 i		i			260	26	9.5	7200	550
Polychlorinated terphenyls (PCTs)			4.50e+00 e			0.018	0.0018	0.0007	0.64	0.27
Polynuclear aromatic hydrocarbons										
Acenaphthene	6.00e-02 i					2200	220	81	61000	4700
Anthanthrene			2.31e+00 o	1.93e+00 o		0.035	0.0041	0.0014	1.2	0.52
Anthracene	3.00e-01 i					11000	1100	410	310000	23000
Benz[a]anthracene			1.06e+00 o	8.85e-01 o		0.075	0.009	0.003	2.7	1.8
Benzo[b]fluoranthene			8.96e-01 o	7.49e-01 o		0.089	0.011	0.0035	3.2	1.3
Benzo[j]fluoranthene			3.82e-01 o	3.19e-01 o		0.21	0.025	0.0083	7.5	3.1
Benzo[k]fluoranthene			3.88e-01 o	3.25e-01 o		0.21	0.025	0.0081	7.4	3.1

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Benzo[ghi]perylene			1.55e-01 o	1.29e-01 o		0.52	0.062	0.02	18	7.7
Benzo[a]pyrene			7.30e+00 i	6.10e+00 h		0.011	0.0013	0.00043	0.39	0.16
Benzo[e]pyrene			5.11e-02 o	4.27e-02 o		1.6	0.19	0.062	56	23
Dibenz[ah]anthracene			8.10e+00 o	6.77e+00 o		0.0098	0.0012	0.00039	0.35	0.15
Fluoranthene	4.00e-02 i					1500	150	54	41000	3100
Fluorene	4.00e-02 i					1500	150	54	41000	3100
Indeno[1,2,3-cd]pyrene			2.03e+00 o	1.70e+00 o		0.039	0.0047	0.0016	1.4	0.59
Naphthalene	4.00e-02 h					1500	150	54	41000	3100
Pyrene	3.00e-02 i					1100	110	41	31000	2300
Prochloraz	9.00e-03 i		1.50e-01 i			0.53	0.053	0.021	19	8
Profluralin	6.00e-03 h					220	22	8.1	6100	470
Prometon	1.50e-02 i					550	55	20	15000	1200
Prometryn	4.00e-03 i					150	15	5.4	4100	310
Pronamide	7.50e-02 i					2700	270	100	77000	5900
Propachlor	1.30e-02 i					470	47	18	13000	1000
Propanil	5.00e-03 i					180	18	6.8	5100	390
Propargite	2.00e-02 i					730	73	27	20000	1600
Propargyl alcohol	2.00e-03 i					73	7.3	2.7	2000	160
Propazine	2.00e-02 i					730	73	27	20000	1600
Propham	2.00e-02 i					730	73	27	20000	1600
Propiconazole	1.30e-02 i					470	47	18	13000	1000
Propylene glycol	2.00e+01 h					730000	73000	27000	20000000	1600000
Propylene glycol, monoethyl ether	7.00e-01 h					26000	2600	950	720000	55000
Propylene glycol, monomethyl ether	7.00e-01 h	5.71e-01 i				26000	2100	950	720000	55000
Propylene oxide		8.57e-03 i	2.40e-01 i	1.30e-02 i		0.33	0.62	0.013	12	5
Pursuit	2.50e-01 i					9100	910	340	260000	20000
Pydrin	2.50e-02 i					910	91	34	26000	2000
Pyridine	1.00e-03 i					37	3.7	1.4	1000	78
Quinalphos	5.00e-04 i					18	1.8	0.68	510	39
Quinoline			1.20e+01 h			0.0066	0.00066	0.00026	0.24	0.1
RDX (Cyclonite)	3.00e-03 i		1.10e-01 i			0.73	0.073	0.029	26	11
Resmethrin	3.00e-02 i					1100	110	41	31000	2300
Ronnel	5.00e-02 h					1800	180	68	51000	3900
Rotenone	4.00e-03 i					150	15	5.4	4100	310
Savey	2.50e-02 i					910	91	34	26000	2000
Selenious Acid	5.00e-03 i					180	18	6.8	5100	390
Selenium	5.00e-03 i					180	18	6.8	5100	390
Selenourea	5.00e-03 h					180	18	6.8	5100	390
Sethoxydim	9.00e-02 i					3300	330	120	92000	7000

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Silver and compounds	5.00e-03 i					180	18	6.8	5100	390
Simazine	2.00e-03 h		1.20e-01 h			0.66	0.066	0.026	24	10
Sodium azide	4.00e-03 i					150	15	5.4	4100	310
Sodium diethyldithiocarbamate	3.00e-02 i		2.70e-01 h			0.3	0.03	0.012	11	4.4
Sodium fluoroacetate	2.00e-05 i					0.73	0.073	0.027	20	1.6
Sodium metavanadate	1.00e-03 h					37	3.7	1.4	1000	78
Strontium, stable	6.00e-01 i					22000	2200	810	610000	47000
Strychnine	3.00e-04 i					11	1.1	0.41	310	23
Styrene	2.00e-01 i	2.86e-01 i	3.00e-02 o		y	0.44	0.27	0.11	95	40
Systhane	2.50e-02 i					910	91	34	26000	2000
2,3,7,8-TCDD (dioxin)			1.50e+05 h	1.50e+05 h		0.00000053	0.000000053	0.000000021	0.000019	0.000008
Tebuthiuron	7.00e-02 i					2600	260	95	72000	5500
Temephos	2.00e-02 h					730	73	27	20000	1600
Terbacil	1.30e-02 i					470	47	18	13000	1000
Terbufos	2.50e-05 h					0.91	0.091	0.034	26	2
Terbutryn	1.00e-03 i					37	3.7	1.4	1000	78
1,2,4,5-Tetrachlorobenzene	3.00e-04 i				y	1.8	1.1	0.41	310	23
1,1,1,2-Tetrachloroethane	3.00e-02 i		2.60e-02 i	2.59e-02 i	y	0.51	0.31	0.12	110	46
1,1,2,2-Tetrachloroethane			2.00e-01 i	2.03e-01 i	y	0.066	0.039	0.016	14	6
Tetrachloroethylene (PCE)	1.00e-02 i		5.20e-02 e	2.03e-03 e	y	1.3	3.9	0.061	55	23
2,3,4,6-Tetrachlorophenol	3.00e-02 i					1100	110	41	31000	2300
p,a,a,a-Tetrachlorotoluene			2.00e+01 h		y	0.00066	0.0004	0.00016	0.14	0.06
Tetrachlorovinphos	3.00e-02 i		2.40e-02 h			3.3	0.33	0.13	120	50
Tetraethyldithiopyrophosphate	5.00e-04 i					18	1.8	0.68	510	39
Tetrahydrofuran	2.00e-03 o					73	7.3	2.7	2000	160
Thallic oxide	7.00e-05 h					2.6	0.26	0.095	72	5.5
Thallium acetate	9.00e-05 i					3.3	0.33	0.12	92	7
Thallium carbonate	8.00e-05 i					2.9	0.29	0.11	82	6.3
Thallium chloride	8.00e-05 i					2.9	0.29	0.11	82	6.3
Thallium nitrate	9.00e-05 i					3.3	0.33	0.12	92	7
Thallium selenite	9.00e-05 i					3.3	0.33	0.12	92	7
Thallium sulfate	8.00e-05 i					2.9	0.29	0.11	82	6.3
Thiobencarb	1.00e-02 i					370	37	14	10000	780
2-(Thiocyanomethylthio)-benzothiazole (TCMTB)	3.00e-02 y					1100	110	41	31000	2300
Thiofanox	3.00e-04 h					11	1.1	0.41	310	23
Thiophanate-methyl	8.00e-02 i					2900	290	110	82000	6300
Thiram	5.00e-03 i					180	18	6.8	5100	390
Tin and compounds	6.00e-01 h					22000	2200	810	610000	47000

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Toluene	2.00e-01 i	1.14e-01 h			y	750	420	270	200000	16000
Toluene-2,4-diamine			3.20e+00 h			0.025	0.0025	0.00099	0.89	0.37
Toluene-2,5-diamine	6.00e-01 h					22000	2200	810	610000	47000
Toluene-2,6-diamine	2.00e-01 h					7300	730	270	200000	16000
Toxaphene			1.10e+00 i	1.12e+00 i		0.073	0.0071	0.0029	2.6	1.1
Tralomethrin	7.50e-03 i					270	27	10	7700	590
Triallate	1.30e-02 i					470	47	18	13000	1000
Triasulfuron	1.00e-02 i					370	37	14	10000	780
1,2,4-Tribromobenzene	5.00e-03 i				y	30	18	6.8	5100	390
Tributyltin oxide (TBTO)	3.00e-05 i					1.1	0.11	0.041	31	2.3
2,4,6-Trichloroaniline			3.40e-02 h			2.3	0.23	0.093	84	35
2,4,6-Trichloroaniline hydrochloride			2.90e-02 h			2.8	0.28	0.11	99	41
1,2,4-Trichlorobenzene	1.00e-02 i	2.57e-03 a			y	18	9.4	14	10000	780
1,1,1-Trichloroethane	9.00e-02 h	2.86e-01 a			y	1300	1000	120	92000	7000
1,1,2-Trichloroethane	4.00e-03 i		5.70e-02 i	5.60e-02 i	y	0.24	0.14	0.055	50	21
Trichloroethylene (TCE)	6.00e-03 e		1.10e-02 y	6.00e-03 e	y	1.9	1.3	0.29	260	110
Trichlorofluoromethane	3.00e-01 i	2.00e-01 a			y	1300	730	410	310000	23000
2,4,5-Trichlorophenol	1.00e-01 i					3700	370	140	100000	7800
2,4,6-Trichlorophenol			1.10e-02 i	1.09e-02 i		7.3	0.74	0.29	260	110
2,4,5-Trichlorophenoxyacetic Acid	1.00e-02 i					370	37	14	10000	780
2-(2,4,5-Trichlorophenoxy) propionic acid	8.00e-03 i					290	29	11	8200	630
1,1,2-Trichloropropane	5.00e-03 i				y	30	18	6.8	5100	390
1,2,3-Trichloropropane	6.00e-03 i				y	37	22	8.1	6100	470
1,2,3-TCP as carcinogen			2.70e+00 e		y	0.0049	0.003	0.0012	1.1	0.44
1,2,3-Trichloropropene	5.00e-03 h				y	30	18	6.8	5100	390
1,1,2-Trichloro-1,2,2-trifluoroethane	3.00e+01 i	8.57e+00 h			y	59000	31000	41000	31000000	2300000
Tridiphane	3.00e-03 i					110	11	4.1	3100	230
Triethylamine		2.00e-03 i				73	7.3			
Trifluralin	7.50e-03 i		7.70e-03 i			10	1	0.41	370	160
Trimethyl phosphate			3.70e-02 h			2.2	0.22	0.085	77	32
1,3,5-Trinitrobenzene	5.00e-05 i					1.8	0.18	0.068	51	3.9
Trinitrophenylmethylnitramine	1.00e-02 h					370	37	14	10000	780
2,4,6-Trinitrotoluene	5.00e-04 i		3.00e-02 i			2.7	0.27	0.11	95	39
Uranium (soluble salts)	3.00e-03 i					110	11	4.1	3100	230
Vanadium	7.00e-03 h					260	26	9.5	7200	550
Vanadium pentoxide	9.00e-03 i					330	33	12	9200	700
Vanadyl sulfate	2.00e-02 h					730	73	27	20000	1600
Vanadium sulfate	2.00e-02 h					730	73	27	20000	1600

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Vernam	1.00e-03 i					37	3.7	1.4	1000	78
Vinclozolin	2.50e-02 i					910	91	34	26000	2000
Vinyl acetate	1.00e+00 h	5.71e-02 i				37000	210	1400	1000000	78000
Vinyl chloride			1.90e+00 h	3.00e-01 h	y	0.023	0.027	0.0017	1.5	0.63
Warfarin	3.00e-04 i					11	1.1	0.41	310	23
m-Xylene	2.00e+00 i	2.00e-01 y			y	1400	730	2700	2000000	160000
o-Xylene	2.00e+00 i	2.00e-01 y			y	1400	730	2700	2000000	160000
p-Xylene		8.57e-02 y			y	520	310			
Xylene (mixed)	2.00e+00 i				y	12000	7300	2700	2000000	160000
Zinc	3.00e-01 i					11000	1100	410	310000	23000
Zinc phosphide	3.00e-04 i					11	1.1	0.41	310	23
Zineb	5.00e-02 i					1800	180	68	51000	3900

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DEPARTMENT OF THE ARMY
HEADQUARTERS 1ST INFANTRY DIVISION (MECH) AND FORT RILEY
FORT RILEY, KANSAS 66442

TO ALL INTERESTED AGENCIES, INDIVIDUALS AND PUBLIC GROUPS

Pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) as amended by the Superfund Amendments and Reauthorization Act (SARA) and the National Contingency Plan, 40 CFR Part 300.820, Fort Riley announces the publication of two distinct Engineering Evaluation / Cost Analyses (EE/CA) documents for two proposed "Removal Actions".

An EE/CA contains a description of the site, a discussion of the contaminants found at the site, and the removal action alternatives for the site and a relative evaluation of cost of the various alternatives.

The United States Department of the Army has prepared an EE/CA for the Fort Riley Pesticide Storage Facility (PSF) located in the Directorate of Engineering & Housing maintenance and equipment storage yard. The PSF EE/CA addresses soil contamination at the PSF and presents include several institutional control, containment (capping) and excavation and off-site disposal alternatives.

The United States Department of the Army has also prepared an EE/CA for the Southwest Funston Landfill (SFL) located in the Camp Funston cantonment area of Fort Riley. The SFL EE/CA addresses stabilization of the Kansas River bank adjacent to the site and improvements to the surface cover of the landfill.

The National Contingency Plan requires a 30-day public review period after the publication of Notice of Availability. Both (PSF & SFL) Engineering Evaluation / Cost Analyses will be available for viewing after August 16, 1993 at the Directorate of Engineering and Housing, Environmental and Natural Resources Division, Building 1970 (Camp Funston), Fort Riley, Kansas, telephone (913) 239-3962. Copies will also be available for viewing at the Dorothy Bramlage Public Library, Junction City, Kansas and the Clay Center Carnegie Library, Clay Center, Kansas.

Comments may be submitted to:

HQ. 1st Infantry Division (Mech) and Fort Riley
Directorate of Engineering and Housing
DEH-Environmental Branch
ATTN: AFZN-DE-V (Ms. Janet Wade)
Bldg 1970
Fort Riley, Kansas 66442