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ENGINEERING AND ENVIRONMENTAL SERVICES

DISCUSSION PAPER

IMPACTS OF ALTERNATE DEVELOPMENT AND EVALUATION BY USING MORE CONSERVATIVE EXPOSURE SCENARIOS

PESTICIDE STORAGE FACILITY
FORT RILEY MILITARY INSTALLATION
Fort Riley, Kansas

Prepared for:

U.S. Army Corps of Engineers
Missouri River Division, Kansas City District
601 East 12th Street
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Prepared by:

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April, 1993

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1.0 INTRODUCTION

Law Environmental Government Service Division (LEGS) has prepared the discussion paper as a supplement to the draft Feasibility Study (FS) for the Fort Riley Pesticide Storage Facility (PSF) based upon the USEPA's reasonable maximum exposure (RME) scenarios. The RME scenario developed by the EPA present hypothetical exposure durations which are more frequent or extensive than current activities at the site. The draft FS report submitted on March 19, 1993 utilized the Fort Riley actual exposure scenario (developed using current operating practices) as a basis. The draft FS identified one area of concern at the PSF site of approximately 250 square feet based upon arsenic risk. Based on the RME scenario, remediation goals (RGs) have been developed for the media of concern at the PSF for this discussion paper. As with the draft FS, the potential media of concern includes groundwater, surface water, soil and sediments. Constituents of concern identified by remediation goals for all media except soil are identical to the draft FS. Soil remediation goals and constituents of concern have changed based on the RME scenario as presented in Section 2.0 of the Draft Discussion Paper.

The remedial action objectives (Section 2.3 of the draft FS) for the PSF have not changed for the discussion paper. Furthermore, the general response actions, remedial technologies and process options identified and screened in the draft FS remain applicable for the discussion paper. However, the analysis and development of alternatives will change slightly due to the RME based RG's. This includes additional constituents of concern as well as an increase in the extent of contamination for soil media in the discussion paper.

Evaluation of the soil data indicates four constituents are present at the PSF in concentrations greater than the RME based RGs. These constituents are arsenic, chlordane, 4,4'-DDT, and dieldrin. These four constituents are addressed in the discussion paper as a supplement to the draft FS.

2.0 CONTAMINANT SPECIFIC SOIL REMEDIATION GOALS

A baseline risk assessment was conducted for the Pesticide Storage Facility at Fort Riley as documented in the Remedial Investigation (RI) report. The purpose of this assessment was to evaluate the potential human health and environmental risks posed by the constituents present in ground water, soil, sediment, and surface water at the PSF site. The results of the baseline risk assessment were summarized in Section 1.5 of the Draft Feasibility Study report submitted on March 19, 1993; refer to this document for the baseline risk assessment summary. Note that the Draft FS, as well as the risk assessment material presented in this discussion paper does not address or incorporate the comments received for the Draft Remediation Investigation report.

2.1 REASONABLE MAXIMUM EXPOSURES SCENARIO

At the Preliminary Site Characterization Study (PSCS) meeting for the PSF site on November 4, 1992 and in a later memo (USEPA, 1992b), USEPA Region VII indicated that the exposure scenarios presented (based on the current operating procedures at the site) did not in EPA opinions represent the reasonable maximum exposure (RME) possible at the site. The RME exposure scenario is intended to represent "an exposure scenario that is both protective and reasonable, but does not represent the worst possible case" (USEPA, 1991a). Exposure scenarios developed for a risk assessment and for risk-based remediation goals must be sufficiently protective (i.e., conservative) for the majority of people who may come into contact with contaminated media on-site while being reasonable and not overly protective for the possible exposed receptors.

The USEPA standard default exposure values generally used for occupational scenarios are protective of site workers, but when compared to the actual exposure patterns occurring at the PSF site, these default values represent the worst possible case and thus are inappropriate for use as the RME. Standard default values (USEPA, 1991a) used to estimate default occupational intakes include such upper-bound values as an exposure frequency of 250 days per year (assumes exposure every work day, with a two-week vacation away from the site), and an exposure time of eight hours daily (USEPA, 1991a). The actual exposure frequency and time for the workers on the PSF site are much less than the default values of these variables. Therefore, in order to estimate the RME for this site, modifications were made to the original site-specific exposure patterns, based on the suggestions and recommendations included in the November 6, 1992 memo issued by USEPA Region VII (EPA, 1992b). These occupational scenarios will be referred to as the RME scenarios and are described in the following paragraph. Three occupational scenarios have been developed; 1) utility worker, 2) landscaper, and 3) site worker.

The utility worker scenario is based on an exposure frequency of 6 eight-hour days each year for the duration of 25 years. A conservative assumption is made in that the same worker is exposed to soils during excavation work 6 days each year for 25 years, instead of a total of three to six, 6.5-hour days in a twenty year period. The exposure duration value of 25 years represents the upper-bound value of time spent with the same employer (USEPA, 1991a).

Similarly, the landscaper scenario is based on an exposure to site soils that occur 8 hours per day, one day a week during the growing season, for a total of 25 years. The growing season in the Fort Riley area is approximately six months long, or 26 weeks (Riley

County Extension Service, 1992). According to USEPA Region VII, it is reasonable to assume that mowing/landscaping work will occur at the site once weekly during the growing season (USEPA, 1992b). Both the landscaper and the utility worker are expected to be in repeated contact with soils throughout the day, therefore, an upper-bound value of 480 mg/day is used for incidental ingestion of soil (USEPA, 1989b).

2.2 DETERMINATION OF SOIL RME REMEDIATION GOALS

The equations for determining soil RME remediation goals for noncarcinogenic and carcinogenic endpoints for occupational receptors are shown in Tables 2-1 and 2-2. In general, soil RG equations for all receptors possess an incidental ingestion, inhalation, and dermal component. An exception to this is the on-site worker; this receptor's exposure considerations are discussed in detail in the draft FS Section 2.2.4.3.

2.3 SOIL RME REMEDIATION GOALS

Table 2-3 presents a comparison of the soil RME based remediation goals (calculated for occupational receptors), RCRA soil action levels, maximum detected soil concentrations, and maximum detected background concentrations. Both the RCRA action levels and the RME remediation goals are considered TBCs for soils. Remediation goals for several constituents (lead, 2-methylnaphthalene, phenanthrene indeno[1,2,3-cd] pyrene and chrysene) are unable to be calculated because these constituents do not have toxicity values.

Table 2-1
REMEDIATION GOALS – NONCARCINOGENIC EFFECTS
Fort Riley Discussion Paper
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF COMMERCIAL/INDUSTRIAL SOIL EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * 10^{-6} kg/mg * IR_{SOIL} * EF * ED}{RfD_O * BW * AT * 365 \; days/yr} + \frac{C * EF * ED * AF * ABS * SA * 10^{-6} kg/mg}{RfD_O * BW * AT * 365 \; days/yr} + \frac{C * EF * ET * ED * IR_{AIR} * 1/PEF}{RfD_I * BW * AT * 365 \; days/yr}$$

$$C \; (mg/kg) \; (risk\text{-}based) = \frac{THI * BW * AT * 365 \; days/yr}{ED * [(1/RfD_O * 10^{-6} kg/mg * IR_{SOIL} * EF) + (1/RfD_O * ET * AF * ABS * SA * 10^{-6} kg/mg * EF) + (1/RfD_I * EF * ET * IR_{AIR} * 1/PEF)]}$$

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)

Actual Receptors (Scenario "A")[a]

	Site Worker	Utility	Landscaper
THI	1	1	1
SF_O	*** chemical specific ***		
EF	150	0.3	3
ED	25	25	25
ET	0.5	8	0.5
IR_{SOIL}	--[c]	480	480
AF	1	1	1
ABS	100%	100%	100%
SA	--[c]	3,600	3,600
SF_I	*** chemical specific ***		
IR_{AIR}	2.5	2.5	2.5
PEF	*** 3.26×10^9 ***		
BW	70	70	70
AT	25	25	25

RME Receptors (Scenario "B")[b]

	Site Worker	Utility	Landscaper
THI	1	1	1
SF_O	*** chemical specific ***		
EF	250	6	26
ED	25	25	25
ET	8	8	8
IR_{SOIL}	--[c]	480	480
AF	1	1	1
ABS	100%	100%	100%
SA	--[c]	3,600	3,600
SF_I	*** chemical specific ***		
IR_{AIR}	2.5	2.5	2.5
PEF	*** 3.26×10^9 ***		
BW	70	70	70
AT	25	25	25

Notes:

a – Scenario A, actual site exposure, is based on current operating procedures on site. These values are presented here for comparison purposes.

b – Scenario B, RME exposure, is based on a conservative estimate of potential site exposure (i.e., the Reasonable Maximum Exposure).

c – Ingestion and dermal RG components were not calculated for this receptor, because they do not have direct contact with site soil

Table 2–1 (continued)
REDUCED EQUATIONS: COMMERCIAL/INDUSTRIAL SOIL – NONCARCINOGENIC EFFECTS

RME SITE WORKER (Scenario B)

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{1 * 70\ \text{kg} * 25\ \text{yrs} * 365\ \text{days/yr}}{250\ \text{days/yr} * 25\ \text{yr} * [(1/RfD_o) * 10^{-6}\ \text{kg/mg} * 0\ \text{mg/day}) + (1/RfD_o * 1\ \text{mg/cm}^2 * 1 * 0\ \text{cm}^2 * 10^{-6}\ \text{kg/mg}) + (1/RfD_i * 2.5\ \text{m}^3\text{/hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{8}\ \text{m}^3\text{/kg}))]}$$

$$\text{Risk-based RG (mg/kg; THI = 1)} = 1.7 \times 10^{9}\ RfD_i$$

RME UTILITY WORKER (Scenario B)

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{1 * 70\ \text{kg} * 25\ \text{yrs} * 365\ \text{days/yr}}{6\ \text{days/yr} * 25\ \text{yr} * [(1/RfD_o) * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (1/RfD_o * 1\ \text{mg/cm}^2 * 1 * 3{,}600\ \text{cm}^2\text{/day} * \{8\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (1/RfD_i * 2.5\ \text{m}^3\text{/hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{8}\ \text{m}^3\text{/kg}))]}$$

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{4.3 \times 10^{3}}{(1.7 \times 10^{-3}/RfD_o) + (6.1 \times 10^{-8}/RfD_i)}$$

RME LANDSCAPER WORKER (Scenario B)

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{1 * 70\ \text{kg} * 25\ \text{yrs} * 365\ \text{days/yr}}{26\ \text{days/yr} * 25\ \text{yr} * [(1/RfD_o) * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (1/RfD_o * 1\ \text{mg/cm}^2 * 1 * 3{,}600\ \text{cm}^2\text{/day} * \{8\ \text{hr/day}/24\ \text{hr/day}\} * 10^{-6}\ \text{kg/mg}) + (1/RfD_i * 2.5\ \text{m}^3\text{/hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{8}\ \text{m}^3\text{/kg}))]}$$

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{9.83 \times 10^{2}}{(1.7 \times 10^{-3}/RfD_o) + (6.1 \times 10^{-8}/RfD_i)}$$

Table 2–2
REMEDIATION GOALS – CARCINOGENIC EFFECTS
Fort Riley Discussion Paper
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) =

$$C = \frac{TR * BW * AT * 365\,days/yr}{ED * [(SF_O * 10^{-6}\,mg/kg * IR_{SOIL} * EF) + (SF_O * AF * ABS * SA * 10^{-6}\,mg/kg * EF) + (SF_I * EF * ET * IR_{AIR} * 1/PEF)]}$$

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)

Parameter		Definition
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)

Actual Receptors (Scenario "A")[a]

	Site Worker	Utility	Landscaper
TR	10^{-6}	10^{-6}	10^{-6}
SF_O	*** chemical specific ***		
EF	150	0.3	3
ED	25	25	25
ET	0.5	8	0.5
IR_{SOIL}	– –[c]	480	480
AF	1	1	1
ABS	100%	100%	100%
SA	– –[c]	3,600	3,600
SF_I	*** chemical specific ***		
IR_{AIR}	2.5	2.5	2.5
PEF	*** 3.26×10^9 ***		
BW	70	70	70
AT	70	70	70

RME Receptors (Scenario "B")[b]

	Site Worker	Utility	Landscaper
TR	10^{-6}	10^{-6}	10^{-6}
SF_O	*** chemical specific ***		
EF	250	6	26
ED	25	25	25
ET	8	8	8
IR_{SOIL}	– –[c]	480	480
AF	1	1	1
ABS	100%	100%	100%
SA	– –[c]	3,600	3,600
SF_I	*** chemical specific ***		
IR_{AIR}	2.5	2.5	2.5
PEF	*** 3.26×10^9 ***		
BW	70	70	70
AT	70	70	70

Notes:

a – Scenario A, actual site exposure, is based on current operating procedures on site. These values are presented here for comparison purposes.

b – Scenario B, RME exposure, is based on a conservative estimate of potential site exposure (i.e., the Reasonable Maximum Exposure).

c – Ingestion and dermal RG components were not calculated for this receptor, because they do not have direct contact with site soil

Table 2-2 (continued)
REDUCED EQUATIONS: COMMERCIAL/INDUSTRIAL SOIL – CARCINOGENIC EFFECTS

RME SITE WORKER (Scenario B)

$$\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\text{ kg} * 70\text{ yrs} * 365\text{ days/yr}}{250\text{ days/yr} * 25\text{ yr} * [(SF_o * 10^{-6}\text{ kg/mg} * 0\text{ mg/day}) + (SF_o * 1\text{ mg/cm}^2 * 1 * 0\text{ cm}^2\text{/day} * \{8\text{ hr/day}/24\text{ hr/day}\} * 10^{-6}\text{ kg/mg}) + (SF_i * 2.5\text{ m}^3\text{/hr} * 8\text{ hr/day} * (1/3.26 \times 10^9\text{ m}^3\text{/kg}))]}$$

$$\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{4.7 \times 10^3}{SF_i}$$

RME UTILITY WORKER (Scenario B)

$$\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\text{ kg} * 70\text{ yrs} * 365\text{ days/yr}}{6\text{ days/yr} * 25\text{ yr} * [(SF_o * 10^{-6}\text{ kg/mg} * 480\text{ mg/day}) + (SF_o * 1\text{ mg/cm}^2 * 1 * 3{,}600\text{ cm}^2\text{/day} * \{8\text{ hr/day}/24\text{ hr/day}\} * 10^{-6}\text{ kg/mg}) + (SF_i * 2.5\text{ m}^3\text{/hr} * 8\text{ hr/day} * (1/3.26 \times 10^9\text{ m}^3\text{/kg}))]}$$

$$\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{1.2 \times 10^{-2}}{(1.7 \times 10^{-3}\ SF_o) + (6.1 \times 10^{-6}\ SF_i)}$$

RME LANDSCAPER WORKER (Scenario B)

$$\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\text{ kg} * 70\text{ yrs} * 365\text{ days/yr}}{26\text{ days/yr} * 25\text{ yr} * [(SF_o * 10^{-6}\text{ kg/mg} * 480\text{ mg/day}) + (SF_o * 1\text{ mg/cm}^2 * 1 * 3{,}600\text{ cm}^2\text{/day} * \{*\text{ hr/day}/24\text{ hr/day}\} * 10^{-6}\text{ kg/mg}) + (SF_i * 2.5\text{ m}^3\text{/hr} * 8\text{ hr/day} * (1/3.26 \times 10^9\text{ m}^3\text{/kg}))]}$$

$$\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{2.8 \times 10^{-3}}{(1.7 \times 10^{-3}\ SF_o) + (6.1 \times 10^{-6}\ SF_i)}$$

Table 2–3
REMEDIATION GOALS – SOILS
SUMMARY TABLE
Fort Riley Discussion Paper
Pesticide Storage Facility
Fort Riley, Kansas

Constituent	"Governing" Remediation Goals [RGs] (mg/kg)						Proposed RCRA Soil Action Levels [b] (mg/kg)	Maximum Detected Concentration (mg/kg)	Maximum Detected Background Concentration (mg/kg)
	Site Worker [a]		Utility Worker		Landscaper				
	Non–Cancer Endpoints	Cancer Endpoints	Non–Cancer Endpoints	Cancer Endpoints	Non–Cancer Endpoints	Cancer Endpoints			
Pesticides:									
Chlordane	––	3.62E+03	1.52E+02	5.43E+00	3.47E+01	1.27E+00 *	5.00E–01 *	3.20E+00 T	7.50E–01 T,e
4,4'–DDT	––	1.38E+04	1.26E+03	2.08E+01 *	2.89E+02	4.84E+00 *	2.00E+00 *	3.30E+01	9.40E–02 e
Dieldrin	––	2.94E+02	1.26E+02	4.41E–01	2.89E+01	1.03E–01 *	4.00E–02 *	2.00E–01	2.70E–02 e
Semi–Volatile Compounds:									
Anthracene	––	––	7.59E+05	––	1.73E+05	––	NA	7.60E–01	ND
Benzo[a]anthracene	––	––	––	6.66E+00	––	1.55E+00	NA	6.00E–01	ND
Benzo[a]pyrene	––	––	––	9.67E–01 *	––	2.26E–01 *	NA	1.30E+00	ND
Benzo[b]fluoranthene	––	––	––	6.92E+00	––	1.61E+00	NA	1.40E+00	ND
Benzo[k]fluoranthene	––	––	––	1.47E+01	––	3.43E+00	NA	1.20E+00	ND
Chrysene	––	––	––	2.43E+02	––	5.68E+01	NA	1.70E+00	ND
Dibenzofuran	––	––	––	5.04E+00	––	1.18E+00	NA	1.30E–01	ND
Indeno[1,2,3–cd]pyrene	––	––	––	––	––	––	NA	4.80E–01	ND
2–Methylnaphthalene	––	––	––	––	––	––	NA	2.00E–01	ND
Phenanthrene	––	––	––	––	––	––	NA	2.70E+00	ND
Metals:									
Arsenic	––	3.13E+02	7.59E+02	3.92E+00 *	1.73E+02	9.15E–01 *	8.00E+01 *	1.20E+02	2.40E+00
Barium	2.38E+05	––	1.77E+05	––	4.04E+04	––	4.00E+03	1.90E+02	9.90E+01
Cadmium	––	7.70E+02	2.53E+03	3.22E+04	5.78E+02	7.52E+03	4.00E+01	5.00E+00	ND
Chromium	––	1.15E+02	1.26E+04	4.80E+03	2.89E+03	1.12E+03	4.00E+02	4.10E+01 d	9.30E+00
Lead	––	––	––	––	––	––	5E+02 to 1E+03 [c]	7.70E+02	4.60E+01
Mercury	––	––	7.59E+02	––	1.73E+02	––	2.00E+02	1.30E+00	ND

* – Indicates an exceedence by the constituent's maximum detected concentration.

a – The only exposure route considered for the site worker is inhalation of fugitive dust. RGs cannot be calculated for the semi–volatile compounds, because none of the semi–volatiles present in site soil samples have inhalation toxicity values.
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.
T – Value is for total chlordanes.
–– RG not calculated; toxicity values not available for this constituent.

The maximum detected level of arsenic in site soils (120 mg/kg) exceeds the RCRA soil action level (80 mg/kg), and the remediation goals calculated for the following receptors: the RME landscaper (0.92 mg/kg), and the RME utility worker (3.9 mg/kg). The maximum concentration of arsenic was detected in a soil sample collected from 3.5 to 4.5 feet beneath the soil surface; thus, direct exposure to this level of arsenic should not occur unless intrusive activities such as excavation are performed on site. The highest concentration of arsenic detected in the four surface soil samples collected from the site is 16 mg/kg.

The maximum detected level of dieldrin in site soils (0.2 mg/kg), exceeded the RCRA soil action level (0.04 mg/kg) and the RGs calculated for the RME landscaper (0.1 mg/kg). 4,4'-DDT's maximum concentration (33 mg/kg) also exceeds the RCRA action level (2 mg/kg) and the remediation goals calculated for the RME landscaper (4.8 mg/kg) and the RME utility worker (21 mg/kg). Finally, the maximum concentration of total chlordane at the site (3.2 mg/kg) exceeds the RCRA soil action level (0.5 mg/kg) and the RG calculated for the RME landscaper (1.3 mg/kg).

Soil concentrations should be compared to the RME based remediation goals calculated for occupational receptors. Review of the soil data indicates four constituents are present at the PSF in concentrations greater than the RME based remedial goals (RG's). These constituents are arsenic, chlordane, 4,4'-DDT, and dieldrin.

For all constituents except arsenic, the RME based RGs are greater than background concentrations. For arsenic, background concentrations (2.4 mg/kg) are greater than RME based RG (0.9 mg/kg). Typically, in this situation the background data would be used in the discussion paper FS for determining the nature and extent of arsenic contamination. However, the background data level reported is based on three samples from one soil boring. These samples are inadequate to define the true background level of arsenic at Fort Riley. Furthermore, at this background concentration (2.4 mg/kg), arsenic background concentrations are exceeded in areas off-site of the PSF (i.e. background samples at the Southwest Funston Landfill. Typical background arsenic concentration for similar soils based upon published geological literature range from 1 to 39 mg/kg. Additional sampling would be required to further define statistically significant background concentration for arsenic. For the purpose of this discussion paper, the RG (23.8 mg/kg) for arsenic used in the draft FS is also used for the discussion paper since it is within the range of typical background concentrations.

3.0 DEVELOPMENT AND DESCRIPTION OF ALTERNATIVES

3.1 REMEDIAL ACTION OBJECTIVES (Same as the Draft FS)

The primary remedial action objective at the site is to protect human health and the environment as presented in the draft FS. Remedial action objectives are specific goals developed to achieve this protection. General remedial action objects developed in the draft FS include:

- Minimize potential exposure to soils above developed risk based preliminary remediation goals
- Control potential leaching of constituents in soil to ground water
- Minimize potential for erosion of soils above preliminary remediation goals
- Control discharge of surface water with constituent concentrations above ambient water quality criteria (AWQC)

3.2 EXTENT OF CONTAMINATION BASED ON RGs AND REMEDIAL ACTION OBJECTIVES

Considering the RME RGs, remedial action objectives and concentration data from the RI, the extent of contamination appears to be limited. As in the draft FS, no concentrations above RGs were observed in ground-water, surface water or sediments. Considering the low mobility of PAHs, pesticides, and arsenic concentrations observed in ground-water and surface water, the remedial action objectives for these media are currently being met. Sediment RGs are expected to continue to be met unless erosion of contaminated soils increases or erosion patterns change.

Soil concentrations of arsenic, chlordane, 4,4'-DDT, and dieldrin were observed above remediation goals. Five areas of concern with soil contamination above remediation goals have been identified and are delineated on Figure 2-1. Areas 1, 2 and 3 overlap and are located within the present fenced perimeter of the PSF while areas 4 and 5 are adjacent and are located outside the eastern fence between the fence and the lined drainage ditch.

Area 1 delineates dieldrin contaminants in concentration above RME RGs covering a surface area of approximately 220 square yards. The depth for dieldrin ranges from 2 to 2.5 feet.

Area 2 delineates an area of chlordane contamination covering a surface area of approximately 140 square yards. The depth of chlordane contamination on the west side of Building 348 is shallow at .5 to 1.5 feet and reduces below RME RGs at a depth of 2 to 2.5 feet. The extent of chlordane contamination on the west side of Area 2 is located in the surface soils. It should be noted that the west side of Area 2 is covered by asphalt. The depth of chlordane contamination on the east side of Building 348 ranges from 4 to 4.5 feet.

Area 3 delineates the area of 4,4'-DDT soil contamination covering a surface area of approximately 60 square yards. The vertical extent of 4,4'-DDT contamination is limited as the 4,4'-DDT concentration reduces from 6.57 mg/kg at 1.5 to 2.5 feet to 3.02 mg/kg (SB-9) at 4 to 4.5 feet depths. The lower value is below the RME based RG for 4,4'-DDT of 4.84 mg/kg.

FIGURE 2-1

AREAS OF CONTAMINATION

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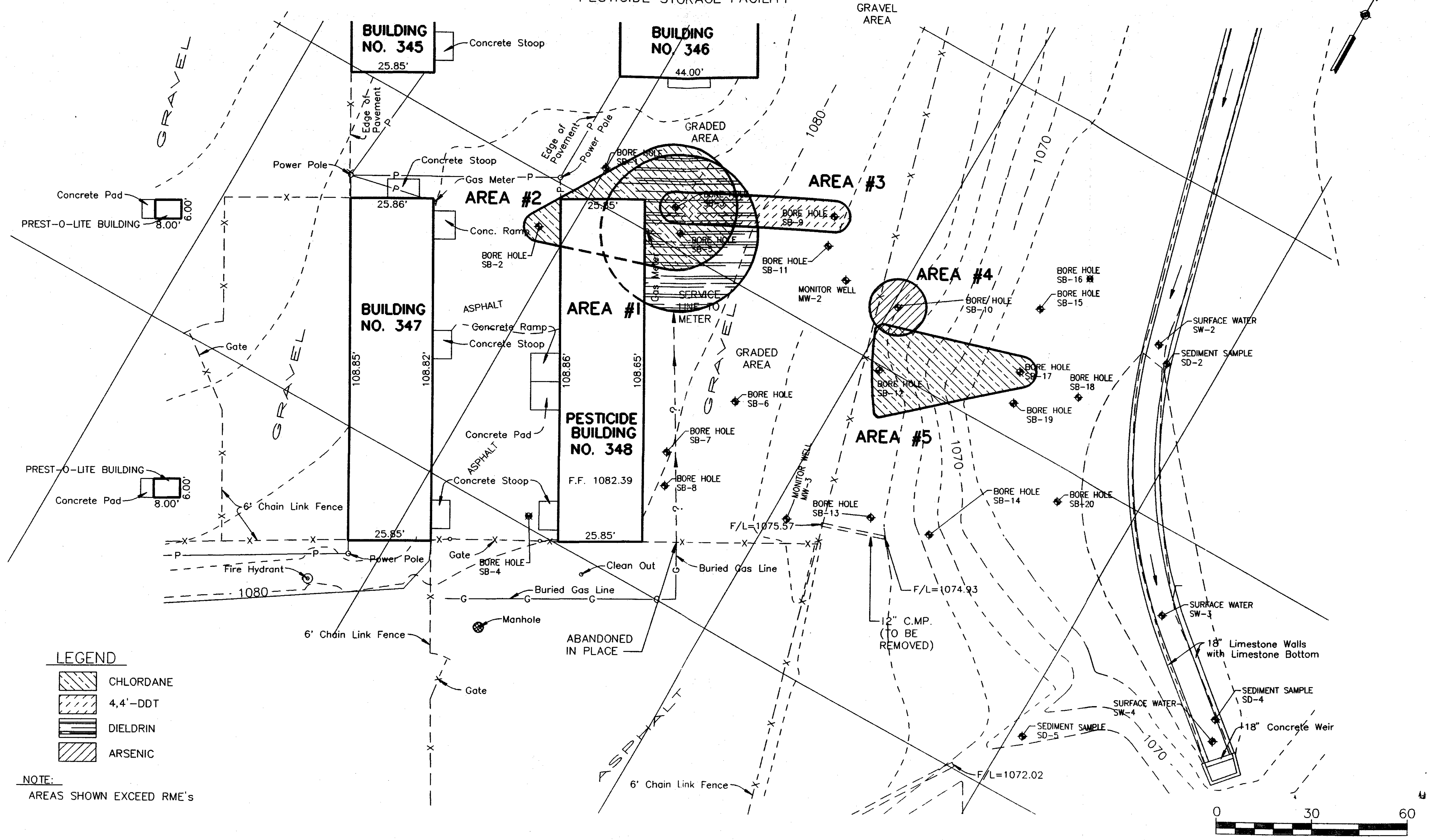

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Only one arsenic sample (SB10) (120 mg/kg) at 3.5 to 4.5 feet presented an unacceptable risk in the areas based upon the Fort Riley actual scenario presented in the draft FS. This area is denoted by Area 4 on Figure 2-1. The surface soil and additional subsurface soil (0' to 3.5') did not present an unacceptable risk in this area. For the RME scenario, the calculated action level for arsenic is 0.9 mg/kg. This level is below PSF background levels for arsenic and also for on-site and off-site soil samples taken at varying depths. Although three background samples have been taken for the PSF site, other Fort Riley background samples and regional geological data has indicated arsenic concentrations comparable to the samples at PSF. The actual exposure scenario concentration (23.8 mg/kg) has been utilized for defining the extent of contamination. Therefore, the extent of contamination for arsenic is the same as the draft FS.

A second area of chlordane contamination in soil is delineated by Area 5 in Figure 2-1. The chlordane contamination of Area 5 covers a surface area of approximately 90 square yards. The vertical depth of chlordane contamination in soil ranges from 4 to 4.5 feet at SB-12 and tapers off to 0.1 to 1.0 feet at SB-17(also SS-4). The chlordane concentration in soil at these depths is 1.7 mg/kg and 1.3 mg/kg, respectively. Chlordane contamination slightly above RME RGs (1.27 mg/kg) is present in both surface and subsurface soils in Areas 5.

3.3 DEVELOPMENT OF ALTERNATIVES

In the draft FS alternatives were developed which would address both pesticide and metals contamination in soils. Considering that arsenic was the only constituent of concern in the draft FS and that arsenic was only identified above RGs in one area, the alternatives and their evaluation originally developed have been modified to address the areas identified in Figure 2-1 for chlordane, dieldrin and 4,4'-DDT soil contamination.

Based on the results of the technology screenings in the draft FS, several remedial action alternatives were developed to achieve site remedial action objectives and the remediation goals. These alternatives were developed considering that migration of the constituents of concern in the soil have not resulted in ground water, sediment or surface water concentrations which exceed RGs. Although a number of constituents of concern (arsenic, chlordane, 4,4'-DDT and dieldrin) have increased, migration of contaminants from the soil is still expected to be limited. Ground water, sediments and surface water are not medias of concern at the PSF site.

The alternatives developed in the draft FS are re-evaluated based on effectiveness, implementability and, to a lesser extent, cost. The six alternatives considered to be effective and implementable at the PSF site for the discussion paper have changed slightly and cover a larger extent of contamination. The clay cap of Alternative 4 in the draft FS is not considered implementable at the PSF for the discussion paper. Since the potential area of contamination around the PSF Building 348 has increased and this area receives periodic traffic, the use of a clay cap for the prevention of infiltration is not feasible or economic compared to the other potential technologies. Without excavation of the site material, a clay cap would require an approximate 2 foot mound of clay east/northeast of Building 348. This clay mound would interfere with present traffic and surface water runoff divergence.

Alternative 5 of the draft FS has been modified for the discussion paper. In the discussion paper, Alternative 5 of the draft FS is similar to Alternative 4. Due to the slope change from elevation 1078 to 1070, the areas from elevation 1082 to 1078 is being covered with asphalt. A berm will be provided to direct flow from the asphalt area to waterway channels which drain into the limestone lined channel. The grade from elevation 1078 to 1070 will be graded to divert surface water runoff to the waterway channels.

The alternatives for the discussion paper are as follows:

- Alternative 1 - No-Action (Same as draft FS)
- Alternative 2 - Institutional Controls (Same as draft FS)
- Alternative 3 - Institutional Controls/Grading (Same as draft FS)
- Alternative 4 - Institutional Controls/Grading/Capping (Asphalt)
- Alternative 5 - Institutional Controls/Grading/Capping (Asphalt/Concrete)
- Alternative 6 - Removal and Disposal (Additional Excavation Area)

The detailed analysis of these alternatives for the discussion paper has changed and will be evaluated in Section 4.0 of this discussion paper. As with the draft FS, 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 (removal and disposal) in the soil. Since the constituents of concern (arsenic, chlordane, 4,4'-DDT, and dieldrin) have not been noted to migrate from the site, installation of monitoring well and an extended monitoring program to evaluate migration into the ground water is not considered appropriate. Therefore, monitoring of ground water at the PSF is not included.

The alternative descriptions for the discussion paper are presented in the following sections.

3.3.1 Alternative 1 - No-Action (Same as Draft FS)

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 there present state. With this alternative, no risk reduction is noted. The no-action alternative 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 implemented, Alternative 2 (Institutional Controls) will be used as the baseline case for comparison.

3.3.2 Alternative 2 - Institutional Controls (Same as draft FS, except for relocation of perimeter fence)

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 facility 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 will need to be relocated as shown in Figure 3-1. The perimeter fence for the discussion paper will need to be moved approximately 30 feet closer to the lined drainage ditch, as compared to the proposed perimeter fence in the

FIGURE 3-1
ALTERNATIVE 3 (GRADING)
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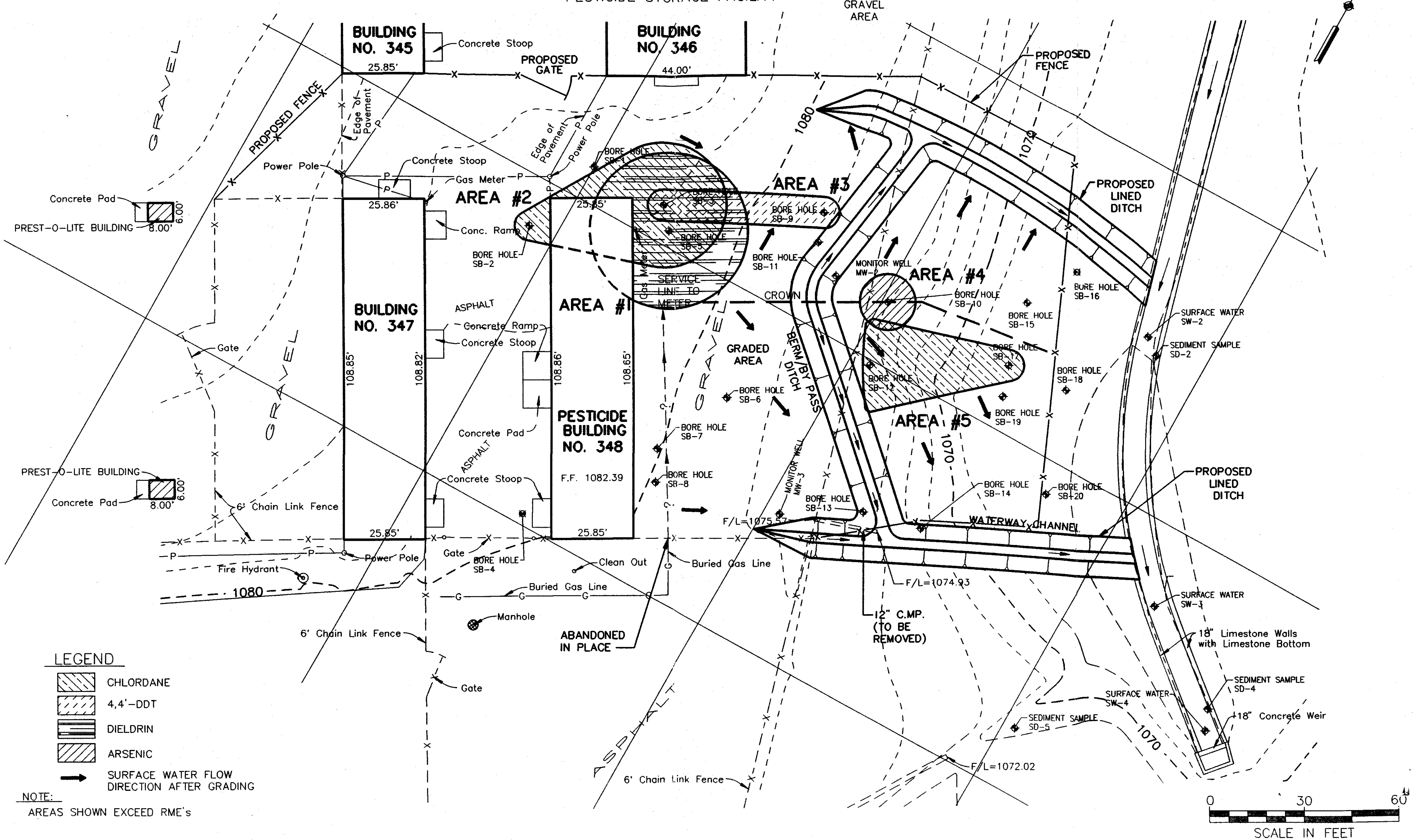

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draft FS. Movement of the fence will encompass Area 5 in the restricted access area. With the relocation of the fence, no areas of potential contamination will be disturbed. Typically, deed restrictions are used to restrict future land use. However, with this site, deed restrictions are not applicable. 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. Electrical lines will not be addressed since electrical service connections are provided on poles above grade. On-site work procedures would be used to prevent landscaping in the area of concern. The current state of the PSF site remains relatively unchanged with the implementation of the institutional action alternative.

3.3.3 Alternative 3 - Institutional Controls/Grading

Due to the limited mobility of the constituent of concern (arsenic, chlordane, 4,4'-DDT, and dieldrin) to the ground water, this alternative considers regrading of the area as shown in Figure 3-1 and implementation of the institutional actions presented in Alternative 2. Similar to Alternative 3 (Section 3.1.3) in the draft FS, the site will 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. The primary focus of this alternative is erosion control at the site. 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.

Drainage from the north will be collected in a proposed drainage ditch which will be placed from the southeast end of Building 348 and drain to the discharge channel. Drainage from the south will be collected in a proposed drainage ditch (as shown in Figure 3-1) which will initiate southwest of Building 348 and also drain to the discharge channel. This alternate 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 gravel. Due to the topography near Building 348, these areas are not likely to be effected by surface water erosion. The proposed center drainage channel roughly follows the topography at the PSF site. Proper grading and revegetation of the area will also be utilized to reduce/minimize the mobility of constituents in contaminated soil.

3.3.4 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 will not be required. This alternative includes asphalt capping of Areas 1, 2, 3, 4 and a portion of Area 5. As shown in Figure 3-2, 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. This

FIGURE 3-2
ALTERNATIVE 4 (ASPHALT COVER)
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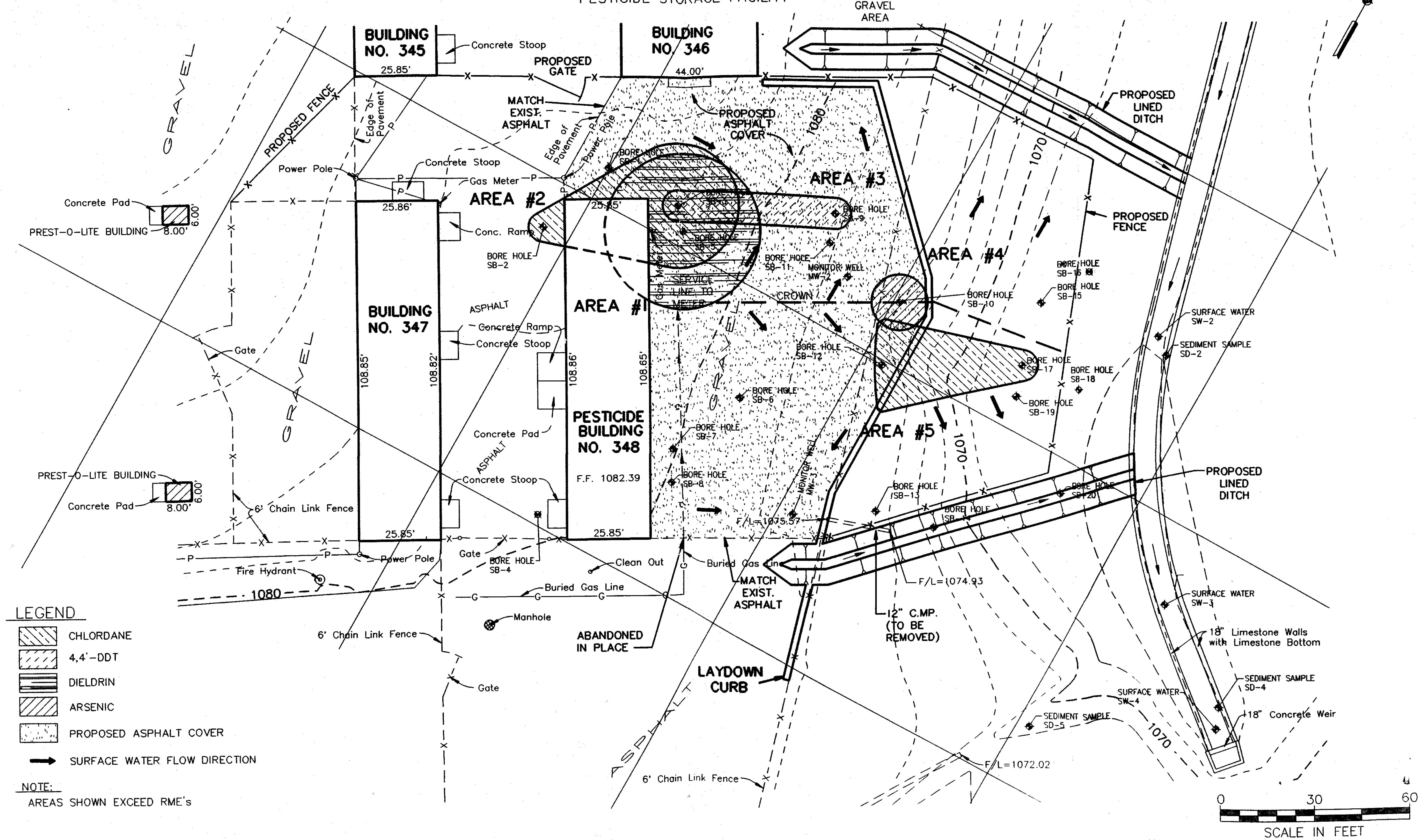

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alternative is similar to Alternative 5 of the draft FS. The purpose of the asphalt cover is to control erosion, eliminate exposure during landscaping and on-site work, and control the infiltration of rainfall into potentially contaminated areas. Waterway channels and curbing will be used on the sides of the asphalt cover to direct water away from the areas of contamination to the limestone channel.

3.3.5 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 mix 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 divergence from the contaminated area. The asphalt and concrete covers will be extended over the area as shown in Figure 3-3. The covers will reduce percolation/infiltration of surface water into the contaminated soil. The cover will also prevent erosion due to surface water. This alternative is similar to that presented in the draft FS since the area of dieldrin, chlordane, and 4,4'-DDT are inclusive to the hard cover (asphalt) shown in Figure 3-3.

FIGURE 3-3

ALTERNATIVE 5 (ASPHALT/CONCRETE COVER)

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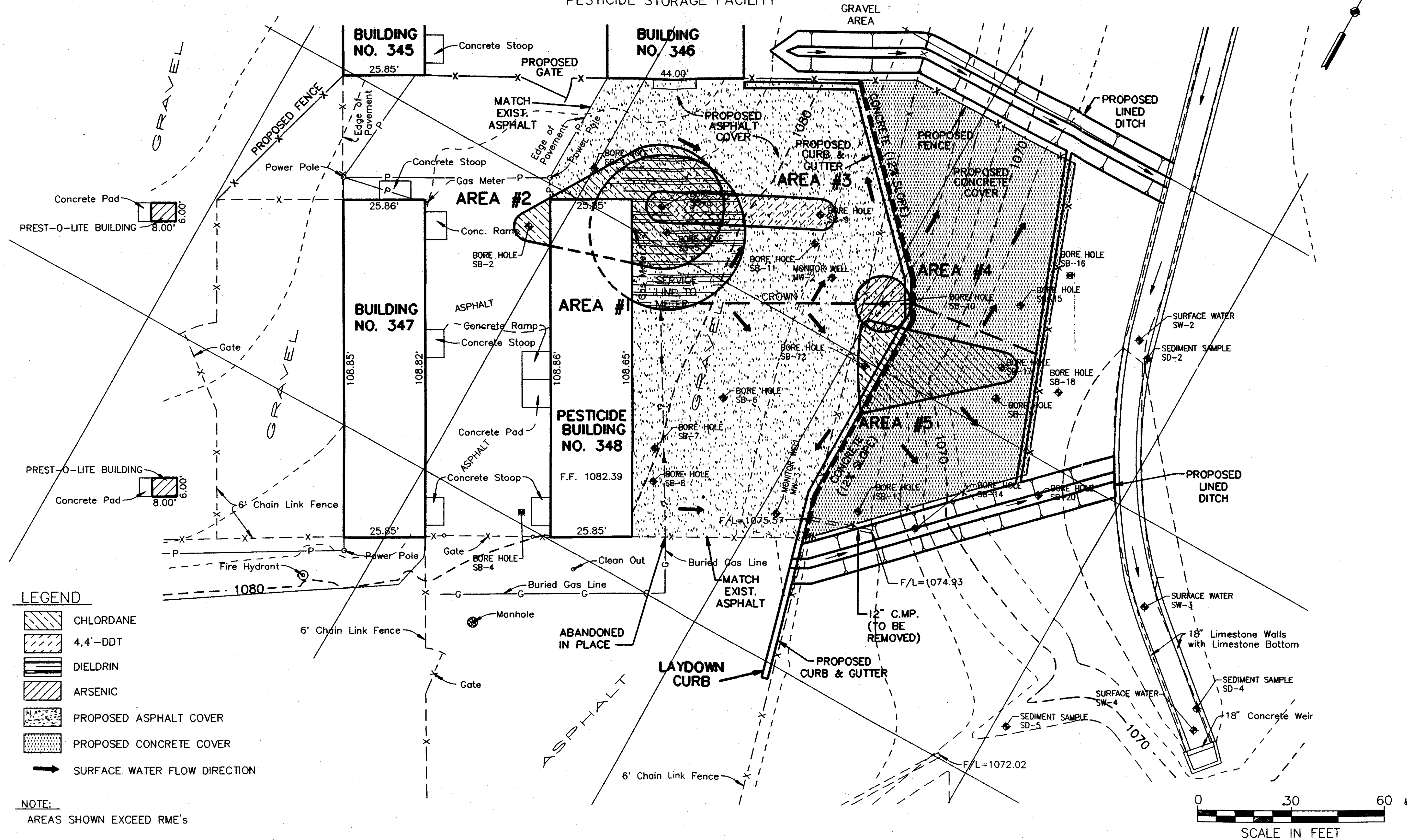

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3.3.6 Alternative 6 - Removal and Disposal

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 2-1. With this alternative it is estimated that approximately 600 cubic yards of contaminated soil will be removed from the site. The soil will be excavated, placed in a disposal box and removed to a secure landfill. Excavation of soil will not be done under the north end of Building 348 or the existing asphalt encompassed by contamination Area 2. The north end of Building 348 may require structural support during excavation. Landfilling is the preferred disposal method for the soils as arsenic is present and cannot be treated by incineration. Initial discussions with permitted disposal facilities indicates that landfills will accept this waste provided it is not considered a RCRA listed hazardous waste. Clean backfill will be brought in and placed in the excavated area. Additional backfill will also be utilized to regrade the area to provide proper drainage from the site as discussed in Alternative 3. With this alternative, it is estimated that hauling boxes will be required. Each box is estimated at approximately 20 cubic yards. Approximately 30 boxes will be required.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

4.1 CRITERIA OF THE DETAILED ANALYSIS

The purpose of the detailed analysis for the discussion paper is to present a comparative evaluation of selected remedial alternatives to facilitate the selection of a remedial alternative for the PSF. The detailed analyses was performed to re-evaluate the selected remedial alternatives for the draft FS discussion paper. These alternatives represent distinct, viable options while also presenting a range of treatment and/or containment. Alternative evaluations that do not differ from the draft FS will be identified in the discussion paper as such.

4.2 EVALUATION OF CRITERIA (Same as draft FS)

The nine point alternative evaluation criteria used in the discussion paper, which are identical to the draft FS, are as follows:

- Overall Protection of Human Health and the Environment - Addresses whether or not a remedy will clean up the site to 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 for materials, equipment and related items, and the operation and maintenance costs. Costing opinions for the discussion paper are based upon our understanding of the site. The costing opinions presented are based upon cost curves, generic unit costs, vendor information and prior similar estimates. The cost opinion estimate accuracy is strongly dependent upon the level of uncertainty of an alternative and detailed design, material estimates and bidding were not performed. Present worth cost are presented in January 1993 dollars and are evaluated on a 30 year basis. Although the FS presents projected cost value, the RD/RA phase of the project should present a more detailed cost estimate.

- 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 FS report. The agency acceptance and community acceptance criteria are evaluated, and the final decision on the proposed plan is selected in conjunction with the preparation of the Record of Decision (ROD). These final two criteria are extremely significant, however, and carefully planning and consideration is required to gain adequate acceptance.

4.3 ALTERNATIVE DESCRIPTION AND INDIVIDUAL ANALYSES

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 3.0. Individual components are presented and discussed as appropriate.

4.3.1 Alternative 1 - No-Action

4.3.1.1 Description of Alterative 1 (Same as the Draft FS)

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 at the levels established in the baseline risk assessment (Section 1.2.7 of the draft FS).

4.3.1.2 Evaluation of Alternative 1 (Same as the Draft FS)

Overall Protection

Since no remedial actions are taken, the human health and environment risks for the site are the same as those described in the baseline risk assessment. The No-Action Alternative does not reduce sources or control migration of constituents.

Compliance with ARARs

No potential chemical-specific ARARs have been defined for the constituent of concern in soil. The RGs are not addressed with this alternative. 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. 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.

Implementability

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

Cost

There is no cost associated with any remedial action for this alternative.

4.3.2 Alternative 2 - Institutional Controls

4.3.2.1 Description of Alternative 2 (Same as Draft FS, except for relocation of perimeter fence to enclose the areas of contamination)

Since the PSF is a secure military facility, site access is already restricted. Warning signs can be located around the PSF. With this alternative, utility service lines will also be isolated. Since the existing data indicates migration of constituents (arsenic, chlordane, 4,4'-DDT, and dieldrin) from the area is limited, it is not anticipated that long-term ground-water monitoring of the migration constituents will be required. To confine the potential contamination in Area 5, this action involves the relocation of the perimeter fence. The perimeter fence proposed in the draft FS will be extended 30 feet closer to the existing lined drainage ditch. This fence extension will encompass the chlordane contamination of area 5 (SB-19/SS-4). Currently a security fence exists at the site limiting access by site personnel. Access to this area is only permitted by authorized personnel. Additionally, the facility boundary is secured to prevent public access to the facility and patrolled continuously with on-site security. With this alternative, the relocation of the perimeter fence should not involve digging or exposing site workers to the potential contaminated areas. The possible exposure with this scenario is to Area 5 if an on-site worker gains access to the secured area. Isolation of utilities does not include subsurface excavation.

4.3.2.2 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.

Compliance with ARARs

No chemical-specific potential ARARs have been identified for the soils. Soil RME based RGs and remedial action objectives would be met by eliminating exposure pathways identified in the development of the RGs. The facility has no future use planned for this area and excavation in the area is not being considered.

Long-Term Effectiveness and Permanence

The baseline risk assessment continues to define exposure hazards 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 boring sample (SB-2) is below asphalt cover and this sample 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 RME action level (1.27 mg/kg).

Short-Term Effectiveness

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.

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 legal, fence installation, and other expenses for installing signs and instituting potential deed restrictions and other procedural mechanisms. Capital costs are estimated at approximately $12,300 (Table A-1, Appendix A). 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 lawn care.

4.3.3 Alternative 3 - Institutional Controls/Grading (Same as the draft FS)

4.3.3.1 Description of Alternative 3 (Same as the draft FS)

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 will be regraded providing a stable slope from the PSF Building 348 to the existing lined drainage channel as shown in Figure 3-1. 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 prevent soil erosion on the bank which leads to the discharge channel and the area northeast of PSF Building 348.

4.3.3.2 Evaluation of Alternative 3

Overall Protection

Changing the present grading of the PSF site will be used to control surface water run-off and soil erosion. Institutional controls combined with grading will reduce the risk to human health and environmental 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 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 who will be utilized for lawn care.

Compliance with ARARs

No chemical-specific potential ARARs have been identified for soils. Soil RGs would be met by controlling exposure and erosion.

Long-Term Effectiveness and Permanence

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

Short-Term Effectiveness

The eastern bank of the pesticide storage building will need to be 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 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 divergence, 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. Regrading 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.

Implementability

Although implementability is straight forward, coordination of grading activities and waterway channels will be 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 (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 is estimated to be approximately $111,600. Individual costs are summarized in Table A-2, Appendix A.

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

4.3.4.1 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 will not be required. A berm will be provided instead of a drainage ditch for surface water flow divergence. This alternative requires containment of the contaminant areas 1, 2, 3, 4, and 5. As shown in Figure 3-2, an asphalt cover is used to cover these areas east/northeast of the PSF. This alternative is similar to alternative 5 of the draft FS. 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 will be 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 will be graded to divert water flow from the areas of potential contamination.

4.3.4.2 Evaluation of Alternative 4

Overall Protection

This alternative is capable of meeting the RME based RGs and remedial 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

No chemical-specific potential ARARs have been identified for soils. Soil clean-up levels derived from potential TBCs would not be met. RME based RGs would be met by controlling potential exposure.

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 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 eastern bank of the pesticide storage building will need to be regraded as shown in Figure 3-2. 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. 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.

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 A-3, Appendix A.

4.3.5 Alternative 5 - Institutional Controls/Grading/Capping

4.3.5.1 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 flat surface area east of the pesticide storage Building 348. The sloped area from elevation 1076 to 1070 will be covered with concrete cover to direct surface runoff away from the area. This concrete extension will cover the chlordane contamination of Area 5 as shown in Figure 3-3. The asphalt and concrete covers will be primarily for surface water runoff and infiltration control. An asphalt berm will be provided between the two areas to prevent runoff from the asphalt to flow onto the concrete cover.

4.3.5.2 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 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.

Compliance with ARARs

No chemical-specific potential ARARs have been identified for soils. Soil clean-up levels derived from potential TBCs would not be met. RGs would be met by controlling potential exposure.

Long-Term Effectiveness and Permanence

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

Short-Term Effectiveness

The eastern bank 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 exposure to contaminants. The toxicity and volume of the contaminants and soil medium would remain at present levels.

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 Table A-4, Appendix A.

4.3.6 Alternative 6 - Removal and Disposal

4.3.6.1 Description of Alternative 6

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

Area 1:	8050 cubic feet
Area 2:	375 cubic feet
Area 3:	196 cubic feet
Area 4:	1145 cubic feet
Area 5:	2375 cubic feet

Evaluation of Area 2 will require removal and disposal of asphalt and surface soils. Once excavation is complete in all areas, clean fill will be utilized to fill in the excavated areas. Additional fill will be utilized for regrading the area for erosion control. During remediation, further examination and testing of the underlying soils would be required. After the contaminated soils have been removed and clean fill placed into the excavations, no special security or site restrictions should be needed to be constructed or enforced.

4.3.6.2 Evaluation of Alternative 6

Overall Protection

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

Compliance with ARARs

No chemical-specific potential ARARs have been identified for soils. 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 from TBCs. Ambient air monitoring and proper handling procedures during implementation can be used to meet action-specific ARARs.

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 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 should be of some concern due to potential air entrainment. As a precaution, fugitive dust and volatile emissions from excavation, storage, and packaging (drumming) may need to be controlled. Appropriate personnel protective equipment will be needed to protect workers from both respirable contaminants and dermal exposure to particulates.

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. Off-site treatment prior to disposal in a RCRA Subtitle C landfill will probably invoke the LDRs, which specify a level of treatment which must be attained prior to disposal.

Implementability

This alternative can be implemented due to the small quantity of soils (600 cubic square yards). Construction requires significant exposure potential and disturbance of the site due to soil excavation. Additional fill and excavation requirements will be required to resurface the site. Permits can be obtained to transport and dispose of contaminated soils. Implementation of this option will require submission of analytical results to the permitted landfill and confirmation of acceptability.

Cost

The total estimated cost of this alternative on a per unit volume disposal basis is approximately $310 per cubic yard of soil. This cost includes mobilization, site preparation, implementation, materials, monitoring, decontamination, and labor. No operational and maintenance costs has been incurred for this alternative associated with excavation and disposal. 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. The present worth cost for this alternative is estimated at approximately $345,000. Individual unit costs are summarized in Table A-5, Appendix A.

5.0 COMPARATIVE ANALYSIS

In the comparative analysis presented below, the assembled alternatives carried forward for detailed analysis from Section 3 are compared relative to each other based on the seven evaluation criteria developed in Section 4.0. Only the relative advantages and disadvantages of the six alternatives are presented in this section. These alternatives are as follows:

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 Contaminated Area)
Alternative 6 - Removal and Disposal

5.1 SHORT-TERM EXPOSURE

Both Alternatives 1 and 2 offer relatively equivalent short-term exposure potential since neither of the alternatives involves the disturbance of contaminated soils.

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 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 packaging, 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 and 2	1st
Alternative 3, 4 and 5	2nd
Alternative 6	3rd

5.2 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 is physically removed from the site.

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 since the constituents of concern are not migrating into the other media at the site.

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

5.3 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. For this FS discussion paper 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 directly reduce the toxicity, mobility and volume of waste at the site. Alternative 2 seeks to reduce 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 5,4 and 3	2nd
Alternative 2	3rd
Alternative 1	4th

5.4 IMPLEMENTABILITY

Alternatives 5 and 6 are 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 potential for human exposure for Alternative 6 is the greater with the excavation of the contaminated media. The exposure associated with Alternative 5 is not as great as with Alternative 6. Alternative 5 will require longer 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. 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

5.5 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, the alternatives are ranked according to cost as follows:

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

5.6 COMPLIANCE WITH ARARs

No potential location or chemical-specific ARARs have been identified for the contaminated soils. 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 activities and the depth of the contamination.

5.7 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 5,4 and 3	2nd
Alternative 2	3rd
Alternative 1	4th

5.8 COMPARATIVE ANALYSIS SUMMARY

The ranking results for the alternatives selected for comparative analysis are summarized in Table 5-1.

TABLE 5-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
DRAFT FS DISCUSSION PAPER
PESTICIDE STORAGE FACILITY, FORT RILEY, KANSAS

ALTERNATIVE NUMBER	ALTERNATIVE NAME	SHORT-TERM EFFECTIVENESS	LONG-TERM EFFECTIVENESS	REDUCTION OF T, M, V (*)	IMPLEMENTABILITY	COST	OVERALL PROTECTION
1	NO ACTION	1	6	4	1	1	4
2	INSTITUTIONAL CONTROLS	1	5	3	2	2	3
3	INSTITUTIONAL CONTROLS/GRADING	2	4	2	3	3	2
4	INSTITUTIONAL CONTROLS/GRADING/ ASPHALT COVER	2	3	2	4	4	2
5	INSTITUTIONAL CONTROLS/GRADING/ ASPHALT AND CONCRETE COVER	2	2	2	5	5	2
6	INSTITUTIONAL CONTROLS/ EXCACATION/ DISPOSAL	3	1	1	6	6	1

(*) T = TOXICITY
M = MOBILITY
V = VOLUME

NOTE: 1 = MOST FAVORABLE
6 = LEAST FAVORABLE

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APPENDIX A

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

ALTERNATIVE 6 - EXCAVATION/DISPOSAL

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			
TRANSPORTATION	$/LOAD	$1,000	30	$30,000
DISPOSAL	$/CY	$310	600	$186,000
CAPITAL COST SUBTOTAL				$216,000
CONTINGENCY @ 30%				$64,800
ENGINEERING AND DESIGN @ 15%				$32,400
CAPITAL COST TOTAL - DISPOSAL				$313,200
TOTAL CAPITAL COST				$330,185
ANNUAL O&M COSTS	$/HOUR	$15.00	104	$1,560
30 YEAR PRESENT WORTH COST (@ 10% INTEREST)				$344,891

* 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.