VOLUME I

FEASIBILITY
STUDY FOR
SUBSURFACE CLEANUP

WESTERN PROCESSING
KENT, WASHINGTON

EPA 37.0L16.2

March 6, 1985

Chapter 4
ENDANGERMENT ASSESSMENT

4.1 INTRODUCTION

The objective of this endangerment assessment is to determine the potential for human health and environmental impacts if no action is taken on the Western Processing site. The assessment that follows contains a brief description of the site; the land use of the site and the surrounding area; a description of the contaminants present in all environmental media; and a toxicology summary of compounds characteristic of site contamination. The exposure scenarios and resulting quantitative risks are discussed separately for each environmental medium.

4.2 SITE DESCRIPTION

The Western Processing site is located approximately 4 miles north of the central business district of the City of Kent, Washington. The site is currently zoned M-2, limited industrial district, by the City of Kent. M-2 zoning requires a minimum lot size of 20,000 square feet, maximum site coverage of 65 percent, and building height may not exceed 35 feet. Principal uses allowed in an M-2 industrial zone include: manufacturing, processing, treating, assembling and packaging of products; printing, publishing, and allied industries; warehousing and distribution; crop and tree farming; scientific laboratories; administrative or executive offices; and warehousing with retail sales. Accessory uses include: repair operations and commercial sales incidental to the principally permitted use; dwelling units for maintenance and security personnel; employee recreation facilities; restaurants or cafeterias in conjunction with the principally permitted use; and temporary buildings for use during construction of permanent buildings. Conditional uses may include: commercial office, retail, and service uses intended to serve the M-2 district; utilities and communication facilities; and public facilities.

The properties to the north and south of the site are also zoned M-2. Properties to the west are zoned M-1, industrial park district, and those to the east are zoned M-3, general industrial district. In general, uses allowed in each of the industrial districts are similar except that M-3 zones may include industrial uses such as sawmills, truck storage yards, electroplating, and transit terminals. Development standards are most restrictive in the M-1 zone and least restrictive in the M-3 zone (City of Kent, 1974).

The Western Processing site is bounded on the south by an empty lot, sparsely vegetated by disturbed area species. On the western edge, Mill Creek runs across the northwestern corner of the site in a northerly direction. A vacant residence lies adjacent to the northwestern corner, west of Mill Creek. Slightly further west is the Century Industrial Park, which contains 15 businesses. The Fairway Building lies just west of the industrial park and contains 10 businesses, including a truck and equipment storage center and repair lot for a major communications firm. Directly north of the site are vacant residences and an open vegetated lot. The Interurban Trail lies east of the site on a former railroad right-of-way that is adjacent to the Burlington Northern Railroad tracks. A Weyerhaeuser complex, an unpaved car lot for South Seattle Auto Auction, and a storage lot for semis and tank trucks of Matlack are found east of the railroad tracks. Figure 4-1 shows the site and surrounding properties.

4.3 CONTAMINATION

Environmental media contaminated at the Western Processing site include:

- o Soils--both surface and at depth
- o Groundwater
- o Mill Creek water and sediments

Eighty-three USEPA priority pollutants were found in onsite soils and 57 were found in onsite groundwater monitoring wells. Surface waters are contaminanted primarily with inorganics, all of which are USEPA priority pollutant metals.

Chapter 3 described the nature and extent of contamination in each medium. It also discussed the issue of tentatively identified compounds in the environmental samples. Because of the high uncertainty in the identity and concentrations of these tentatively identified compounds, it has not been possible to include them in this endangerment assessment. Appendix D discusses the fate and transformation of the indicator compounds or classes.

4.4 TOXICOLOGY AND EXPOSURE TO SITE CHEMICALS

The human health risk from exposure to chemicals at Western Processing will result from the compound effects of exposure to the multiple chemicals present. Simultaneous exposure to a variety of chemicals could lead to a wide range of effects. The potential for synergistic or potentiating effects exists. In this endangerment assessment, however, risk is assumed to be additive because the toxicological data are not adequate to describe the synergisms or antagonisms of multiple chemical exposures. A total of 29 compounds known or suspected to be human carcinogens were among the priority pollutants (Table 4-1).

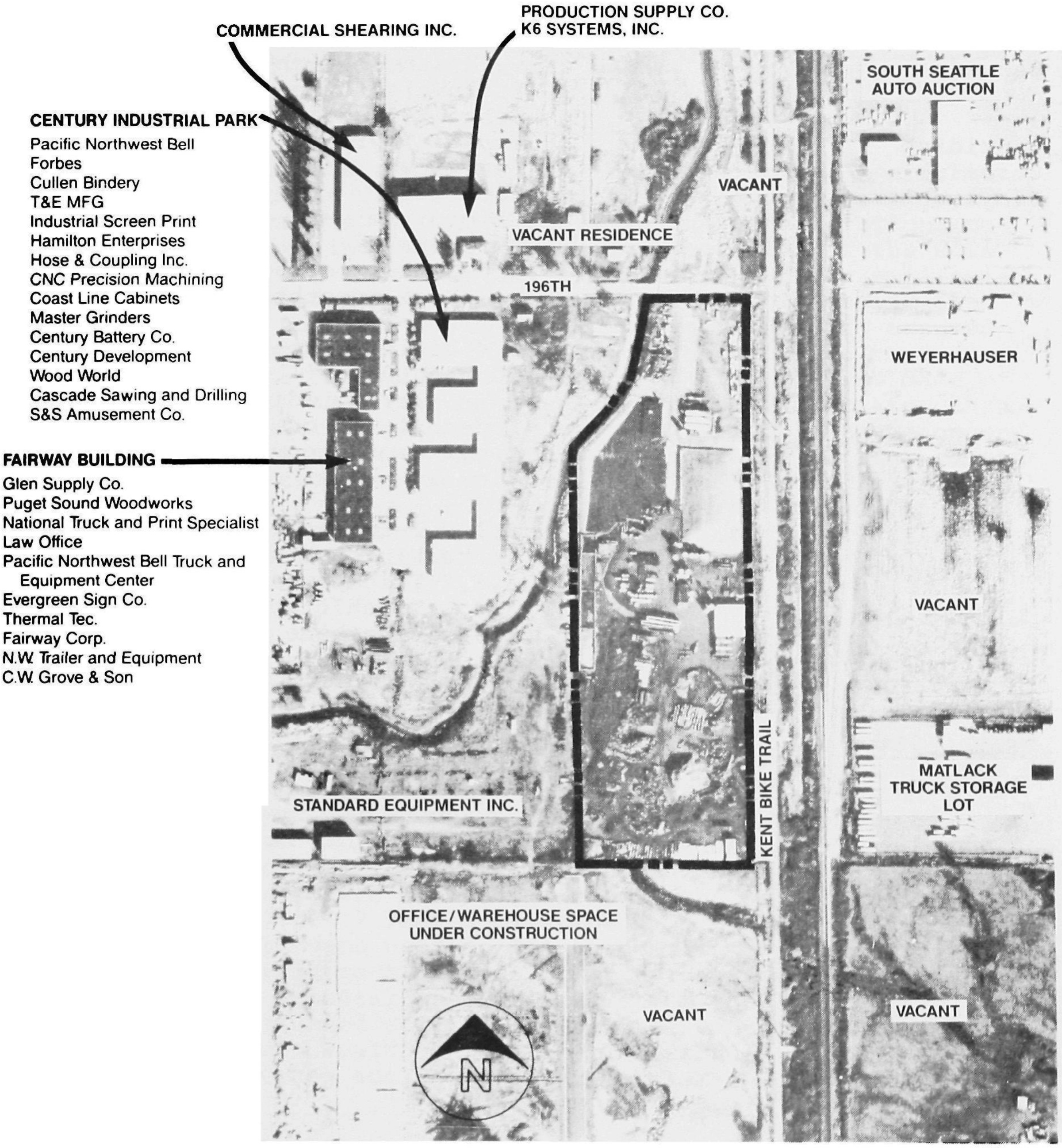

FIGURE 4-1
EXISTING LAND USE

Table 4-1
KNOWN AND SUSPECTED CARCINOGENS ON
EPA PRIORITY POLLUTANT LIST

Known Carcinogens Found Onsite[a]	Suspected Carcinogens Found Onsite[a]
Arsenic	Aldrin
Benzene	γ-Benzene hexachloride (γ-BHc)
	Benzo(a)anthracene[b]
	Benzo(k)fluoranthene[b,c]
Benzidine	Benzo(a)pyrene
Chromium[d]	Beryllium
Vinyl chloride	Cadmium[d]
	Chloroform
	Chrysene[e]
	1,2-Dichloroethane
	1,1-Dichloroethene
	Dieldrin
	2,4-Dinitrotoluene
	Fluoranthene[b,c]
	Hexachlorobutadiene
	Indeno(1,2,3-cd) pyrene[b]
	N-nitrosodiphenylamine
	Nickel[d]
	PCB
	1,1,2,2-Tetrachloroethane
	Tetrachloroethene
	1,1,2-Trichloroethane
	2,4,6-Trichlorophenol
	Trichloroethene

[a] IARC, 1982.

[b] Sax, 1984.

[c] Equivocal tumorigenic agent.

[d] No evidence that the chemical is a human carcinogen via the ingestion route, but a carcinogenic potential has been associated with other routes.

[e] Clayton and Clayton, 1981.

Human exposure to contaminants onsite is dependent on the environmental media in which the contaminant is present and the present and future land uses of the site and surrounding areas. Exposure may occur from ingestion, inhalation, or dermal contact with soils; ingestion or contact with groundwater; or ingestion or contact with surface waters, sediments, or organisms living in surface waters. The exposure scenarios and resulting risks in each environmental medium are discussed separately below.

4.5 SOILS

Data used for the assessment of risk from soil contamination are presented in Chapter 3, Section 3.5, and all soil contaminant data are reported in dry weight concentrations unless otherwise indicated. Extensive regrading of the site occurred during late 1984. The effect on surface soil concentrations and the reported depths for samples below the surface are not known. For this assessment, it is assumed that the concentrations reported in Chapter 3 are representative of the depths reported there. A listing was made of all compounds that had reported concentrations greater than the detection limit at onsite sampling points. Mean concentrations of inorganic compounds were screened against concentrations of each compound in the Kent Valley or in local sediments (see Table 3-5). Compounds were not used in this assessment of health and environmental impacts unless site concentrations exceeded these expected background concentrations.

Mean surface concentrations were then calculated for compounds that were present in at least three surface sampling points spread over the site, using the detection limit for the concentration reported as non-detects. For some sample concentrations that were not quantified, the concentrations were reported as between the detection limit and five times the detection limit. Doses were calculated using both concentrations to derive means.

Maximum concentrations were also used in the health risk assessment and were obtained for both the surface soils and from soils 0 to 12 feet deep. The maximum concentration for soils at depth was used on the assumption that excavation of the site during construction of structure foundations could occur if no remedial action is taken on the site. This could bring contaminated soil to the surface and it was assumed that this soil would be left at the surface. It was further assumed that the soil concentrations remain constant as a worst case.

The exposure scenario used in this assessment of risk from soil contamination assumed soil ingestion and no change in current land use patterns in the area. One scenario assumed worker exposure only, as the site is presently industrial and future use was assumed to be the same.

Although no study has shown adult soil ingestion during outdoor work or play (USEPA, November 1984), Kimbrough et al. (1983) estimated an adult soil ingestion rate of 0.1 gm/day. This value has been used in this study, although it may be an upper bound estimate. This provides a lifetime average soil ingestion rate of 0.00082 gm soil per kilogram body weight per day for exposure to carcinogens for a 70-kg person with a 40-year exposure period and a 70-year lifetime. To estimate the dose, this rate was multiplied by the ratio of expected workdays with less than 0.01 inch of rainfall (148) to the number of days in the year (NOAA, 1979-1983) because it was assumed that soil ingestion could only occur on those days. For noncarcinogens, the daily soil ingestion rate of 0.1 gm/day for adults was used.

A residential scenario for carcinogens was also considered. Although it is unlikely that a zoning change to residential would ever take place for the site, current zoning allows dwelling units for maintenance and security personnel. Three lifetime soil ingestion rates were developed for the residential scenario for exposure to carcinogens: 0.00048 g soil per kilogram body weight per day (assumes child ingestion of 0.1 g/day for ages 2 to 6 and zero at all other ages); 0.024 g/kg/day (assumes child ingestion of 5 g/day for ages 2 to 6 and zero at all other ages); and 0.028 g/kg/day (assumes soil ingestion rates from Kimbrough et al., 1983). A soil ingestion rate of 0.1 g/day for adults and one gram per day for children was used for noncarcinogens (see Appendix E for the derivations). These rates were multiplied by the ratio of the expected days with less than 0.01 inch of rainfall (217) to the number of days in the year to estimate the dose.

The risk assessment for carcinogens and dose estimate for noncarcinogens were calculated using both the mean onsite surface soil concentration and the maximum onsite surface soil and soil-at-depth concentrations. The average concentrations were estimated using an area-weighted average of the measured surface concentrations, based on Thiessen polygons.[1] The estimated excess lifetime cancer risk,[2] R, was

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[1] With the Thiessen polygon method, each point of the surface is assigned the concentration of the closest sampling point.

[2] The excess lifetime cancer risk is the incremental increase in the probability of getting cancer compared to the background probability.

calculated with the following model:

$$R = 1 - e^{-pd} \quad (4\text{-}1)$$

where
p = cancer potency (kg-day/mg)
d = dose (mg/kg/day)

Cancer potencies were obtained from USEPA's Carcinogen Assessment Group. These are derived from the upper limit of cancer risk associated with a given exposure, and the actual risk may be less.

The results of this analysis for the worker scenario are shown in Tables 4-2 and 4-3 for the carcinogens found onsite for surface soil and soils at depth, respectively. Ingestion of site soil is estimated to lead to an excess lifetime cancer risk of 5×10^{-6} using the maximum concentrations in surface soils, and 2×10^{-4} using the maximum concentrations in soils at depth. The mean concentrations of surface soils yield an excess cancer risk of 5×10^{-7}. The prime contributor to the cancer risk is PCB's. For the ingestion rate of 0.00048 g/kg/day in the residential scenario, the excess lifetime cancer risks are estimated to be 1×10^{-4} for the maximum concentrations in soils 0 to 12 feet deep, 4×10^{-6} for the maximum observed surface concentrations, and 4×10^{-7} for the mean observed surface concentrations. For the residential scenario with 0.024 g/kg/day soil intake, the excess lifetime cancer risks are estimated to be 7×10^{-3}, 2×10^{-4}, and 2×10^{-5}, respectively. For the residential scenario with 0.028 gm/kg/day intake, the excess lifetime cancer risks are 8×10^{-3}, 2×10^{-4}, and 2×10^{-5}, respectively. These estimated cancer risks would increase if all contaminants could be used in the derivation of risk, but cancer potency values do not exist for the PAH compounds found at Western Processing. Also potency values available for benzene and vinyl chloride are derived on the basis of worker inhalation exposure and animal inhalation studies, respectively, and are not directly applicable to the ingestion pathway. Use of five times the detection concentrations for the trace compounds did not alter the total cancer risk.

PCB's (reported here as the sum of concentrations of reported mixtures) were also detected in six off-property areas. Areas II and III had single reported sediment concentrations of 3,510 and 1,170 μg/kg, respectively. Two samples had detected concentrations in Area V (with 270 and 1,900 μg/kg). Of the six detected concentrations reported in Area VI, four were reported in terms of wet weight (500, 1,000, 4,300, and 24,800 μg/kg) and two in terms of dry weight (28.6 and 4,100 μg/kg). One sample of the Mill Creek sediment near 196th Street had a reported PCB concentration

Table 4-2
SUMMARY OF ONSITE SURFACE SOIL CONTAMINATION AND CANCER POTENCIES FOR CARCINOGENS, WORKER SCENARIO

			Maximum Observed Level			Mean Observed Level[c]		
Fraction	Contaminant of Concern	Cancer Potency[a] (kg-day/mg)	Concentration (µg/kg)	Lifetime Average Dose[b] (µg/kg/day)	Cancer Risk ($\times 10^{-6}$)	Concentration (µg/kg)	Lifetime Average Dose[b] (µg/kg/day)	Cancer Risk ($\times 10^{-6}$)
Volatile Organics	Trichloroethene	0.019[d]	37	0.000012	0.0002	4.2	1.4×10^{-6}	0.00001
Base/Neutral	Benzo(a)anthracene	---	884,000	0.30	---	38,000	1.1×10^{-2}	---
	PCB	4.34	3,300[e]	0.0011	5	310[e]	1.0×10^{-4}	0.5
	Chrysene	---	1,210,000	0.41	---	50,000	1.6×10^{-2}	---
	Fluoranthene	---	234,000	0.079	---	25,000	7.1×10^{-3}	---
TOTAL					5			0.5

[a] USEPA, December 1984..

[b] Dose calculated from lifetime average soil ingestion rate of 0.00082 g/kg/day and exposure fraction = 0.41.

[c] Mean concentrations calculated using detection limit for nonquantifiable but detected concentrations.

[d] International Agency for Research on Cancer believes that there is inadequate evidence for classifying trichloroethene as a human carcinogen.

[e] Sum of all PCBs.

Table 4-3
SUMMARY OF ONSITE SOIL CONTAMINATION TO A DEPTH OF 12 FEET AND CANCER POTENCIES FOR CARCINOGENS, WORKER SCENARIO

			Maximum Observed Level[c]		
Fraction	Contaminant of Concern	Cancer Potency[a] (kg-day/mg)	Concentration (µg/kg)	Lifetime Average Dose[b] (µg/kg/day)	Cancer Risk ($\times 10^{-6}$)
Volatile Organics	Benzene	---	6,500	0.0022	
	Chloroform	0.007	18,000	0.0061	0.04
	Trichloroethene	0.019[d]	580,000	0.19	4
Base/Neutral	Benzo(a)anthracene		884,000	0.29	
	PCB	4.3	114,000	0.038	200
	Chrysene	---	1,210,000	0.41	
	Fluoranthene	---	234,000	0.079	
	Fluorene	---	8,600,000	2.9	
TOTAL					200

[a] USEPA, December 1984.

[b] Dose calculated from lifetime average soil ingestion rate of 0.00082 mg/kg/day and exposure fraction = 0.41.

[c] Mean concentrations calculated using detection limit for nonquantifiable but detected concentrations.

[d] International Agency for Research on Cancer believes that there is inadequate evidence for classifying trichloroethene as a human carcinogen.

[e] Sum of all PCBs.

of 690 μg/kg. In Area IX, two sediment samples had reported concentrations (2,000 and 37,200 μg/kg) and two detected concentrations were reported in one bore hole: 13,900 μg/kg at the surface and 121 μg/kg at 34 feet in depth. With the same industrial use scenario as in Tables 4-2 and 4-3, the excess lifetime cancer risks for the maximum and mean observed surface concentrations in Area VI are 4×10^{-5} and 9×10^{-6}, respectively, and in Area IX are 5×10^{-5} and 3×10^{-5}, respectively. The excess lifetime cancer risks from the two residential scenarios would be between 0.8 times (for the 0.00048 g/kg/day case) and 50 times (for the 0.028 g/kg/day case) these risks.[1] It should be noted that the sampling locations in Area VI were not chosen randomly, but by proximity to stained surface soils without vegetation.

The calculated daily doses for noncarcinogenic compounds at 0.1 g soil per day are shown in Table 4-4 and Table 4-5 for mean and maximum concentrations of surface soil and maximum concentration of soils at depth. The daily doses of lead and chromium (assuming hexavalent) exceed their acceptable daily intakes (ADI). At one gram of soil per day, the cadmium concentration also exceeds its ADI. Because the analytical method that measured the inorganics in the soil involved a total digest, it is not clear how much of the inorganics are bioavailable. Several of the compounds listed on Tables 4-4 and 4-5 do not have ADI values.

The maximum observed off-property, surface lead concentrations are 1,300 mg/kg in Area II; 260 mg/kg in Area V; 270 mg/kg in Area VI; and 3,850 mg/kg in Area VIII (average of duplicate samples). The 95th percentile on local background soil lead concentrations was 76 mg/kg. With the same assumptions as in Table 3-5, the lead intake with these maximum concentrations would be 0.13, 0.026, 0.027, and 0.38 mg/day, respectively. Areas II and VIII exceed the lead ADI with the maximum soil concentrations. However, assuming a higher ingestion rate of one gram per day, the ADI for lead is exceeded in all four areas.

Exposure pathways of dust inhalation, dermal contact with contaminated soils, and inhalation of volatiles released from soils were not examined quantitatively in this endangerment assessment. Determining the impact on humans from dust inhalation requires data on a variety of factors, such as particle size, wind speed, direction and pattern, and

[1] Cancer risks were calculated only for those areas with three or more reported surface detections.

Table 4-4
SUMMARY OF ONSITE SURFACE SOIL CONTAMINATION AND CRITERIA FOR NONCARCINOGENS

Fraction	Contaminant of Concern	Acceptable Daily Intake (mg/day)	Maximum Observed Level		Mean Observed Level[a]	
			Soil Concentration (mg/kg)	Calculated Dose at 0.1 g Soil/Day (mg/day)	Soil Concentration (mg/kg)	Calculated Dose at 0.1 g Soil/Day (mg/day)
Base/Neutrals	Bis(2-ethylhexyl)phthalate	42	860	0.086	120	0.012
Acids	2,4-Dimethylphenol	---	11	0.0011	4.4	0.00044
	Phenol	7	19	0.0019	4.8	0.00048
Inorganics	Antimony	0.29	98	0.0098	13	0.0013
	Boron	---	90	0.009	65	0.0065
	Cadmium	0.17[b]	420	0.042	48	0.0048
	Chromium	0.175 (VI) 125 (III)	1,210	0.12	310	0.031
	Copper	---	880	0.088	320	0.032
	Cyanide	7.6	15	0.0015	3.1	0.00031
	Lead	0.1	31,000	3.1	5,700	0.57
	Nickel	1.5	740	0.074	150	0.15
	Zinc	---	81,000	8.1	12,000	1.2

[a]Mean concentrations calculated using detection limit for nonquantifiable but detected concentrations.

[b]Oral threshold effect level for smokers.

Table 4-5
SUMMARY OF ONSITE SOIL CONTAMINATION TO A DEPTH OF 12 FEET AND CRITERIA FOR NONCARCINOGENS

			Maximum Observed Level	
Fraction	Contaminant of Concern	Acceptable Daily Intake (mg/day)	Soil Concentration (mg/kg)	Calculated Dose at 0.1 g Soil/Day (mg/day)
Volatile Organics	1,1-Dichloroethane	---	18	0.0018
	Ethylbenzene	1.6	37	0.0037
	Toluene	30	394	0.0394
	1,1,1-Trichloroethane	38	174	0.0174
	Trichlorofluoromethane	---	0.073	0.0000073
Base/Neutrals	Bis(2-ethylhexyl)phthalate	42	860	0.086
	1,2-Dichlorobenzene	---	565	0.0565
	Di-n-butyl phthalate	88	2.6	0.00026
	Di-n-octyl phthalate	---	29	0.0029
Acids	2,4-Dichlorophenol	7	7.9	0.00079
	2,4-Dimethylphenol	---	11	0.0011
	Pentachlorophenol	2.1	17	0.0017
	Phenol	7	27	0.0027
Inorganics	Antimony	0.29	130	0.013
	Boron	---	240	0.024
	Cadmium	0.17[a]	420	0.042
	Chromium	0.175 (VI) 125 (III)	7,600	0.76
	Copper	---	5,700	0.57
	Cyanide	7.6	179	0.0179
	Lead	0.1	141,000	14.0
	Nickel	1.5	1,900	0.19
	Selenium	---	30.5	0.00305
	Zinc	---	81,000	8.1

[a]Oral threshold effect level for smokers.

distance to receptors. These data were not available. Risk would increase to persons who spend most of their working day out of doors and downwind of the site (prevailing wind direction is from the south). Dermal contact with contaminated soils would be expected also to increase the potential public health risk.

Inhalation of volatiles from disturbance of soils below the surface would be expected to increase the overall exposure from the site. Many of the volatile compounds, however, are present only in soils at depth. During the remedial investigation, site personnel measured air organic concentrations above background (about one ppm with the HNU) in the breathing zone only when near drums. All surface drums have been removed from the site. HNU readings of split-spoon samples, which approximate the condition of freshly exposed soil, were as high as 1,500 ppm, but more generally were below 10 ppm.

4.6 GROUNDWATER

Data used for the groundwater contamination assessment are presented in Chapter 3, Section 3.6. No known major water supplies are currently affected by the site. The nearest municipal wells, serving the City of Kent, are approximately 6,500 feet to the southeast, hydraulically upgradient. Two domestic wells (T23NR4E36N and T22NR4E2H1), whose condition and use are unknown, are located about 2,000 feet regionally downgradient at the site (Hart Crowser, 1984). Based on the current conceptual model of the groundwater flow system (Section 3.3), contaminated groundwater from Western Processing does not move to the west beyond Mill Creek. If contaminants do move under the creek, then the two domestic wells, if still in use, may eventually become contaminated.

Data used in this assessment are from onsite monitoring wells only. Site averages were calculated for each compound that was present in at least 5 of the 32 monitoring stations (28 well stations with four stations having two wells). The concentrations for samples at which non-detects were reported were assumed to be the detection limit in computing the mean. For some compound concentrations that were not quantified, the concentrations were reported as between the detection limit and five times the detection limit. Doses were calculated using both concentrations to derive means.

The scenario used to assess risk from exposure to onsite groundwater is ingestion of water. One case assumed ingestion of onsite groundwater as a result of industrial development of the site and use of groundwater as the potable water source. Another case assumed a lifetime of daily residential exposure that estimates a "worst case" risk through consumption of groundwater. Currently, no onsite wells or contaminated off-property wells are known to be used for potable water. If new wells are ever constructed in this aquifer, they will probably be screened below 50 feet in the more permeable fine to medium sand. As a worst case, it was assumed that the chemicals in the groundwater would reach this depth undiluted. Therefore, the mean groundwater concentration (0- to 30-foot depth) was used in this assessment. It was also assumed that contaminants in the groundwater remained at a constant concentration for the entire exposure period, 70 years for the residential and 40 years for the worker scenarios.

For carcinogens, the worker exposure scenario assumed 0.017 L of water per kg body weight per day over a 40-year period, 250 days per year, to determine the daily intake of each contaminant. The residential exposure scenario assumed a lifetime average water intake of 0.035 L of water per kg body weight per day over a 70-year period. (See Appendix E for the derivation of both intake values.) Risk was assumed to be additive, as stated previously, and Equation 4-1 was used to estimate the excess lifetime cancer risk. For non-carcinogens, a daily ingestion rate of 2 liters of water per day was assumed for derivation of the daily dose of each compound.

The results of the worker exposure analysis are presented on Table 4-6. Ingestion of site groundwater over a 40-year, 5-day work week period is estimated to lead to an excess lifetime cancer risk of 0.2 using maximum concentrations and 0.008 using mean concentrations at the detection limit for compounds detected but not quantified. Use of mean values calculated with trace contaminants at five times their detection limit does not alter the cancer risk. Prime contributions to the cancer risk come from exposure to arsenic, 1,2-dichloroethane, chloroform, and trichloroethene.

The results of the residential exposure analysis are shown in Table 4-7. Exposure to site groundwater for the residential scenario is estimated to lead to an excess lifetime cancer risk of 0.5 using maximum concentrations and 0.03 using mean concentrations with the detection limit for compounds detected but not quantified. Use of mean concentrations at five times the detection limit for the trace concentrations did not alter the cancer risk. Major contributors to the cancer risk with both maximum and mean concentrations are arsenic, 1,2-dichloroethane, chloroform, and trichloroethene. The estimated cancer risks would increase if cancer potency values for ingestion were available for benzene and vinyl chloride. It should be emphasized that the cancer risks represent potential but not current situations, as there are no water production wells onsite. High-

Table 4-6
SUMMARY OF ONSITE GROUNDWATER CONTAMINATION AND CANCER POTENCIES FOR CARCINOGENS, WORKER SCENARIO[a]

Fraction	Contaminant of Concern	Cancer Potency[b] (kg-day/mg)	Maximum Observed Level			Mean Observed Level[d]		
			Concentration (µg/L)	Lifetime Average Dose[c] (µg/kg/day)	Cancer Risk ($x10^{-6}$)	Concentration (µg/L)	Lifetime Average Dose[c] (µg//kg/day)	Cancer Risk ($x10^{-6}$)
Volatile Organics	1,2-Dichloroethane	0.069	16,000	170	10,000	300	3.3	200
	Benzene	---	2,200	24		43	0.47	---
	Chloroform	0.07	27,000	290	20,000	2,100	22	2,000
	Tetrachloroethene	0.035[e]	1,800	20	1,000	47	0.51	20
	1,1,2-Trichloroethane	0.573[e]	45	0.49	30	8.3	0.090	5
	Trichloroethene	0.019[e]	210,000	2,300	40,000	18,000	200	4,000
	Vinyl chloride	---	360	3.9		23	0.25	
Inorganic	Arsenic	15	600	6.5	100,000	17	0.18	3,000
TOTAL					200,000			8,000

[a] As described in the text, these risks represent potential exposure scenarios, not current ones. There are no production wells onsite. Cancer risks have been rounded off to one significant figure.

[b] USEPA, December 1984.

[c] Dose calculated from lifetime average water ingestion rate of 0.016 L/kg/day and exposure fraction = 0.68.

[d] Mean concentrations calculated using detection limit for nonquantifiable but detected concentrations.

[e] International Agency for Research on Cancer believes that there is inadequate evidence for classifying chemical as a human carcinogen.

Table 4-7
SUMMARY OF ONSITE GROUNDWATER CONTAMINATION AND CANCER POTENCIES FOR CARCINOGENS, LIFETIME RESIDENTIAL SCENARIO[a]

Fraction	Contaminant of Concern	Cancer Potency[b] (kg-day/mg)	Maximum Observed Level: Concentration (µg/L)	Maximum Observed Level: Lifetime Average Dose[c] (µg/kg/day)	Maximum Observed Level: Cancer Risk ($x10^{-6}$)	Mean Observed Level[d]: Concentration (µg/L)	Mean Observed Level[d]: Lifetime Average Dose[c] (µg/kg/day)	Mean Observed Level[d]: Cancer Risk ($x10^{-6}$)
Volatile Organics	1,2-Dichloroethane	0.069	16,000	560	40,000	300	10	700
	Benzene	---	2,200	77		43	1.5	
	Chloroform	0.07	27,000	950	60,000	2,100	74	5,000
	Tetrachloroethene	0.035[e]	1,800	63	2,000	47	1.6	60
	1,1,2-Trichloroethane	0.0573[e]	45	1.6	100	8.3	0.29	20
	Trichloroethene	0.019[e]	210,000	7,400	10,000	18,000	630	10,000
	Vinyl chloride	---	360	13		23	0.80	
Inorganic	Arsenic	15	600	21	300,000	17	0.6	9,000
TOTAL					500,000			30,000

[a] As described in the text, these risks represent potential exposure scenarios, not current ones. There are no production wells onsite. Cancer risks have been rounded off to one significant figure.

[b] USEPA, December 1984.

[c] Dose calculated from lifetime average water ingestion rate of 0.035 L/kg/day and exposure fraction = 1.

[d] Mean concentrations calculated using detection limit for nonquantifiable but detected concentrations.

[e] International Agency for Research on Cancer believes that there is inadequate evidence for classifying chemical as a human carcinogen.

capacity production wells downgradient of the site are drilled near the valley margins. They penetrate a different aquifer that discharges to the upper aquifer. Thus, contamination from Western Processing is not probable.

Daily intakes for the noncarcinogenic compounds are shown on Table 4-8. With the maximum onsite observed levels, ADI's are exceeded for toluene, 1,1,1-trichloroethane, bis(2-ethylhexyl)phthalate, phenol, cadmium, chromium, cyanide, lead, and mercury. With the mean onsite contaminant concentration level, phenol, cadmium, chromium (assuming hexavalent), lead, and nickel intakes exceed the ADI's. Intake of mercury and 1,1,1-trichloroethane represent 75 and 60 percent, respectively, of their ADI's.

Using the mean concentration calculated for the nonquantifiable but detected compounds at five times the detection limit does not change the results. All other compounds listed on Table 4-8 do not have ADI's.

Scenarios using dermal contact or inhalation of volatiles as the exposure pathway were not assessed quantitatively in this endangerment assessment. Cancer risks would be expected to increase if these pathways were quantified and the dose added to the chemical intakes via ingestion calculated above (Andelman, 1984; Brown et al. 1984).

4.7 SURFACE WATER--MILL CREEK

Groundwater movement from the site and the influence of groundwater on surface waters of Mill Creek are discussed in Section 3.3 of this report. This section examines the impacts of the groundwater discharge in the creek.

4.7.1 HUMAN HEALTH

Mill Creek is not known to be a source of potable water. Contamination of Mill Creek does not appear to pose a hazard to human health because the primary contaminants (several metals) do not have large bioconcentration factors and are not particularly toxic to humans. With an upper limit consumption of 2 liters per day, dissolved metal concentrations in Mill Creek near and downstream of Western Processing in 1984 samples would lead to metal intakes less than the ADI's for cadmium, hexavalent chromium, lead, and nickel. With total mercury, the daily intake would also be less than its ADI. Table 3-49 summarizes the maximum organic concentrations found in Mill Creek. Assuming an ingestion rate of 2 L/day for those chemicals with ADI's, bis(2-ethylhexyl) phthalate, di-N-butylphthalate, 2,4-dichlorophenol, phenol, ethylbenzene, and toluene all result in daily intakes less than their ADI's. With the lifetime water intake rate of

Table 4-8
SUMMARY OF ONSITE GROUNDWATER CONTAMINATION AND CRITERIA FOR NONCARCINOGENS

Fraction	Contaminant of Concern	Acceptable Daily Intake (mg/day)	Maximum Observed Level: Concentration (µg/L)	Maximum Observed Level: Dose at 2 L water/day (mg/day)	Mean Observed Level: Concentration[a] (µg/L)	Mean Observed Level: Dose at 2 L water/day (mg/day)
Volatile Organics	1,1-Dichloroethane	---	33,000	66	620	1.2
	Ethylbenzene	1.6	95	0.19	8.6	0.017
	Toluene	30	22,000	44	570	1.1
	Trans-1,2-dichloroethene	---	390,000	780	14,000	28
	1,1,1-Trichloroethane	38	340,000	680	7,600	15
Acids	2,4-Dimethylphenol	---	10,000	20	930	1.9
	Phenol	7	270,000	540	75,000	150
Inorganics	Boron	---	110,000	220	5,900	12
	Cadmium	0.17[b]	60,000	120	1,100	2.2
	Chromium	0.175 (VI) 125 (III)	65,000	130	1,500	3.0
	Cobalt	---	5,500	11	420	0.84
	Copper	---	13,000	26	740	1.5
	Cyanide	7.6	35,000	70	190	0.38
	Iron	---	480,000	960	85,000	170
	Lead	0.1	3,300	6.6	210	0.42
	Manganese	---	480,000	960	89,000	180
	Mercury	0.02	46	0.092	7.7	0.015
	Nickel	1.5	280,000	560	11,000	22
	Zinc	---	510,000	1,000	93,000	190

[a] Mean concentrations calculated using detection limit for nonquantifiable but detected concentrations.

[b] Oral threshold effect level for smokers.

0.035 L/kg/day, exposure to suspected carcinogens 1,2-dichloroethane, tetrachloroethane, and trichloroethane lead to excess lifetime cancer risks of about 10^{-5} to 10^{-6}. The same exposure to the chloroform and 1,1,2-trichloroethane in Mill Creek would lead to an excess lifetime cancer risk of about 10^{-4}. The total cancer risk from these five suspected carcinogens in Mill Creek would be 2×10^{-4}. These intake rates represent potential scenarios only, however, and it would be expected that creek water ingested during recreational activities would be much less than the above assumed rates.

Some organics that are known or suspected carcinogens were observed in creek sediments. However, their occurrence was not consistent and their concentrations were low (see Table 3-49). Concentrations of halogenated volatile organic compounds in sediment were measured on more than one occasion. Concentrations were lower in 1984 than in 1983, possibly as a result of loss to the atmosphere or movement downstream.

4.7.2 AQUATIC ORGANISMS

The Municipality of Metropolitan Seattle (Metro) has done biological sampling at stations E317 and 0317 (Plate 1), both downstream of Western Processing. The results are reviewed by GCA (Yake, 1985; Draft Report). Metro staff concluded that the biota from the two locations in Mill Creek (actually Mill Creek and the Black River) indicated poorer water quality than is representative of the region. However, the lack of an upstream reference station precludes reaching direct conclusions about the impacts of Western Processing on Mill Creek. The absence of normal biota in areas upstream of Western Processing has been noted by Yake (1985).

Lacking direct biological evidence, conclusions about the effects of Western Processing on aquatic life must be based on water-quality information. The concentrations of several pollutants increased several fold in Mill Creek in the vicinity of Western Processing. Cadmium, copper, and zinc dissolved in Mill Creek waters at and below Western Processing, however, routinely exceed USEPA ambient water quality criteria for the protection of aquatic life. Concentrations of dissolved cadmium always exceed the criteria for 24-hour exposure, and usually exceed the maximum-exposure criteria in areas adjacent to and downstream of Western Processing.

Concentrations of dissolved copper exceeded the 24-hour criteria for aquatic organisms on four of five occasions when measured by WDOE (Table 3-38) and also when measured by USEPA in January 1984. The maximum allowable concentration of copper was exceeded once in the WDOE data and probably in the USEPA sampling (Table 3-44). Water hardness, necessary for the calculation of a maximum allowable concentration, was not reported by USEPA, but the hardness values from the WDOE samples indicate a range of 52 to 140 mg/L as $CaCO_3$. The 24-hour criteria for copper were also exceeded upstream of Western Processing in January 1984 (Table 3-38).

Concentrations of dissolved zinc always exceeded the 24-hour average criteria for aquatic organisms of 47 ppb, and usually exceeded the maximum allowable concentrations (based on hardness). On occasions when hardness was not measured, concentrations of zinc were much higher than the criteria calculated for the highest hardness value observed by WDOE (Table 3-38). It is highly likely that the maximum allowable concentrations of zinc were exceeded on all but one occasion when dissolved concentrations were measured.

Concentrations of dissolved lead were often below limits of detection. However, occasionally the 24-hour criteria for aquatic organisms were exceeded both upstream and downstream of Western Processing.

Current USEPA criteria for hexavalent and trivalent chromium were used for comparison with concentrations in Mill Creek. Chromium could be present in either the +6 or +3 valence state in Mill Creek depending on the valence state discharged to the creek. Unfortunately, the limits of detection for dissolved chromium were always in excess of the 24-hour criterion for freshwater aquatic life for hexavalent chromium (WDOE samples, Table 3-38), and concentrations of chromium upstream of Western Processing were rejected for quality control reasons (USEPA samples, Table 3-44). It is therefore difficult to determine whether criteria values were exceeded upstream of Western Processing. Hexavalent chromium, while soluble, has a high affinity for reducing agents such as organic particles, and typically is bound to particulate matter in aerobic water. Concentrations of chromium in Mill Creek were always far below the maximum allowable concentration for trivalent chromium. There is no 24-hour average criterion for trivalent chromium.

The criteria for aquatic organisms are generally based on total recoverable metals (USEPA, March 1979). If suspended matter is present in the water sampled, total recoverable metals would exceed concentrations of dissolved metals, but be less than total metals. Comparison of concentrations of dissolved metals with the USEPA criteria for protection of aquatic life is likely to underestimate the actual exposure and risk. Comparison with concentrations of total metals could substantially overestimate the risk. When concentrations of dissolved metals exceed the criteria, a clear threat to aquatic life exists.

The criteria to protect aquatic life are based on toxicity to a large number of species. Two salmonid fish of commercial or recreational importance presently inhabit or previously inhabited portions of the Mill Creek-Springbrook Creek drainage. Those species are coho salmon (Williams, Laramie, and Ames, 1975) and cutthroat trout (Rick Tosper, Washington Department of Fisheries, personal observation). Juvenile coho salmon are planted upstream of Western Processing as part of a salmon rehabilitation program by the Washington Department of Fisheries and must migrate past Western Processing to reach the sea. Toxicity of copper and zinc to both species and toxicity of cadmium to coho salmon have been measured in test systems. Table 4-9 shows the ranges of acute toxicities and the chronic toxicity data available from the USEPA criteria documents (USEPA, October 1980). Toxicity of the three metals for two other salmonids with similar habitat requirements is also shown. One of these species (rainbow trout) has also been reported to use Mill

Table 4-9
SUMMARY OF TOXICITY VALUES FOR CADMIUM, COPPER, AND ZINC TO FOUR SALMONID FISH

Metal and Species	Species Acute Values (μg/L)	Chronic Values (μg/L)
Cadmium		
Coho Salmon	--	7.2 (44)
Rainbow Trout	1-7 (23)	--
Chinook Salmon (Juveniles)	1.8-3.5 (23)	--
Copper		
Coho Salmon	46-70 (20-99)	--
Cutthroat Trout	15.7-367 (26-205)	--
Rainbow Trout	19.9-890 (30-290)	19 (45.4)
Chinook Salmon	10-130 (13-359)	--
Zinc		
Coho Salmon	905-4,600 (25-94)	--
Cutthroat Trout	90 (-)	--
Rainbow Trout	90-7,210 (20-333)	277 (26)
Chinook Salmon	97-701 (24-24)	371 (25)

Notes: Coho salmon and cutthroat trout are species of concern likely to inhabit Mill Creek, and rainbow trout and Chinook salmon are similar representative species. Associated hardness values in mg/L are shown in parentheses.

Creek, but its presence has not been confirmed by the Washington Department of Fisheries. Concentrations of dissolved cadmium, copper, and zinc in Mill Creek are sufficient to cause mortalities over a few days to the species shown. It is reasonably certain that the species listed could not remain in Mill Creek in the immediate vicinity of Western Processing without being killed or otherwise adversely affected. Based on data in the criteria documents, the water in Mill Creek is likely to be toxic to a wide variety of aquatic organisms. However, there are also aquatic organisms that might survive in Mill Creek because of relative insensitivity to toxicity of metals.

Metals draining into Mill Creek appear to be adsorbed by sediment in suspension and the streambed. Suspended and bedload transport of metals was discussed in Section 3.7.3. In general, metals adsorbed to sediment are not readily removed. However, extraction procedure (EP) toxicity tests (45 Federal Register, 33127) performed by the USEPA (1984) on Mill Creek sediments indicate that relatively large amounts of soluble cadmium, copper, and zinc are present in Mill Creek sediments, either adsorbed or as pore water. Sediment collected at or downstream of Western Processing gave EP concentrations that exceeded the maximum allowable concentrations of those three metals for aquatic organisms in the extraction volume (USEPA, May 1982 and January 1984). Sediment elutriate from upstream of Western Processing exceeded the maximum allowable concentration for copper, but by a lesser amount than sediment from near or downstream of Western Processing. In the creek, leaching volumes would be much greater, the pH would be higher, and the concentrations of metals in Mill Creek from sediment leachate would be lower than observed during EP toxicity tests.

Dissolved lead exceeded criteria values upstream, adjacent to, and downstream of Western Processing. Similar values were observed at all three locations.

If the EP toxicity samples were filtered prior to analysis, as confirmed by USEPA (Gahler, personal communications, 1984), contaminated sediment in Mill Creek is a potential source of soluble metals in toxic concentrations.

With the exception of one measured value of bis(2-ethylhexyl) phthalate, the concentrations of organic compounds detected in Mill Creek sediment were well below concentrations that pose a hazard to aquatic life. The highest concentration of bis (2-ethylhexyl) phthalate in sediment was observed upstream of Western Processing. Sediment samples collected most recently contained low concentrations of volatile organics but were not tested for other organic compounds (Schmidt and Vandervort, 1984).

4.8 LIMITATIONS OF THE METHODOLOGY

Uncertainties inherent in the calculation of excess lifetime cancer risk may act to either increase or decrease risk, depending on the source of the uncertainty. Factors that may have led to an underestimate of the human health risk include:

- Not all known or suspected human carcinogens have estimated cancer potencies, or potencies are only available for exposure pathways not used in this assessment. Therefore, the estimated total cancer risk will not include their contributions.

- Chemical doses may act synergistically rather than additively.

- Dermal and inhalation doses were not calculated, and these would add to the total body burden.

- Higher concentrations may be present, although not measured.

- Environmental transformation and degradation of chemicals may produce products with increased toxicities compared to their parent chemicals.

Factors that may have led to an overestimate of the human health risk include:

- The intestinal absorption rate from ingestion has been assumed to be 100 percent.

- Cancer potencies from USEPA's Carcinogen Assessment Group are established as an upper bound estimate.

- The true value for an adult soil ingestion rate may be closer to zero rather than the 0.1 g/day estimated by Kimbrough et al. (1983) and used in this endangerment assessment.

- This assessment assumed that the environmental chemical concentrations do not change with time, whereas some can be expected to decrease over time through biological and chemical degradation.

- Exposure times of 40 and 70 years for the worker and residential scenarios were assumed, whereas employment and residential turnover would be expected to lead to shorter exposure periods.

- Chemical doses may act antagonistically rather than additively.

- Concentrations for nondetected chemicals may be less than the detection limits and therefore the estimated mean concentrations may be high.

A factor that may lead to an over- or underestimate of the human health risk is that regrading the site in late 1984 may either have increased or decreased surface soil concentrations.

4.9 SUMMARY AND CONCLUSIONS

Implementation of the no-action alternative on the Western Processing site may result in the following impacts from each environmental medium:

- Soils--There is a potential excess lifetime cancer risk of 5×10^{-7}, principally from PCB contamination, associated with the ingestion of onsite surface soils with site mean concentrations in a future worker scenario. An estimated potential cancer risk of 5×10^{-6} is associated with the ingestion of soils if the maximum surface concentrations are used. This increases to an estimated 2×10^{-4} risk if maximum concentrations from zero to 12 feet deep are used. Excess lifetime cancer risks in three potential future residential scenarios ranged from about 0.8 times to 50 times greater. Ingestion of soils could lead to an exceedance of the acceptable daily intake for lead.

  Soils in six off-property areas (II, III, V, VI, and IX and Mill Creek sediments) also had detected PCB's. Areas VI and IX had at least three reported detections in the surface soils, which was the criterion for calculating a cancer risk for an area. With the mean and maximum concentrations and the worker scenario, the potential excess lifetime cancer risks associated with ingestion of soil are 9×10^{-6} and 4×10^{-5}, respectively, in Area VI and 3×10^{-5} and 5×10^{-5}, respectively, in Area IX. Excess lifetime cancer risks in the three residential scenarios would be 0.8 times to 50 times greater. Ingestion of surface soil in Areas II and VIII could lead to an exceedance of the acceptable daily intake for lead.

- Groundwater--No known water supplies are currently affected by the site. Use of onsite groundwater as a potable water source for a work place, however, would present an estimated excess lifetime cancer risk of 0.2 using maximum onsite concentrations and 0.008 using mean onsite concentrations. Cancer risk would increase to an estimated 0.5 if a residential scenario is used with maximum concentrations and 0.02 if mean onsite concentrations are used. It is emphasized, however, that these exposure scenarios represent only potential exposures, as contaminated groundwater is not now being used.

- Surface water (Mill Creek)--Mill Creek is not currently known to be used as a source of potable water. Even assuming that Mill Creek is the sole source for someone's potable water, no ADIs were exceeded and the potential excess lifetime cancer risks were about 10^{-4} with maximum reported organic concentrations. Endangerment to aquatic life in Mill Creek is in the form of toxic concentrations of cadmium, chromium, copper, and zinc that are presently occurring in Mill Creek water and sediment as a result of groundwater flow from Western Processing. Organic contaminants from Western Processing do not appear to pose a threat to aquatic life because concentrations are well below those known to cause harm.

Chapter 5
REMEDIAL ACTION TECHNOLOGIES

Remedial action technologies were identified through the following process:

1. A list of site-specific problems was derived from a review of Chapter 3 (Nature and Extent of Contamination).

2. General responses addressing site problems were determined and categorized as "technology groups."

3. Specific technologies were identified within the technology groups.

5.1 SITE PROBLEMS

This section provides an overview of existing site problems previously identified in Chapter 3. They can be classified in the following categories:

- Surface water contamination and runoff
- Leachate generation and contaminated groundwater
- Contaminated soils and underground debris
- Contaminated groundwater discharge to Mill Creek
- Contaminated sediments
- Underground utilities within the zone of contamination

These problems are discussed below as they pertain to the subsurface cleanup at Western Processing.

5.1.1 SURFACE WATER CONSIDERATIONS

Mill Creek (also called King County Drainage Ditch No. 1) runs in a northerly direction along the northwest corner of the site. Before stormwater drainage improvements were implemented in 1983, Mill Creek was a receptor of both contaminated surface water and groundwater from Western Processing. Berms and an asphalt cover were constructed by DOE to control stormwater; they have minimized the amount of contaminated surface water reaching Mill Creek. More recently, a stormwater collection system has collected stormwater for discharge to the Metro sewer system. However, groundwater flow from Western Processing into Mill Creek still occurs. In addition, Mill Creek sediments are contaminated and these contaminated materials contact the stream flow.

A similar situation exists in a small drainage ditch along the east side of the site. The contaminated sediments present within the ditch could contaminate the water flowing through the ditch.

5.1.2 LEACHATE GENERATION AND CONTAMINATED GROUNDWATER

Leachate from the contaminated soils on the Western Processing site has contaminated the groundwater under the site. There is also some evidence of off-property migration of contaminated groundwater locally in all directions. This is believed to be due to a groundwater mound located beneath the site. Mill Creek is the major discharge point for contaminated groundwater.

5.1.3 CONTAMINATED SOILS AND UNDERGROUND DEBRIS

The soils of the Western Processing site have been found to be grossly contaminated with metals and organics, as described in Chapter 3. The contaminated soils are documented as the source of groundwater contamination and must be considered a major site problem. In addition, buried drums have been found on the Western Processing site. The magnitude of this problem is unknown and will remain unknown until either additional subsurface exploration (such as magnetometer or ground penetrating radar) or an excavation is done.

Other underground materials that may be encountered during remedial action include underground septic tanks, abandoned underground piping and utilities, and old foundations and footings.

5.1.4 CONTAMINATED SEDIMENTS

The sediments of Mill Creek have been found to be contaminated with the metals cadmium, chromium, copper, and zinc, as described in Chapter 3. At present, Mill Creek waters contact contaminated sediments. As described in Chapter 3, the metals probably have saturated the ion-exchange sites in the sediments at the points of entry to the creek, so these sediments may not be contributing more metal ions than are already in the groundwater. However, as water with lower metal concentrations or with a low pH contacts these sediments, metal ions will leach from them.

5.1.5 UNDERGROUND UTILITIES IN THE ZONE OF CONTAMINATION

Underground utilities that pass near the site include power cables, sewer and water lines, telephone ducts, an oil line, and a natural gas line. The presence of utilities within or near the zone of contamination represents additional pathways for contaminant migration. Other unidentified utility lines may be located on or near the site, and they may present problems during a subsurface cleanup.

5.2 TECHNOLOGY GROUPS

This section evaluates several technology groups for their applicability to the site problems at Western Processing. Technologies applicable to Western Processing fall into one or more of the following technology groups:

- Surface water controls
- Leachate and groundwater controls
- Waste and soil excavation and removal
- Contaminated sediments removal or containment
- In situ treatment methods
- Disposal of groundwater
- Direct waste treatment
- Disposal of excavated soils
- Mitigation of problems caused by underground utilities within the zone of contamination

Each technology group is discussed below in terms of its applicability to Western Processing.

5.2.1 SURFACE WATER CONTROLS

Surface water controls are designed to prevent the migration of contaminated surface water off-property and to prevent the contamination of bodies of surface water. Surface water controls may also be used to prevent surface water from interfering with other remedial actions. They are also used to prevent surface water from running on or running off the area of contamination or to collect contaminated runoff for treatment and disposal.

5.2.2 LEACHATE AND GROUNDWATER CONTROLS

Leachate and groundwater controls are designed to prevent or to minimize the contamination of groundwater by leachate generation as well as contaminant migration via groundwater. Leachate and groundwater controls can include the use of caps, containment barriers, and/or groundwater removal and treatment.

5.2.3 WASTE AND SOIL EXCAVATION AND REMOVAL

Excavation and removal of waste and contaminated soils may be implemented to eliminate or reduce the source of groundwater pollution, to reduce the threat of direct exposure to contaminated soils, and/or to aid in the implementation of another remedial action, such as the installation of a slurry wall. The removal of underground debris is included in this technology group.

5.2.4 CONTAMINATED SEDIMENTS REMOVAL OR CONTAINMENT

This technology group is designed to prevent contact between contaminated sediments and Mill Creek surface water flow. The primary problem caused by the presence of contaminated sediments in Mill Creek is that contaminants can dissolve into the stream flow from those contaminated sediments.

5.2.5 IN SITU TREATMENT METHODS

In situ treatment methods are designed to mitigate contamination problems without moving contaminated materials. Methods include contaminant destruction, treatment, and fixation. In situ treatment is usually used in more homogeneous situations than those found at Western Processing. Individual in situ treatment technologies are examined later in this chapter to determine if any are applicable to Western Processing site problems.

5.2.6 DIRECT WASTE TREATMENT

Direct waste treatment can be implemented to destroy contaminants in, to remove contaminants from, or to stabilize and in some instances to fixate contaminants within solid, liquid, or gaseous waste streams. Incineration can completely decompose many types of organic contaminant molecules. Treatment systems can remove contaminants from liquid and gaseous waste streams. Solids treatment systems can remove contaminants from homogeneous solid areas. Direct waste treatment may be applicable to many of the Western Processing site problems, including contaminated groundwater and possibly contaminated soils.

5.2.7 DISPOSAL OF GROUNDWATER

This technology group is designed to dispose of groundwater once the water has been removed from the aquifer. Groundwater can be disposed after or in lieu of treatment. The range of disposal options is affected by the degree of groundwater treatment implemented prior to disposal.

5.2.8 DISPOSAL OF EXCAVATED SOILS

This technology group becomes applicable to Western Processing site problems if and when contaminated soils are removed from the site. Excavated soils may be disposed of or treated onsite or offsite.

5.2.9 MITIGATION OF PROBLEMS CAUSED BY UNDERGROUND UTILITIES WITHIN THE ZONE OF CONTAMINATION

As discussed in Chapter 3, there may be problems with contaminants leaving the site in or adjacent to utility conduits. Since it is a rather minor task to seal the utilities leaving the site, each example alternative assumes that all utility trenches and conduits leaving the site will be sealed to block the transport of contamination, and all utilities passing through the contamination zone will be checked for leak potential and/or rerouted.

5.2.10 SUMMARY OF TECHNOLOGY GROUPS

Table 5-1 summarizes the existing site problems that would be significantly affected by the selection of a particular technology group. The table shows that a particular technology group will sometimes apply to more than one site problem.

After the technology groups were identified they were assessed in preparation for assembling and screening example remedial action alternatives. Each technology group was assessed separately without consideration of positive or negative effects when used in combination with other technologies.

The preliminary assessment procedure considers only major impacts of the identified technologies. The procedure uses available data to allow preliminary conclusions to be drawn about effects and to facilitate comparisons between technologies before detailed analysis is performed. It also permits identification of sensitive general issues. This procedure catalogs only major impacts and does not rely on quantification since it is a preliminary screening procedure for identifying and eliminating infeasible technologies. The feasible technologies were available for use in the example remedial action alternatives discussed in Chapter 6.

Table 5-1
IMPACT OF TECHNOLOGY GROUPS
ON EXISTING AND POTENTIAL SITE PROBLEMS

Technology Groups	Soil and Under-ground Debris	Mill Creek Sedi-ments	Ground-water
Surface Water Controls		X	X
Leachate and Groundwater controls		X	X
Waste and Soil Excava-tion and Removal	X	X	X
Contaminated Sediments Removal or Containment		X	
In Situ Treatment	X	X	X
Direct Waste Treatment	X		X
Disposal of Groundwater			X
Disposal of Excavated Soils	X	X	

Note: "X" indicates that site problem would be positively affected by implementation of the technology group.

5.3 ASSESSMENT CRITERIA

The technologies found to be potentially applicable to Western Processing are listed in Table 5-2. Selection of the potential applicable remedial technologies was based on the following general conditions:

- Physical site conditions that preclude, restrict, or promote the use of a specific technology
- Chemical and physical characteristics of contamination that affect the effectiveness of a remedial technology
- Inherent nature of a technology, such as performance record, reliability, and operating problems

Table 5-2
TECHNOLOGIES POTENTIALLY APPLICABLE AT WESTERN PROCESSING

Surface Water Controls

- o Capping
  - Sprayed asphalt membrane
  - Portland cement concrete
  - Bituminous concrete (asphalt)
  - Gravel over geotextile over clay
  - Loam over clay
  - Loam over synthetic membrane over sand
  - Loam over sand over synthetic membrane over clay

- o Diversion and Collection Systems (Mill Creek Diversion)
  - Piped gravity bypass
  - Ditches and trenches (new channel)
  - Pump and pipe system with diversion dam

Groundwater Controls

- o Containment or Diversion Barriers
  - Soil-bentonite slurry wall
  - Cement-bentonite slurry wall
  - Vibrating beam-asphalt wall
  - Grout curtains

- o Groundwater Pumping
  - Well points
    - (a) Suction wells
    - (b) Jet ejector wells
    - (c) Submersible wells
  - Deep wells

Waste and Soil Excavation and Removal

Contaminated Sediments Removal and Containment

- o Mechanical Dredging
- o Hydraulic Dredging
- o Pneumatic Dredging

In Situ Treatment Methods

- o Hydrolysis
- o Oxidation
- o Vitrification
- o Reduction
- o Soil aeration

Table 5-2
(continued)

- o Solvent flushing
- o Neutralization
- o Polymerization
- o Bioreclamation
- o Permeable treatment beds
- o Solidification

<u>Direct Waste Treatment</u>

- o Onsite Treatment of Aqueous and Liquid Waste Streams
  - \- Biological Treatment Techniques
    - (a) Aerobic Biological Treatment Systems
      - \- Activated sludge
      - \- Trickling filters
      - \- Aerated lagoons
      - \- Waste stabilization ponds
      - \- Rotating biological discs
      - \- Fluidized bed bioreactors
    - (b) Anaerobic Biological Treatment Systems
  - \- Chemical Treatment Techniques
    - Neutralization
    - Precipitation
    - Cyanide oxidation
    - Organic chemical oxidation
    - Hydrolysis
    - Reduction
    - Organic chemical dechlorination
    - Molecular chlorine removal
  - \- Physical Treatment Techniques
    - (a) Flow equalization
    - (b) Coagulation/flocculation
    - (c) Sedimentation
    - (d) Activated carbon
    - (e) Ion exchange
    - (f) Membrane processes
      - Reverse osmosis
      - Electrodialysis
      - Ultrafiltration
    - (g) Liquid/liquid extraction
    - (h) Oil-water separator
    - (i) Steam distillation
    - (j) Air stripping
    - (k) Steam stripping
    - (l) Filtration
    - (m) Dissolved air flotation
- o Off-property Treatment

Table 5-2
(continued)

Disposal of Groundwater

- Discharge to a publicly owned treatment works
- Discharge to Mill Creek
- Discharge to Green River
- Spray irrigation
- Shallow reinjection
- Deep well injection

Disposal of Excavated Soils

- Offsite landfill disposal at a RCRA-permitted facility
- Onsite landfill disposal
- Incineration at an offsite facility

To refine the relative applicability of each technology, the following additional criteria were applied:

- <u>Technical Feasibility</u>. Technical feasibility includes a general assessment of reliability, implementation capability, and safety. Reliability is assessed in categories of effectiveness, durability, and whether or not the technology is proven. Implementation capability is assessed in the categories of ease of installation, applicability to site conditions, time required to implement, and monitoring requirements. The safety category addresses the relative safety of a technology during operation and in the event of failure of the technology.

- <u>Environmental, Public Health, and Institutional Impacts</u>. The evaluation and screening of remedial technologies from an environmental perspective addresses both short-term (construction-related) and long-term (operation-related) effects on the natural and manmade environment. Short-term effects considered during technology screening include odor, noise, air pollution, groundwater pollution, surface water pollution, wildlife habitat alteration, disposal of construction materials, and disruption of households, businesses, and services. Long-term effects considered during technology screening include odor, noise, air pollution, surface water pollution, groundwater pollution, and wildlife habitat alteration; effect on any threatened and endangered species, or on the use of natural resources; alteration of parks, transportation, and urban facilities; relocation of households, businesses, or services; and aesthetic changes. Public health evaluations for each technology were made by judging exposure (short- and long-term) for each alternative. Institutional impacts were evaluated relative to political jurisdiction; surface water and groundwater standards; air quality, odor, and noise standards; land acquisition, land use restrictions, and zoning; and federal, state, or local laws or policies.

- <u>Cost</u>. Costs were compared for each technology. The comparison reflects relative rather than absolute costs and, wherever possible, considers life-cycle as well as capital costs. A negative assessment indicates that a technology is more expensive relative to other technologies, and a positive assessment indicates that a technology is less expensive relative to other technologies.

The applicable technologies were individually rated by assessing them with regard to the above criteria. The following scale was used for rating the technologies on the summary tables:

Rating	Definition
--	Extremely negative effects, even with mitigating measures; technology not worth further consideration
-	Negative effects that are not strong enough or certain enough to be sole justification for eliminating a technology; only moderate negative effects
o	Of very little apparent positive or negative effect, but inclusion can be justified for some special reason; little change from existing conditions
+	A positive or moderately positive benefit
++	An extremely positive benefit
*	Inappropriate to draw conclusions at this point in the evaluation process

5.4 DISCUSSION OF ASSESSED APPLICABLE REMEDIAL TECHNOLOGIES

Applicable technologies have been organized by technology group. Each technology by itself does not address all public health impacts of the site. To allow consistent ratings, each technology is rated relative to its impact or effectiveness in application to a specific hazard. This assumes that concerns regarding site hazards not addressed by a single action can potentially be mitigated through implementation of other technologies. The effect of combining technologies will be considered in Chapter 6. Because a complete analysis of the effectiveness of a technology requires that its interaction with other technologies be examined, this chapter contains only general assessments of the remedial action technologies.

5.4.1 SURFACE WATER CONTROLS

5.4.1.1 Capping

The following capping technologies assume no soil removal, treatment, or other containment. Table 5-3 shows the results of the preliminary assessment of capping technologies. Capping is used to eliminate human or animal contact

Table 5-3
PRELIMINARY ASSESSMENT OF SURFACE CAP TECHNOLOGIES

	Evaluation			
Technology	Technical (see comment a.)	Environmental, Public Health, and Institutional (see comment b.)	Cost (see comment c.)	Comments
Sprayed Asphalt	-	o	o	a. Asphalt membrane is not durable.
Portland Cement Concrete	-	+	-	a. Concrete cap is relatively difficult to install properly. b. Concrete cap would allow limited future site use. c. Capital costs for this type of cap are high.
Bituminous Concrete (Asphalt)	-	+	o	a. Susceptible to cracking. b. Asphalt cap would allow limited future site use.
Gravel Over Geotextile Over Clay	-	o	o	a. Requires three passes to construct. Technology has little proven, long-term experience.
Loam Over Synthetic Membrane Over Sand	-	o	o	a. Time consuming and difficult to implement. "Self-healing" capacity of clay is not present.
Loam Over Clay	o	o	o	
Loam Over Sand Over Synthetic Membrane Over Clay	+	+	-	a. Although construction is difficult and time consuming, this cap is more durable than other types of caps. b. This capping technology is compliant with RCRA regulations. c. Capital costs for this type of cap are high.

with contaminated soils, to reduce water infiltration through contaminated soils, and to eliminate contaminant transport by surface water runoff and airborne emissions.

5.4.1.1.1 Sprayed Asphalt Membrane

This technology involves surface grading and spray application of a 1/4- to 1/2-inch-thick layer of asphalt to reduce infiltration and eliminate volatile and particulate emissions from the soil surface. It requires minimal material handling and a small labor force, and is easy to implement. However, the membrane is not very durable because it is photosensitive, has poor weather resistance, becomes brittle with age, and is susceptible to severe progressive cracking.

5.4.1.1.2 Portland Cement Concrete

This technology involves surface grading and placement of a base course and a concrete slab with steel mesh to minimize infiltration and reduce emissions of volatiles and particulates from the surface soil. The technology is durable and resistant to chemical and mechanical damage. However, Portland concrete is susceptible to cracking from settlement and shrinkage. Installation requires the placement of forms and steel and the making of expansion joints. It has very high capital costs although proper design and installation generally result in relatively low maintenance costs.

5.4.1.1.3 Bituminous Concrete (Asphalt)

This technology involves surface grading and placement of a base course and bituminous (asphalt) pavement to minimize infiltration and reduce emissions of volatiles and particulates from the soil surface. The technology has proven effective. However, as with the other more rigid materials, bituminous concrete is susceptible to cracking from settlement and shrinkage. Bituminous concrete is photosensitive and tends to weather more rapidly than Portland concrete. This weathering generally contributes to operation and maintenance expenses that are greater than for Portland concrete. An asphalt cap is presently in place over the area of the site used as a solids reaction pond.

5.4.1.1.4 Gravel Over Geotextile Over Clay

This technology involves surface grading and compaction of native materials to minimize infiltration and reduce particulate emissions from the soil surface. A clay layer is then placed and compacted over the surface. The clay is covered with a geotextile and compacted gravel to provide a flexible surface course that can withstand heavy vehicular traffic.

5.4.1.1.5 Loam Over Clay

This technology involves surface grading and the placement of compacted clay to minimize infiltration and eliminate volatile and particulate emissions from the soil surface. The clay is covered with loam (topsoil) to control moisture, protect the integrity of the clay layer, and allow revegetation. The clay has some self-healing properties but is subject to cracking due to desiccation and will not carry vehicular traffic.

5.4.1.1.6 Loam Over Synthetic Membrane Over Sand

This technology involves grading and covering site soils with a blanket of sand overlaid with an impermeable synthetic membrane that is covered by loam (topsoil) to protect the synthetic liner and allow revegetation. The synthetic membrane is susceptible to punctures, cracking, and chemical degradation, and will not carry vehicular traffic.

5.4.1.1.7 Loam Over Sand Over Synthetic Membrane Over Clay (RCRA Cap)

This technology involves grading and covering site soils with compacted clay and an impermeable synthetic membrane that is covered by sand. Overlying this sequence of materials is loam (topsoil) to protect the membrane and allow revegetation. The technology takes advantage of the self-healing properties of clay and the impermeable nature of synthetic membrane at correspondingly higher capital cost. The cap complies with RCRA requirements for site closure. The cap requires difficult construction techniques and will not withstand vehicular traffic.

5.4.1.2 Diversion and Collection Systems (Mill Creek Diversion)

The following technologies may be used should a diversion of Mill Creek be implemented. Preliminary assessments of Mill Creek diversion technologies are shown in Table 5-4. Since Mill Creek is being relied upon to capture groundwater and minimize westward migration of the contamination, any diversion may increase the area in which contaminated groundwater flows.

5.4.1.2.1 Piped Gravity Bypass

This technology would involve installing a large conduit pipe around Mill Creek as it passes Western Processing. This action would eliminate any hydraulic connection between the site and Mill Creek. To avoid flooding, the system would have to be sized to carry the maximum anticipated seasonal creek flow. This action could be used as a temporary or a permanent response. Local groundwater discharging to the creek would have to be managed in the area of the excavation.

Table 5-4
PRELIMINARY ASSESSMENT OF MILL CREEK DIVERSION TECHNOLOGIES

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Cost (see comment c.)	Comments
Piped Gravity Bypass	o	-	-	b. If permanent, destroys any biological use of Mill Creek. May alter local groundwater gradients. c. Expensive to implement.
Ditches and Trenches (New Channel)	o	-	-	b. Diversion of creek may alter local groundwater gradients. New channel will involve an excavation through potentially hazardous areas. c. Expensive to implement.
Pump and Pipe System with Diversion Dam	+	-	-	a. Pumping increases versatility of the diversion system. b. Diversion of creek may alter local groundwater gradients. c. Expensive to implement.

5.4.1.2.2 Ditches and Trenches (New Channel)

This technology involves digging a new creek channel farther from the Western Processing site. The creek flow would be dammed and diverted to the new channel. This new channel would probably be located north and west of the present creek location. The diversion could be made permanent or used only for the period of time necessary to implement some other remedial action.

5.4.1.2.3 Pump and Pipe System with Diversion Dam

This technology involves the use of a diversion dam with a low-head pump to divert the Mill Creek flow. The water would be pumped through a pipe to an alternate stream bed or would be pumped to a different section of Mill Creek. The diversion could be made permanent or used only for the period of time necessary to implement some other remedial action.

5.4.2 GROUNDWATER CONTROLS

5.4.2.1 Containment or Diversion Barriers

The following containment or diversion technologies assume that capping would also be employed. Table 5-5 summarizes the preliminary assessment of containment or diversion barrier technologies. Containment or diversion barrier technologies are assessed assuming that complete containment is the goal of the remedial response. Discussion of other uses for barriers is presented in Chapter 6.

5.4.2.1.1 Soil-Bentonite Slurry Wall

This technology involves excavation of a trench using bentonite slurry for temporary stabilization. Backhoes can be used to excavate a trench to depths of up to 50 to 60 feet. The trench is then backfilled with a soil-bentonite mixture to provide a low permeability confining wall. Cost-effectiveness of this technology is greatly enhanced where native soil can be used in the soil-bentonite mixture. The suitability of native soil for use in the soil-bentonite mixture depends upon texture, grain size distribution, moisture content, and permeability. The effectiveness of this technology has been proven in other hazardous waste applications. However, the heterogeneity of the subsurface materials and extreme depth to bedrock (or other relatively impermeable strata) at the Western Processing site make complete containment difficult.

5.4.2.1.2 Cement-Bentonite Slurry Wall

This technology involves the excavation of a trench using bentonite slurry for temporary stabilization. The trench is

Table 5-5
PRELIMINARY ASSESSMENT OF CONTAINMENT BARRIER TECHNOLOGIES

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Cost (see comment c.)	Comments
Soil-Bentonite Slurry Wall	-	-	o	a. Aquiclude is approximately 150 feet beneath Western Processing site. Possibility of chemical degradation of slurry wall. b. Due to deep aquiclude, complete containment is very difficult.
Cement-Bentonite Slurry Wall	-	-	-	a. Aquiclude is approximately 150 feet beneath Western Processing site. Cement-bentonite is simpler to install than soil-bentonite. Possibility of chemical degradation of slurry wall. b. Due to deep aquiclude, complete containment is very difficult. c. More expensive then soil-bentonite slurry wall.
Vibrating Beam Asphalt Wall	--			a. Membrane is thin. Effectiveness of seal is difficult to determine. Susceptible to chemical attack. Possibility of chemical degradation of wall.
Grout Curtain	-	-	-	a. Determining effectiveness of grout curtain at the Western Processing site would be difficult. Possibility of chemical degradation of curtain. b. Due to the depth of the aquiclude, complete containment is very difficult. c. Relatively high material costs.

then backfilled with cement-bentonite mixture to displace the slurry and provide a confining wall. The technology has proven effective and durable in other hazardous waste applications. However, the extreme depth to bedrock (or other relatively impermeable strata) at the Western Processing site makes complete containment difficult. A cement-bentonite slurry wall technology requires less operating space and involves a less complicated construction operation but is more permeable than a soil-bentonite slurry wall.

5.4.2.1.3 Vibrating Beam-Asphalt Wall

This technology involves using vibratory force to advance a steel beam into the ground and injecting a relatively thin wall of asphalt (or cement, bentonite, or both) as the beam is withdrawn. The wall is constructed by successive placement of adjacent segments. The technology is most applicable to clean fine to medium sands and has the inherent problem of maintaining beam alignment and the continuity of adjacent segments. The extreme depth to bedrock (or other relatively impermeable strata) at the Western Processing site make complete containment difficult.

5.4.2.1.4 Grout Curtain

This technology involves the injection of cement grout (with bentonite) through vertical pipes installed into the ground. Typically, a minimum of three rows of pipes is required at staggered spacing. This technology is more expensive than the slurry wall technologies, and grout curtains are usually used in porous or fractured rock. The major difficulty with grouting for water cut-off is the inability to control where grout actually ends up and, therefore, the integrity of the containment cannot be assured.

5.4.2.2 Groundwater Pumping

The assessment of the following groundwater pumping technologies assumes that the effluent will undergo proper treatment and/or disposal. Table 5-6 summarizes the assessment.

5.4.2.2.1 Well Points

Well points are a common method of dewatering excavations and are used in groundwater pumping networks. A well point system generally consists of a series of closely spaced small-diameter wells, usually interconnected by a header pipe or a manifold. Pumps commonly used in well point systems include suction pumps, jet ejector pumps, and submersible pumps. Well points are best suited for use in low-permeability soils. Well points can be used at a variety of depths, depending upon the type of pump used.

Table 5-6
PRELIMINARY ASSESSMENT OF GROUNDWATER PUMPING TECHNOLOGIES

Technology	Evaluation			Comments
	Technical (see comment a.)	Environmental, Public Health, and Institutional (see comment b.)	Cost (see comment c.)	
Well Points with Suction Pump System	-	o	+	a. Maximum effective lift is approximately 15 feet. c. Less expensive than other pumping systems.
Well Points with Jet Ejector Pump System	+	o	o	a. Jet ejector pumps can lift water from greater depths than can suction pumps.
Well Points with Submersible Pump System	-	o	-	a. Requires electrical power to many pumps. c. Higher O&M and capital costs than other well point pumping systems.
Deep Wells	o	o	o	

Suction Pumps. In a suction pump system, each well point is connected to a central centrifugal suction pump. The well points are usually spaced from two to six feet apart, depending on the permeability of the saturated soil and on the desired zone of drawdown. The maximum effective lift that can be generated by a suction pump system is approximately 15 feet.

Jet Ejector Pumps. Jet ejector pumps are used in deeper well point systems requiring a greater lift than can be delivered by a suction pump system. Jet ejector pumps can lift water from depths of 100 feet or more. The jet ejector system requires an additional unit to recirculate water through the pump.

Submersible Pumps. Submersible pumps are centrifugal pumps placed inside each well casing below the water level. They generally require a 3-inch-minimum well diameter. The lift capabilities of submersible pumps are generally limited only by the size of the pump that will fit in a given well.

5.4.2.2.2 Deep Wells

Deep wells are generally considered to be higher capacity single-unit wells screened at greater depths than those found in a well point system. Submersible pumps and vertical turbine pumps are commonly used in deep wells. Deep wells are generally best suited for use in higher permeability soils because of their higher pumping capacity.

5.4.3 WASTE AND SOIL EXCAVATION AND REMOVAL

Waste and soil excavation and removal technologies are not categorized. No assessment is provided since the choice of excavation methods is generally made by the contractor.

5.4.4 CONTAMINATED SEDIMENTS REMOVAL AND CONTAINMENT

The following technologies for the removal of contaminated sediments from Mill Creek are assessed in Table 5-7. It is assumed that the excavated sediments will be disposed of at a RCRA-permitted landfill and that Mill Creek will be temporarily diverted around the dredging activity.

5.4.4.1 Mechanical Dredging

Mechanical dredging technologies include the use of clamshells, draglines, and backhoes. Mechanical dredging technologies are easier to implement than are other types of dredging, and they do not require the treatment or disposal of large quantities of potentially contaminated surface water. Dewatering of the sediments may be required prior to transport and disposal of contaminated material.

Table 5-7
PRELIMINARY ASSESSMENT OF SEDIMENT REMOVAL TECHNOLOGIES

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Cost (see comment c.)	Comments
1. Mechanical Dredging	+	o	o	a. Relatively easy to implement.
2. Hydraulic Dredging	--			a. Results in the removal of large quantities of potentially contaminated surface water which then must be treated or disposed of.
3. Pneumatic Dredging	--			a. Results in the removal of large quantities of potentially contaminated surface water which then must be treated or disposed of.

5.4.4.2 Hydraulic Dredging

Hydraulic dredging technologies involve the pumping of sediments and some water from Mill Creek and the subsequent separation and disposal of the sediments and water. Hydraulic dredging technologies include the use of suction devices, cutterheads, and dustpans. These technologies would remove the sediments; however, they would be extremely difficult to implement because of the need for sedimentation basins and for disposal and treatment of the water. Also some dewatering of the channel may be required for complete containment of contaminated material.

5.4.4.3 Pneumatic Dredging

Pneumatic dredging technologies involve the use of air to induce an upward flow of air, water, and sediments. Pneumatic dredging technologies include the use of airlifts and oozers. Large amounts of water are removed from the stream along with the sediments. That water must then be treated or otherwise disposed.

5.4.5 IN SITU TREATMENT METHODS

The following assessment of in situ soil treatment technologies assumes that the process is implemented with no soil removal, other treatment, or containment technologies. This simplified overview is useful in determining if the technology has any application for the site. The determination of whether an in situ treatment technology would be functionally useful for actual site cleanup requires a further evaluation of how it can or cannot be effectively combined with other technologies. A preliminary assessment of these methods is presented in Table 5-8.

5.4.5.1 Hydrolysis

Hydrolysis is a chemical reaction in which water reacts with another substance to form two or more new substances. It involves the ionization of the water molecule as well as the splitting of the compound hydrolyzed. It is effective in degrading organic compounds, ionic salts, and organometallic compounds but is not an effective treatment for metals. In addition, some type of catalyst or heat addition is required for many of the desired reactions. Since metals are a problem at Western Processing this technology may not be effective.

5.4.5.2 Oxidation

Oxidation involves the transfer of electrons from contaminant compounds to desired oxidizing agents. Cyanide and organic compounds such as phenols, alcohols, and pesticides can be oxidized. Ozone, hydrogen peroxide, and chlorine are

Table 5-8
PRELIMINARY ASSESSMENT OF IN SITU TREATMENT TECHNOLOGIES

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Cost (see comment c.)	Comments
Hydrolysis	--	--		a. Very difficult to implement without heat or catalysis; ineffective in treating metals. b. May result in hazardous side reactions. May worsen existing ground-water contamination problem.
Oxidation	-	--		a. Very difficult to implement on a heterogeneous system. b. May result in hazardous side reactions.
Vitrification	--			a. Technology is still developmental. It has not been demonstrated on a field-scale operation.
Reduction	-	--		a. Very difficult to implement on a heterogeneous system. b. May result in hazardous side reactions.
Soil Aeration	-	--		a. Very difficult to implement on deep subsurface contamination. b. May worsen air pollution problem. May result in a gas migration problem.
Solvent Flushing	--	-		a. Solvents may not leach through the entire zone of contamination. b. Technology may involve the use of potentially hazardous compounds. Hazardous solvents may actually contribute to the subsurface contamination problem.

Table 5-8
PRELIMINARY ASSESSMENT OF IN-SITU TREATMENT TECHNOLOGIES
(continued)

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Cost (see comment c.)	Comments
Neutralization	-	--		a. Very difficult to implement on a heterogeneous system. b. Involves the addition of potentially hazardous compounds to the zone of contamination.
Polymerization	--			a. Prohibitively difficult to implement on a heterogeneous, uncontrolled system.
Bioreclamation	--			a. High levels of heavy metal contamination make implementation of bioreclamation prohibitively difficult.
Permeable Treatment Beds	--			a. Technology requires shallow impermeable strata to be effective (not present at Western Processing).
Solidification	o	--		a. Long-term reliability has not been demonstrated for this application.

the major oxidizing agents used to treat waste. Oxidation is difficult to implement in the solid phase due to the need for the diffusion of the oxidizing agent.

5.4.5.3 Vitrification

In situ vitrification involves the melting of waste and soil in place to bind the waste in a glassy solid matrix. The melting is done by passing an electric current through the contaminated soils. Some organics would be destroyed by the high operating temperature. In situ vitrification, although still in development, is theoretically applicable to a wide range of soil contamination problems, including inorganic contamination. Control of air emissions and side reactions during the heating process may be a problem.

5.4.5.4 Reduction

Reduction involves the transfer of electrons from reducing agents to contaminant compounds. Reduction is most often used to convert hexavalent chromium to its trivalent form. Reduction is difficult to implement in the solid phase and is not compatible with oxidation processes that may be required to treat other site contaminants.

5.4.5.5 Soil Aeration

Soil aeration involves the "saturation" of soil with air or some similar gas. It is generally used for surface or near-surface applications. It is difficult to aerate subsurface soils. Soil aeration is very effective treatment for volatile organic contamination but is not applicable for other types of contamination.

5.4.5.6 Solvent Flushing

Solvent flushing involves the use of a solvent to leach contaminants from an unsaturated zone. The elutriate is then gathered by wells or well points and the hazardous constituents are treated and/or disposed. Typical solvents used are water, acids, ammonia, and chelating agents. In situ solvent extraction of hazardous wastes has not been demonstrated. In addition, solvent flushing is difficult to implement on nonhomogeneous wastes. Total containment of the solvent waste stream would be extremely difficult. The chemistry of the process in soil is not completely understood or predictable. Flushing times can vary depending on the pollutant being flushed. The metals at Western Processing would require long flushing times. Flushing has the potential to mobilize contaminants that would otherwise be bound to the soils. For these less mobile contaminants capture must be complete to mitigate potentially adverse environmental and public health impacts.

5.4.5.7 Neutralization

Neutralization is a process used to adjust the pH of a waste stream. It is accomplished by adding acidic material to alkaline wastes and alkaline material to acidic wastes. Neutralization techniques are often used to allow the use of other treatment technologies. The technology is an applicable treatment for areas of extreme pH, but would be difficult to implement on in situ soils.

5.4.5.8 Polymerization

Polymerization involves the conversion of hazardous monomer compounds to nonhazardous and stable polymers. Polymerization is applicable to many organic compounds; however, each compound requires a different and rather refined polymerizing technique. Polymerization is not an applicable treatment for inorganic contamination, and therefore is not applicable to many of the contaminants found at Western Processing.

5.4.5.9 Bioreclamation

Bioreclamation involves the use of microoganisms for in situ treatment of waste material. The microorganisms break down compounds via metabolic activity. Bioreclamation can be effective in treating a wide range of organic contamination but is ineffective in treating inorganic contamination. The microorganisms must be adapted for specific contaminants by pilot-scale testing. Bioreclamation is very difficult to apply to deep subsurface contamination or multi-compound contamination.

5.4.5.10 Permeable Treatment Beds

Permeable treatment beds involve the use of trenches filled with a reactive permeable medium to act as an underground reactor. They are used to treat contaminated groundwater or leachate via the precipitation process. Permeable treatment beds are applicable in relatively shallow aquifers, since the trench must be constructed down to an impermeable layer.

The materials used in permeable bed reactors include:

- Limestone or crushed shell for metals removal
- Activated carbon for nonpolar organics removal
- Alauconitic green sand for heavy metals removal
- Zeolites and synthetic ion exchange resins to remove solubilized heavy metals
- Sodium hypochlorite to remove cyanide

Because of the varied nature of the contaminants found at Western Processing and the depth to an impermeable layer, it would be extremely difficult to employ this technology effectively.

5.4.5.11 Solidification/Stabilization

Stabilization is the use of chemical fixants to physically stabilize contaminated soils. The chemical fixants are applied through probes that can be drilled up to 45 feet into the soil. Few chemical stabilizations have been done and the technology is unproven. Solidification involves the use of materials to absorb liquid and/or to solidify the matrix. For both stabilization and solidification, testing must be done to determine the leachability of the final product.

5.4.6 TREATMENT OF AQUEOUS AND LIQUID WASTE STREAMS

The assessment of the following treatment technologies assumes that no response actions other than capping and groundwater pumping are employed. Individual treatment technology assessments are based on how well the technologies remove the specific contaminants for which they are designed and on whether they interfere with the implementation of any other technology (see Table 5-9).

5.4.6.1 Aerobic Biological Treatment Systems

Biological treatment systems are usually classified on the basis of whether they are aerobic or anaerobic. By definition, aerobic treatment systems require air to function while anaerobic treatment systems function in the absence of air.

Aerobic treatment systems include the following technologies:

- Activated sludge
- Trickling filters
- Aerated lagoons
- Waste stabilization ponds (both aerobic and anaerobic)
- Rotating biological discs
- Fluidized bed bioreactors (may be aerobic or anaerobic)

Table 5-9
PRELIMINARY ASSESSMENT OF GROUNDWATER TREATMENT TECHNOLOGIES

	Evaluation				
Technology	Technical (see comment a.)	Environmental, Public Health, and Institutional (see comment b.)	Operating Cost (see comment c.)	Capital Cost (see comment c.)	Comments
Aerobic Treatment Systems					
Activated Sludge	+	+	+	-	a. Well proven technology. b. Removes many toxic compounds. c. Low operating, high capital cost.
Trickling Filters	o	o	+	-	c. Low operating, high capital cost.
Aerated Lagoon	-	-	+	-	a. Requires operating area larger than site. b. Large, open area of hazardous materials during operation. c. High capital, low operating costs.
Waste Stablization Ponds	-	-	+	-	Same comments as for aerated lagoons.
Rotating Biological Discs	-	+	+	-	a. Historically has had operating difficulties. b. Process is self-contained. Removes most organics. c. Low operating, high capital costs.
Fluidized Bed Bioreactors	o	+	+	-	Same considerations as for rotating biological discs.

Table 5-9
PRELIMINARY ASSESSMENT OF GROUNDWATER TREATMENT TECHNOLOGIES
(continued)

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Operating Cost (see comment c.)	Evaluation: Capital Cost (see comment c.)	Comments
Anaerobic Treatment Systems	--	o	-	-	a. Very sensitive to heavy metals. c. High capital, high energy costs.
Chemical Treatment Techniques					
Neutralization	++	o	o	o	a. Relatively easy to implement. Well proven technology.
Precipitation	++	o	+	-	a. Well proven for the removal of heavy metals. c. High capital, low operating costs.
Cyanide Oxidation	++	+	-	+	a. Well proven for the removal of cyanide. b. Destroys hazardous material. c. Low capital, high operating costs.
Organic Chemical Oxidation	+	+	-	+	a. Well proven for the removal of some organics. b. Destroys hazardous material. c. Low capital, high operating costs.
Hydrolysis	--				a. Beneficial reactions would have already occurred in aqueous environment.

Table 5-9
PRELIMINARY ASSESSMENT OF GROUNDWATER TREATMENT TECHNOLOGIES
(continued)

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Operating Cost (see comment c.)	Evaluation: Capital Cost (see comment c.)	Comments
Reduction	++	+	-	+	a. Best way to destroy hexavalent chrome. b. Trivalent chrome less toxic than hexavalent chrome. c. Low capital, high operating costs.
Organic Chemical Dechlorination	+	+	-	+	a. Easy to implement. Required for cyanide oxidation process. b. Degrades chlorinated organic compounds. c. Low capital, high operating costs.
Molecular Chlorine Removal	+	o	-	+	a. Easy to implement. Required for some cyanide oxidation processes. c. Low capital, high operating costs.
Flow Equalization	++	o	+	o	a. Easy to implement. Required for many processes. c. Low maintenance costs.
Coagulation/ Flocculation	--				a. No suspended solids in groundwater. Technology is not directly applicable.

Table 5-9
PRELIMINARY ASSESSMENT OF GROUNDWATER TREATMENT TECHNOLOGIES
(continued)

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Operating Cost (see comment c.)	Evaluation: Capital Cost (see comment c.)	Comments
Sedimentation	--				a. Technology is not applicable for Western Processing site problems. NOTE: Both sedimentation and flocculation are used as part of precipitation technology.
Activated Carbon	++	o	-	o	a. Removes most organic compounds. c. Uses large amounts of carbon.
Ion Exchange	++	o	-	o	a. Effectively removes metals and boron. c. Expensive to regenerate ion exchange resin.
Membrane Processes					
Reverse Osmosis	o	o	-	-	c. Expensive equipment needed. Process is power intensive.
Electrodialysis	o	o	-	-	c. Expensive equipment. Process is power intensive.
Ultrafiltration	o	o	o	-	c. Expensive equipment.

Table 5-9
PRELIMINARY ASSESSMENT OF GROUNDWATER TREATMENT TECHNOLOGIES
(continued)

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Operating Cost (see comment c.)	Evaluation: Capital Cost (see comment c.)	Comments
Liquid/Liquid Extraction	-	-	-	-	a. Organics concentration too low for efficient operation. b. Process uses potentially hazardous solvents. c. Requires expensive equipment and uses large amounts of chemicals.
Oil-Water Separator	--				a. No free oil expected. Technology is not applicable for site problems.
Filtration	-	o	+	o	a. No suspended solids in groundwater. Technology is not directly applicable. Required as pretreatment. c. Very low operating costs.
Air Stripping	++	-	+	o	a. Simple to implement. Removes volatile organic compounds. b. May cause air pollution problems in immediate area. c. Low operating costs.

Table 5-9
PRELIMINARY ASSESSMENT OF GROUNDWATER TREATMENT TECHNOLOGIES
(continued)

	Evaluation				
Technology	Technical (see comment a.)	Environmental, Public Health, and Institutional (see comment b.)	Operating Cost (see comment c.)	Capital Cost (see comment c.)	Comments
Steam Stripping	+	-	-	o	a. Readily implementable. Removes volatile organic compounds. b. May cause air pollution problems in immediate area. c. High operating costs.
Dissolved Air Flotation	--				a. Not applicable for Western Processing site problems.
Offsite Treatment at a Commercial Facility	-	o	-	o	a. Nearby facilities may require modifications to handle contaminants. c. User fees at commercial facilities are usually very high.

Aerobic treatment systems remove biodegradable organic compounds, bioadsorb a limited amount of metals and nondegradable organic compounds, and oxidize reduced compounds. Aerobic treatment systems produce sludge that may still contain hazardous constituents. High levels of metals or volatile organic compounds could disrupt the entire process. Each of the aerobic biological processes will perform generally the same functions; however, each process may be more or less efficient for a particular application.

5.4.6.1.1 Activated Sludge

This technology is an effective way to remove most toxic organic compounds. Water containing extremely high levels of metals may require pretreatment before activated sludge is used. The sludge would probably require disposal as hazardous waste.

5.4.6.1.2 Trickling Filters

Trickling filters are columns packed with media which, like activated sludge, remove organic compounds. They will often have lower removal efficiencies, however, and be more prone to nonuniform loading.

5.4.6.1.3 Aerated Lagoons

Aerated lagoons are large complete-mix basins in which organic wastes are biodegraded by organisms as in an activated sludge system. The large basin volume helps to dampen feedstream variations. The lagoons requires a very large land area.

5.4.6.1.4 Waste Stabilization Ponds

Waste stabilization ponds are similar to aerated lagoons except that air is not artificially diffused. Waste stabilization ponds require the largest land area of any of the biological systems.

5.4.6.1.5 Rotating Biological Disks

The rotating biological disk technology treats organic wastes by fixed-film biological growth. The biological mass is contained on a series of disks. These disks are partially immersed in a tank containing the waste material. The disks are then rotated, providing alternate immersion and aeration. As with most biological treatment processes, this technology is more effective in treating organics than inorganics, but it is the most sensitive to feedstream variations.

5.4.6.1.6 Fluidized Bed Bioreactors

This technology implements the processes of biological treatment by using a fluidized bed reactor. A fluidized bed reactor is a solid phase reactor. The reactor medium is usually some type of finely powdered or granular material. Air or water is passed through the reactor medium, creating a fluidized effect. As with most biological treatment processes, fluidized bed bioreactors are more effective treating organic contamination than inorganic contamination.

5.4.6.2 Anaerobic Biological Treatment Systems

Anaerobic treatment systems remove organic compounds by bacterial conversion to carbon dioxide, methane, and sometimes hydrogen sulfide. Anaerobic treatment systems will destroy biodegradable compounds. The methane gas produced can be recovered for useful applications. Most anaerobic systems are very sensitive to heavy metals. Anaerobic degradation may be occurring at Western Processing. However, the heterogeneous nature of the contamination at Western Processing, the high concentrations of heavy metals in the groundwater, and the probably low concentration of biodegradable organics would make the implementation of an anaerobic biological treatment system very difficult.

5.4.6.3 Neutralization

Neutralization is used to treat waste streams that are alkaline or acidic in order to meet pH discharge standards. Neutralization is often used in conjunction with other treatment technologies as a pre-treatment or post-treatment remedial action. Neutralization is implemented by adding acidic reagents to alkaline streams or by adding alkaline reagents to acidic streams.

5.4.6.4 Precipitation

Precipitation is a technology by which the chemical equilibrium of a waste stream is altered to reduce the solubility of undesirable components. These materials precipitate out as a solid phase and are removed by solids removal processes. Precipitation is often used to remove heavy metals from water. It is assumed that the precipitation technology includes both coagulation/flocculation and sedimentation functions.

5.4.6.5 Cyanide Oxidation

Cyanide oxidation is usually implemented via chlorination. Chlorine and a caustic are added to the cyanide-contaminated waste stream, producing first the less toxic cyanate ion and then nontoxic bicarbonates and nitrogen. If organics are present in the waste stream, potentially hazardous chlorinated organics may be produced.

Another method for achieving cyanide oxidation is ultraviolet/ozonation. Ozone is a powerful oxidizing agent and it breaks down many refractory organic compounds not treatable with biological treatment technologies. Ozone reacts with oxidizable materials present in the waste stream. To ensure adequate reaction time, large vessels called contactors are required for the ozonation process. Ultraviolet radiation enhances the destructive power of the ozone.

5.4.6.6 Organic Chemical Oxidation

Organic oxidation is often accomplished by using wet air oxidation (WAO). The WAO process is a liquid-phase combustion implemented through the addition of high-pressure air and sometimes a catalyst at elevated temperatures. The reaction products are steam, nitrogen gas, carbon dioxide, and an oxidized liquid waste stream. Supercritical water (water above its critical temperature and pressure) may also be used as an oxidizing agent.

Another form of organic oxidation is chemically induced oxidation, accomplished by adding an oxidizing agent to the waste stream. Commonly used chemical oxidants include hydrogen peroxide and potassium permanganate. Chemical oxidation is effective only if the reaction produces less hazardous constituents.

As with cyanide oxidation, ultraviolet/ozonation can also be used to achieve organic oxidation. Ozonation is an effective treatment for chlorinated hydrocarbons, alcohols, chlorinated aromatics, and pesticides, as well as cyanides.

5.4.6.7 Hydrolysis

Hydrolysis is a chemical reaction in which water reacts with another substance to form two or more new substances. The reaction involves the ionization of the water molecule as well as the splitting of the hydrolyzed compound. Hydrolysis reactions may have been occurring naturally at Western Processing and catalysis would be required to increase the reaction rate above what is naturally occurring.

5.4.6.8 Reduction

Reduction involves the transfer of electrons from reducing agents to contaminant compounds. Reduction is most often used to convert hexavalent chromium to its less toxic trivalent form. Chrome reduction is effected by adding a reducing agent to the waste stream under highly acidic conditions. The trivalent chromium is then removed by precipitation.

5.4.6.9 Organic Chemical Dechlorination

Organic chemical dechlorination involves the degradation of chlorinated organic compounds by breaking the carbon-chlorine bond. Ultraviolet/ozonation is a method that has been used to degrade chlorinated hydrocarbons and chlorinated aromatics through oxidation.

5.4.6.10 Molecular Chlorine Removal

Molecular chlorine removal involves the use of sulfur dioxide gas or activated carbon to remove chlorine from a waste stream. It may be necessary to implement this technology if cyanide removal via chlorination is used.

5.4.6.11 Flow Equalization

Flow equalization involves the use of basins or tanks to control and lessen flow and concentration fluctuation. The technology is used as a pretreatment operation for many biological, chemical, and physical treatment processes. Flow equalization can be implemented as in-line equalization, or as off-line equalization, in which only the flow above a specified amount is diverted to the equalization area and is fed back into the main stream at low flow.

5.4.6.12 Coagulation/Flocculation

Coagulation/flocculation involves the combination of suspended particles to form small clumps of solid matter. It is promoted by gentle stirring with slow-moving paddles. The technology may be used as part of a precipitation process to remove sludges after treatment but will not be used by itself because of the apparent absence of suspended solids in the Western Processing groundwater.

5.4.6.13 Sedimentation

Sedimentation is the settling out by gravity of solids particles suspended in a liquid. It is generally used with precipitation and flocculation as a post-treatment operation and will not be used as a main treatment process at Western Processing.

5.4.6.14 Activated Carbon

Activated carbon is used in the granular or powdered form to remove contaminants from aqueous wastes via carbon adsorption. The technology is primarily used to remove those organic compounds that are not treatable by biological treatment. Activated carbon is often used to protect biological treatment systems from being overloaded with toxic contamination.

5.4.6.15 Ion Exchange

The ion exchange technology can be used to remove soluble metallic elements; anions such as halides, cyanides, and nitrates; and carboxylic acids, sulfonic acids, and some phenols at alkaline pH. Ion exchange involves the use of insoluble resins capable of promoting a reversible interchange of ions with species in the waste stream. Periodically, the ion exchange resins must be regenerated to maintain the system capacity and effectiveness.

5.4.6.16 Membrane Processes

Membrane processes involve the use of semi-permeable membranes to remove contaminants from aqueous waste streams. Relatively clean product water is produced, leaving behind a more concentrated waste stream equal to 10 to 50 percent of the original volume which requires further treatment or disposal. Membrane processes are highly susceptible to fouling and often require extensive pretreatment, even with wastes that are relatively low in contaminants. Membrane processes in use today include reverse osmosis, electrodialysis, and ultrafiltration.

5.4.6.16.1 Reverse Osmosis

Reverse osmosis is accomplished by passing the waste stream through a semi-permeable membrane at high pressure. Typical membranes are impermeable to most inorganic and some organic compounds.

5.4.6.16.2 Electrodialysis

Electrodialysis is accomplished by using an electric current to aid in the separation of substances that ionize in solution. Semi-permeable membranes are placed between electrodes to isolate and separate constituents as anions (-) or cations (+). Electrodialysis is generally effective for most inorganic species, but does not remove organics. Organics may in fact degrade the electrodialysis membranes.

5.4.6.16.3 Ultrafiltration

Ultrafiltration involves the use of microscopic filters to remove wastes from aqueous streams. The technology is generally effective at removing all suspended solids and some dissolved molecules with a molecular weight greater than 1,000.

5.4.6.17 Liquid/Liquid Extraction

The liquid/liquid extraction technology involves the use of a solvent to extract contaminants from the aqueous phase. The solvent is vigorously mixed with the aqueous phase, removing certain contaminants. The solvent phase is then allowed to separate from the aqueous phase and is treated or disposed of. The technology requires the use of potentially hazardous solvents and the disposal of the hazardous solvent phase effluent.

5.4.6.18 Oil-Water Separation

Oil-water separation technology is used to remove free oil from water. No free oil has been found in the groundwater under and near the Western Processing site, so this technology was eliminated from further consideration.

5.4.6.19 Air Stripping

Air stripping removes volatile organic compounds from aqueous waste streams. It is effected through the use of a stripping tower. The aqueous waste stream is pumped into the top of the tower and allowed to cascade down. Air is forced up the tower from the bottom. The air removes the volatiles from the waste stream. It may be necessary to use an emission control device to prevent the development of an air pollution problem at the site.

5.4.6.20 Steam Stripping

Steam stripping is similar to air stripping except that steam acts as the stripping agent. Steam stripping removes a wider range of compounds than are ordinarily removed by air stripping, including those that are less volatile. Steam stripping is very energy-intensive because of the high steam usage.

5.4.6.21 Filtration

Filtration is a physical method for separating suspended solids from liquids but is not effective for the removal of dissolved solids. It could be used as a pre-treatment and post-treatment operation for many of the other treatment technologies.

5.4.6.22 Dissolved Air Flotation

Dissolved air flotation removes insoluble hazardous components from an aqueous phase. Since suspended solids do not seem to be a problem at Western Processing, the technology was eliminated from further consideration.

5.4.6.23 Offsite Treatment at a Commercial Facility

An alternative to constructing an onsite treatment plant would be to transport the contaminated groundwater to a commercial treatment facility. There are commercial treatment facilities in the region that have indicated that they are interested in treated contaminated water from Western

Processing. The transport and treatment costs of the large quantities of water needing treatment would have to be evaluated against the costs of onsite treatment.

5.4.7 DISPOSAL OF GROUNDWATER

The following groundwater disposal technology assessments assume that no other remedial action except groundwater pumping and treatment will be used. The amount of groundwater treatment necessary for a particular groundwater disposal technology is considered during the technical assessment. The preliminary assessments of groundwater disposal technologies are shown in Table 5-10.

5.4.7.1 Discharge to a Publicly Owned Treatment Works

This technology would be implemented by discharging the groundwater pumped from under the Western Processing site into the Metro sewage system. High levels of contamination make this response action institutionally unacceptable without preliminary groundwater treatment. In addition, Metro will impose a limit on the quantity of discharge.

5.4.7.2 Discharge to Mill Creek

This technology involves the discharge of groundwater into Mill Creek under an NPDES permit. High levels of contamination make this response action institutionally unacceptable in the absence of groundwater treatment. The treatment requirements for the NPDES discharge permit are generally more stringent than the requirements for a Metro discharge permit.

5.4.7.3 Discharge to the Green River

This technology involves the discharge of groundwater into the Green River under an NPDES permit. High levels of contamination make this option institutionally unacceptable in the absence of groundwater treatment. This option offers greater flexibility over discharge to Mill Creek because of the larger size and flow of the Green River; however, the water must be pumped one to 1-1/2 miles from the site to the Green River.

5.4.7.4 Spray Irrigation

This technology involves the use of treated groundwater to irrigate fields in the surrounding area. The wet climate in the Puget Sound area makes this technology virtually infeasible.

Table 5-10
PRELIMINARY ASSESSMENT OF GROUNDWATER DISPOSAL TECHNOLOGIES

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Cost (see comment c.)	Comments
Discharge to a Publicly Owned Treatment Works	+	-	+	a. Easy to implement. Requires less pretreatment than other technologies. b. Requires permitting to implement. c. Must pay user fees.
Discharge to Mill Creek Under an NPDES Permit	--	-	--	a. Must meet stringent discharge criteria. b. Requires permitting to implement. c. No user fees required.
Discharge to Green River Under an NPDES Permit	--	-	o	a. Must meet stringent discharge criteria. Must pump water from site to Green River. b. Requires permitting to implement.
Spray Irrigation	--			a. Not feasible due to wet climate.
Shallow Reinjection	--	--	o	a. Similar effluent criteria as discharge to Mill Creek. b. Effects on local groundwater system need evaluation; permits could be required.

5.4.7.5 Shallow Reinjection

This technology involves the reinjection of treated groundwater into the shallow aquifer. The desirability of this technology would depend on whether the shallow aquifer required recharge during groundwater pumping. Reinjection would replace the pumped groundwater with higher quality water and would minimize drawdown of the water table. Even with a high degree of water treatment there are strong institutional objections to reinjection.

5.4.8 DISPOSAL OF EXCAVATED SOIL

The following soil disposal technology assessment assumes that no other remedial action except soil excavation will be taken (see Table 5-11).

5.4.8.1 Landfill Disposal at an Offsite Facility.

This technology involves the transportation and disposal of hazardous wastes at a RCRA-permitted and -compliant hazardous waste landfill. The hazardous materials are not removed from the environment, only transferred to a more controlled situation. There is a slight environmental risk involved in the transport of the hazardous materials.

5.4.8.2 Construction of an Onsite Landfill

This technology involves the construction of an onsite, secure hazardous waste landfill. Hazardous material is excavated and clean backfill imported and placed so that the bottom liner of the landfill can be located above the seasonal high water table. A bottom liner is then installed according to the latest available technologies. A leachate detection system is installed between the liners and a leachate collection system installed above the top liner. The landfill would also include a gas venting system and a secure impermeable cover. The hazardous materials remain onsite, but in a more controlled situation.

5.4.8.3 Incineration at an Offsite Facility

This technology involves the destruction by incineration of the soil-contaminant matrix at an approved offsite hazardous waste incinerator. Incineration will destroy all forms of soil contamination with the exception of heavy metals. Incineration may not render the soil-contaminant matrix nonhazardous and that material may still require disposal at a hazardous waste disposal facility.

5.4.9 SUMMARY OF PRELIMINARY TECHNOLOGY ASSESSMENT

A technology is considered to have passed through the preliminary assessment procedure if it did not receive a double negative (--) mark in any of the assessment categories. The

Table 5-11
PRELIMINARY ASSESSMENT OF SOIL DISPOSAL TECHNOLOGIES

Technology	Evaluation: Technical (see comment a.)	Evaluation: Environmental, Public Health, and Institutional (see comment b.)	Evaluation: Cost (see comment c.)	Comments
Offsite Landfill	+	-	o	a. Materials present at Western Processing are eligible for landfill disposal. b. Suitable capacity must be available to implement. Does not remove hazardous material from environment. c. Disposal costs are a function of market conditions.
Onsite Landfill	-	-	-	a. Construction of onsite landfill is difficult and lengthy. Requires extensive monitoring for many years. b. Does not remove hazardous material from environment. c. Costs less than offsite landfill disposal for large volumes of material.
Offsite Incineration	-	+	-	a. Heavy metals are not destroyed. Some licensed incinerators may not accept due to heavy metal content. b. Destroys some types of contamination. c. Costs more than landfill disposal.

preliminary assessment procedure is designed only to screen out those technologies that appear to be infeasible for the Western Processing site. The screened technologies generated from this chapter may be used in example remedial action alternatives. In developing the example remedial action alternatives, no attempt will be made to incorporate all possible technologies. Detailed design work may indicate that technologies that passed preliminary assessment but were not used in an example alternative may have technical, environmental/institutional, or cost benefits greater than the benefits of those technologies used in the example alternatives. Table 5-12 is a list of all technologies that have passed the preliminary assessment.

Table 5-12
TECHNOLOGIES AVAILABLE FOR USE IN EXAMPLE REMEDIAL ACTION ALTERNATIVES

A. Surface Caps

- o Sprayed asphalt
- o Portland cement concrete
- o Bituminous concrete (asphalt)
- o Gravel over geotextile over clay
- o Loam over synthetic membrane over sand
- o Loam over clay
- o Loam over sand over synthetic membrane over clay (RCRA Cap)

B. Mill Creek Diversion

- o Piped gravity bypass
- o Ditches and trenches (new channel)
- o Pump and pipe system with diversion dam.

C. Groundwater Containment or Diversion Barriers

- o Soil-bentonite slurry wall
- o Cement-bentonite slurry wall
- o Grout curtain

D. Groundwater Pumping

- o Well points
  - Suction pump system
  - Jet ejector pump system
  - Submersible pump system
- o Deep wells

E. Soil Excavation

F. Sediment Removal

- o Mechanical dredging

G. Groundwater Treatment

- o Aerobic treatment systems
  - Activated sludge
  - Trickling filters
  - Aerated lagoon
  - Waste stabilization ponds
  - Rotating biological discs
  - Fluidized bed bioreactors

Table 5-12
(continued)

- o Neutralization
- o Precipitation
- o Cyanide oxidation
- o Organic chemical oxidation
- o Reduction
- o Organic chemical dechlorination
- o Molecular chlorine removal
- o Flow equalization
- o Activated carbon
- o Ion exchange
- o Membrane processes
  - Reverse osmosis
  - Electrodialysis
  - Ultrafiltration
- o Liquid/liquid extraction
- o Filtration
- o Air stripping
- o Steam stripping
- o Offsite treatment at a commercial facility

Groundwater Disposal

- o Discharge to a publicly owned treatment works (Metro)
- o Discharge to Mill Creek
- o Discharge to the Green River
- o Shallow reinjection

Table 5-12
(continued)

Soil Disposal

- Offsite landfill
- Onsite landfill
- Offsite incineration

Chapter 6
EXAMPLE REMEDIAL ACTION ALTERNATIVES

6.1 INTRODUCTION

This chapter presents the description and detailed analysis of example remedial action alternatives for Western Processing. The example alternatives were developed using Chapter 3--Nature and Extent of Contamination, Chapter 4--Endangerment Assessment, and Chapter 5--Remedial Action Technologies.

The purpose of this chapter is to present a range of example alternatives available to mitigate present and potential future problems arising from contamination at Western Processing. The example alternatives presented here are not intended to describe the only alternatives that could be implemented at Western Processing or to describe a preferred alternative or a final design. Additional example alternatives can be developed using data contained in this report. The range of alternatives facilitates comparison of the relative benefits and adverse impacts of each alternative. Example Alternative 4 was developed and evaluated by the Potentially Responsible Parties (PRP's).

Six remedial action components were defined and analyzed as the first step in the development of the example alternatives. The six components were excavation, capping, containment or diversion barriers, groundwater extraction and treatment, Mill Creek remedial action, and monitoring. These components are discussed below in Section 6.2. On the basis of the component analysis, four source control alternatives and two migration management (Mill Creek) alternatives were then developed. These example alternatives and the PRP remedial action plan are described in Section 6.3. A detailed discussion of the example alternatives covering technical evaluation, environmental and public health assessments, institutional requirements, and cost estimates is presented in Section 6.4. Summary tables comparing the example alternatives are presented in Section 6.5.

The example alternatives presented in this chapter (except the no-action alternatives) are effective in reducing risks to public health and the environment. A major difference is the length of time necessary to achieve the remedy. A 30-year period has been used as a reference time for comparing the relative effectiveness of the example alternatives. Performance beyond 30 years is discussed for those alternatives that would not achieve criteria by that time.

6.2 COMPONENT ANALYSIS

Contaminants at Western Processing can be released via three primary pathways: air, surface water, and groundwater.

Contaminants will follow one or more of these pathways. Contaminants may migrate at different rates along each pathway or at different rates relative to other contaminants. The contaminants will also present different potentials for environmental harm or human endangerment depending on their concentrations, the pathway followed, and the level at which toxic or carcinogenic effects could occur.

Contamination released from the Western Processing site into groundwater discharges to Mill Creek and the east drain. The potential for human exposure to contaminated groundwater is currently remote because the contaminated zone is relatively small and is almost completely isolated by discharge to Mill Creek and the east drain. There are also no potable water wells on or in the immediate vicinity of the site. The potential for human ingestion of contaminants in Mill Creek is similarly remote because the creek and other downstream waters are not sources of potable water. Exposure would be limited to potential recreational contact or to ingestion of potentially contaminated aquatic organisms.

Aquatic organisms in the creek downstream of the location of the old sanitary discharge line would be exposed to both chronic and acute toxic levels of certain contaminants discharging into the creek from the site via groundwater. This situation is expected to continue for the foreseeable future unless additional remedial activities, such as those described in this chapter, are implemented.

An evaluation of contaminant release and exposure potential at Western Processing has led to the identification of remedial action technologies (Chapter 5). These technologies have led in turn to the identification of six remedial action components that could be used to eliminate or mitigate these conditions. The six components are excavation, capping, containment or diversion barriers, groundwater extraction and treatment, Mill Creek remedial action, and monitoring.

The purpose of the following component analyses is to present the objectives of the individual components, discuss in general terms their merits, and discuss their relationship to the other components.

6.2.1 EXCAVATION

Soil excavation can accomplish several objectives. It can reduce the source of groundwater and surface water contamination, reduce the potential for direct contact with the contaminated soils by humans or animals, and reduce the need for or extent of other remedial action components.

6.2.1.1 Discussion

The endangerment assessment examined the excess cancer risk associated with exposure to carcinogens based upon the ingestion of on-property soils and examined the comparison between the predicted daily doses of non-carcinogens and their acceptable daily intake (ADI) for a number of scenarios. A detailed discussion of the results is presented in Chapter 4. The major results can be summarized as follows:

- For the worker scenario, ingestion of Area I soils is estimated to lead to a maximum excess lifetime cancer risk of 2×10^{-6} for surface soils and 2×10^{-4} for soil at depths up to 12 feet.

- For the residential scenario, ingestion of Area I soils is estimated to lead to a maximum excess lifetime cancer risk of 2×10^{-4} for surface soils and 8×10^{-3} for soils at depth.

- All off-property areas showed a lower than 2×10^{-3} excess lifetime cancer risk.

- For non-carcinogens, the predicted daily doses of chromium (assuming that all chromium is in the hexavalent state) and lead exceed their ADI's for the ingestion of Area I soils. For off-property contamination, only Area VIII exceeds the ADI for any non-carcinogen. The one ADI exceeded in Area VIII is for lead.

In addition to present endangerment, the potential also exists for continuing environmental degradation due to soil contamination. In the absence of remedial action, soil contaminants could be transported to adjacent properties and surface water via surface runoff and lead to further environmental degradation. In addition, soil contaminants in the unsaturated zone would continue to leach into shallow groundwater thus adding to the contaminant mass already migrating to and adversely affecting Mill Creek and the east drain. Leaching and groundwater migration are major causes of continued environmental degradation. A discussion of the interaction between Mill Creek and the local groundwater flow system is presented in Chapter 3.

The nature and extent of soil contamination are summarized in Chapter 3 and Appendix F. Area I soils generally have high levels of metal contaminants to depths of 15 feet or less compared to near-surface soil background concentrations. Area I organics were also found in high concentrations to 15 feet, with a few to over 30 feet. Approximately 95 percent of the Area I contamination is in the upper 15 feet. The contaminant levels in off-property soils were highest in Areas II, V, VI, VIII, and IX. The contaminants detected in Areas II, V, and IX probably came from Western Processing. Contaminants in Area VI cannot be attributed to Western Processing because a well-defined migration pathway has not been established. Contamination in Area VIII appears to be confined to metals in the surface soil based on the limited data available. Area VIII contamination may be attributed to wind-blown dust from the South 196th Street roadway or incidental spillage from truck traffic.

Table 6-1 shows the average soil concentrations of several metals remaining after excavation to selected depths in Areas I, II, V, and IX. These analyses are based on data presented in Chapter 3 and include samples taken from soils that have already been removed from the site. Table 6-2 shows the average remaining soil concentrations of several organic compounds with no excavation and after excavation to 15 feet for the same areas.

A 15-foot excavation in Areas I and II would lower the site average concentration of all indicator metals except zinc to below background levels and would greatly reduce or eliminate organic contaminants. Areas V and IX would require less extensive excavations to reach background for metals. A 15-foot excavation in Areas I and II and a 3-foot excavation in Areas V and IX would remove about 95 percent of the mass of all contamination in these areas. A 6-foot excavation in Areas I and II combined with a 3-foot excavation in Areas V and IX would remove about 60 percent of the contamination in these areas.

The area average concentrations presented in Appendix F have been used in this feasibility study to define contaminant levels. The averaging process can mask small horizontal and vertical zones of high contaminant levels (hot spots). If excavation is part of the selected remedial action, optimization based on the three dimensional distribution of contaminants should be done prior to final design.

6.2.1.2 Relationship to Other Components

Both excavation and capping can reduce the potential for human and animal exposure to contaminated soils. Both can also reduce the contaminant mass released to the shallow groundwater, which in turn reduces or prevents further environmental degradation. Excavation directly reduces the contaminant mass, while capping reduces infiltration that leaches contaminants from the unsaturated zone soils.

Excavation and capping can enhance the performance of diversion barriers and groundwater extraction by increasing their efficiency and/or shortening the time of active remedial action.

6.2.1.3 Cost Considerations

The principal variables affecting excavation costs are disposal method and excavation depth. For disposal of excavated materials offsite in a double-lined, RCRA regulated

Table 6-1
SITE AVERAGE METALS CONCENTRATIONS REMAINING IN SOIL
BY AREA AT SELECTED DEPTHS

Area	Excavation Depth (feet)	Site Average Concentrations Remaining in Soil (μg/kg)						
		Cd	Cr	Cu	Ni	Pb	Zn	As
I/II	0	15,900	313,000	177,000	54,300	2,420,000	1,620,000	5,000
	3	14,500	311,000	166,000	48,100	1,900,000	1,130,000	4,750
	6	12,700	275,000	144,000	38,400	968,000	844,000	4,160
	9	8,810	187,000	107,000	25,800	325,000	616,000	4,080
	12	4,240	102,000	64,000	18,200	105,000	392,000	4,180
	15	1,480	40,500	25,900	12,500	12,800	227,000	4,390
V	0	1,190	17,400	22,300	11,200	40,200	207,000	7,200
	3	580	13,100	20,700	10,400	13,400	94,500	7,050
	6	420	11,300	20,200	9,940	6,430	68,300	7,100
	9	330	10,400	20,000	9,600	6,200	63,300	7,300
	12	220	9,600	20,100	9,400	5,490	51,800	7,670
	15	200	8,950	20,600	9,460	2,380	32,000	8,130
IX	0	1,800	104,000	41,000	14,200	17,200	252,000	9,090
	3	1,500	84,400	36,800	13,000	11,700	230,000	8,760
	6	1,010	42,400	29,600	12,200	5,800	172,000	8,240
	9	640	17,700	24,500	11,600	2,580	120,000	7,640
	12	470	13,520	22,200	11,200	2,350	89,000	7,090
	15	410	12,100	21,400	10,900	2,180	63,900	6,600
Background at 95% Confidence Interval (μg/kg) (See Table 3-5)		2,900	40,000	73,000	43,000	76,000	109,000	10,600

Table 6-2
SITE AVERAGE ORGANIC CONCENTRATIONS REMAINING IN SOIL BY AREA AT SELECTED DEPTHS

Area	Excavation Depth (feet)	Site Average Concentration Remaining in Soil (μg/kg)								
		Chloroform	Ethylbenzene	Methylene Chloride	Phenol	Tetrachloro-ethene	Toluene	Trans 1,2-dichloroethane	1,1,1-Trichloro-ethane	Trichloro-ethene
I/II	0	270	465	950	3,000	601	3,870	170	1,200	9,100
	15	6	7	150	1,100	4	55	5	5	46
V	0	0	0	830	520	5	26	2	0	11
	15	0	0	1,600	0	1	37	3	0	6
IX	0	0	0	82	0	0	10	0	0	0
	15	0	0	68	0	0	18	0	0	1

Area	Excavation Depth (feet)	Site Average Concentration Remaining in Soil (μg/kg)						
		Benzo(a) anthracene	Bis(2-ethyl-hexyl)phthalate	Fluoranthene	Naphthalene	PCB	Phenanthrene	Pyrene
I/II	0	1,300	8,900	1,400	10,400	400	27,800	20,700
	15	0	360	0	11	0	0	0
V	0	0	0	1	0	25	1	1
	15	0	0	0	0	0	0	0
IX	0	2	180	1	1	270	0	1
	15	0	340	0	0	0	0	0

Note: Nondetects = 0 except for Area I/II volatiles where nondetects = detection limit.

hazardous waste landfill, costs were estimated to be $100 per ton. Transportation costs were estimated at $40 per ton to the nearer of the two existing Northwest hazardous waste disposal facilities. The cost for double-lined, offsite disposal is an estimate and could vary substantially from $100 per ton. Double-lined capacity is not currently in service at either of the Northwest facilities. It is estimated that this type of capacity will be available by mid-1985. The cost for double-lined disposal is approximately twice that for current disposal and significantly affects the costs for any alternatives involving disposal of materials in offsite hazardous waste disposal facilities.

Disposal costsfor a new, onsite hazardous waste landfill are discussed in Example Alternative 3. Onsite disposal has some practical limitations due to the size of the site and the shallow groundwater table. Based on the analyses in this report, onsite disposal costs for soil in the unsaturated zone are approximately $110 per ton.

Excavation costs at Western Processing, including shoring and a dewatering and treatment system where necessary, vary substantially depending on the excavation depth and its relation to the water table. For this study, excavation above the water table was estimated to cost approximately $13 per cubic yard. Excavation between water table and 25 feet below the ground surface (about 19 feet below the groundwater table) was estimated to cost $31 per cubic yard. Deeper excavations (to 50 feet) were estimated to cost approximately $42 per cubic yard.

All costs could vary depending on actual construction methods and unanticipated variations in site conditions. Factors not included in these unit costs are allowances for mobilization, contractor overhead, health and safety systems, engineering, and associated indirect costs and contingencies.

6.2.2 CAPPING

Surface caps can perform three major functions: (1) reduce infiltration that leaches contaminants from soils to groundwater; (2) eliminate direct contact between contaminated soils and stormwater and thus prevent contaminated runoff to adjacent surface water or soil; and (3) eliminate the potential for human or animal contact with contaminated surface soils.

6.2.2.1 Discussion

The nature and extent of soil contamination are summarized in Chapter 3. The areas of greatest concern are Areas I, II, V, and IX. Soils in these areas contain sufficient amounts of source contaminants to continue degrading the environment through leaching to groundwater and through surface water runoff. Ingestion of on-property surface soils leads to maximum excess lifetime cancer risks of 5×10^{-6} for the worker scenario and 2×10^{-4} for the residential scenario.

Installation of a surface cap is probably a minimum remedial response for the more contaminated areas. CERCLA compliance with the Resource Conservation and Recovery Act (RCRA) may require an impermeable multimedia cap or equivalent for those alternatives that do not remove all contaminants to <u>de minimus</u> (i.e., insignificant) or background levels.

The effectiveness of a cap depends on its intended purpose, the area capped, the type of cap used, construction techniques, and operation and maintenance procedures. If significant amounts of source contaminants remain in the soil above the water table, then the primary purpose of the cap would be to reduce water infiltration and leaching. A RCRA multimedia cap (soil over sand over a synthetic membrane over clay) would probably be the most effective cap for this purpose because it consists of two impermeable layers. The use of this type of cap, however, would prohibit future site development. If future site development is an important consideration, then an asphalt or concrete cap would be preferable. Because these caps are more permeable than RCRA caps, the amount of source contaminants remaining in the unsaturated zone becomes more important.

The caps discussed in this chapter effectively eliminate the potential for human or animal exposure to contaminated surface soils. They also effectively reduce the potential for contaminated surface water runoff.

6.2.2.2 Relationship to Other Components

Capping can reduce groundwater contamination by reducing infiltration and thus contaminant leaching to groundwater. It therefore may reduce the need for source reduction by excavation or groundwater extraction.

An effective cap would reduce the amount of contaminants entering the groundwater and hence improve diversion barrier performance or shorten the groundwater pumping time.

6.2.2.3 Cost Considerations

Preliminary costs were developed for multimedia (RCRA) and asphalt caps. The cost shown below for the asphalt cap is for flat coverage of the 503,000 square feet in Area I. The cost of the RCRA cap is based on the design described in the example alternatives. The cost of the RCRA cap includes stormwater control structures; the cost for the asphalt cap does not include stormwater control structures. These costs would increase if it were necessary to stockpile materials under a temporary cap or increase the area of the cap.

These costs do not include contingencies and indirect costs and should be used for comparison only.

RCRA CAP (MEMBRANE AND CLAY):
503,000 sq ft @ $5.70 = $2,867,000

ASPHALT CAP:
503,000 sq ft @ $1.20 = $604,000

6.2.3 CONTAINMENT AND DIVERSION BARRIERS

Containment barriers are subsurface structures commonly used with capping and/or groundwater pumping to isolate a contaminant source from local and regional groundwater flows.

Diversion barriers are subsurface structures that modify groundwater flow and associated contaminant migration but do not completely isolate the source. Their objective is to reduce the release of contaminants beyond the barrier.

6.2.3.1 Discussion

The purpose of complete containment is usually to prevent the continued migration of contaminated groundwater and to isolate the zone of contamination from the environment. To accomplish this, the barrier should completely surround the contamination zone and be extended into a relatively impermeable layer that underlies the entire contaminated area. An effective surface cap should also be provided. Soil or groundwater contamination left outside the perimeter of the containment barrier would remain uncontrolled and could continue to degrade the environment.

The shallowest impermeable layer at Western Processing is approximately 150 to 200 feet below the ground surface. Constructing a barrier to this depth is not possible using standard installation techniques.

A diversion barrier can reduce the amount of groundwater flowing into and out of a contaminated zone, thereby reducing the release of contaminants from the contaminated zone. The degree of reduction is related to the hydrogeologic characteristics of the site, the barrier depth, and the barrier orientation in relation to the local groundwater flow pattern. A diversion barrier does not need to reach an impermeable layer or totally surround the zone of contamination to be effective. At the Western Processing site, a diversion barrier could reduce the groundwater flow rate and thus the amount of contamination entering Mill Creek from the site.

Depending on the barrier depth, configuration, and length, the contaminants migrating from behind the barrier could follow the local groundwater flow pattern into Mill Creek, enter the regional flow pattern and be carried beneath the creek to more distant discharge locations such as the Green River, or follow both pathways.

6.2.3.2 Relationship to Other Components

A diversion barrier combined with a cap and/or excavation could reduce contamination potential by reducing or eliminating unsaturated zone leaching and by reducing contaminant transport beyond the barrier.

A diversion barrier combined with a groundwater extraction system within the barrier can increase the system's effectiveness by directing groundwater up through the contaminated zone and by reducing or eliminating lateral inflow of relatively uncontaminated water, particularly from Mill Creek. Groundwater contamination beyond the barrier would remain relatively unaffected.

6.2.3.3 Cost Considerations

Preliminary costs were developed for two depths of soil-bentonite barriers: 160 feet (the depth to a continuous impermeable layer based on data from well DB-1) and 50 feet. Both barriers were assumed to surround Area I (perimeter length, 3,300 feet). The costs presented below would increase if the containment barrier depth or length increases. The costs exclude contingencies and indirect costs.

50-FOOT DEPTH: 3,300 ft. @ $385 = $1,270,500
160-FOOT DEPTH: 3,300 ft. @ $2,640 = $8,712,000

6.2.4 GROUNDWATER EXTRACTION AND TREATMENT

The objectives of groundwater extraction are to reduce or eliminate contaminant release via groundwater during pumping, and to reduce the contaminant source strength to sufficiently low levels so that, after the pumping stops, subsequent contaminant releases will not present an endangerment to human health or the environment.

6.2.4.1 Groundwater Extraction

The shallow groundwater under the site is contaminated with organic and inorganic priority pollutants (Chapter 3). Data indicate that contaminant migration has occurred to the north, west, and east of the site. Hydrogeological data indicate that Mill Creek and the east drain together currently receive most, if not all, local groundwater flow and associated contamination. Although the discharge to Mill Creek limits the extent of contaminant migration, it also results in the environmental degradation of the creek. In general, the zone of major groundwater contamination is bounded on the west by Mill Creek, on the east by the east drain, on the north by Well 13, and on the south by the site property boundary.

The endangerment assessment examined the excess cancer risk associated with the ingestion of carcinogens in the groundwater and examined the predicted daily doses of non-carcinogens and their ADI's for a number of scenarios. A detailed discussion of the results is in Chapter 4. The major results are summarized below. It must be stressed that these are potential scenarios because there are no potable water wells at Western Processing.

- For the worker scenario, ingestion of contaminated groundwater from under the site could to lead to a maximum excess lifetime cancer risk of 0.2 (2×10^{-1}).
- For the residential scenario, ingestion of contaminated groundwater from under the site could lead to a maximum excess lifetime cancer risk of 0.5 (5×10^{-1}).
- Using maximum onsite groundwater concentrations, ADI's would be exceeded for toluene, 1,1,1-trichloroethane, bis(2-ethylhexyl)phthalate, phenol, cadmium, chromium, cyanide, lead, and mercury.
- Using mean onsite groundwater concentrations, ADI's would be exceeded for phenol, cadmium, chromium (assuming hexavalent), and lead.

In addition to the potential endangerment from present levels of contamination in shallow groundwater, the possibility of further environmental degradation due to groundwater contaminant migration also should be considered. Groundwater from beneath the Western Processing site is discharging to Mill Creek at a rate of approximately 0.1 to 0.15 cubic foot per second (50 to 70 gallons per minute; see Chapter 3). This discharge has been calculated to be a major contributor of contamination to Mill Creek and its sediments.

Extraction systems are usually based on the extent of the contamination plume and the type of contamination present. Because most, if not all, of the local, shallow groundwater and associated contamination discharges to Mill Creek and the east drain, groundwater contamination from Western Processing has not migrated significant distances off-property. Extraction system pumping requirements were based on the need to prevent contaminated groundwater from continuing to migrate to Mill Creek and the east drain during the pumping period. The extraction system was sized to pump at a rate at least equal to the estimated rate of groundwater discharge to Mill Creek.

Because of the relatively impermeable nature of the soil and the need to maintain maximum flexibility in the extraction system, a well-point extraction system was chosen for use in the example alternatives. The system configuration varies among alternatives. The example alternative well-point extraction systems have from 170 to 340 wells, with a total pumping rate ranging from about 80 to 100 gpm.

Based on an extraction rate of 100 gpm, the pumping period needed to meet groundwater and Mill Creek water quality criteria varies widely depending on the criteria, the contaminant being considered, and the type and extent of other remedial action components. Table 6-3 shows calculated concentrations in groundwater beneath the site for selected contaminants based on 30 years of pumping at 100 gpm (with no other remedial action component in place). As this table indicates, metal concentrations are not significantly reduced even after 30 years of pumping. This is because most inorganic contaminants move through the saturated zone at a rate many times slower than water; some, like lead, barely move at all. Organics, on the other hand, are much more readily removed, as Table 6-3 illustrates. Higher pumping rates may shorten the pumping period required to achieve the percent reductions shown in Table 6-3.

The analysis results are very sensitive to assumptions regarding the volume of contaminated soils, porosity, pumping rate, and contaminant distribution coefficients (among others). The differences between these results (Table 6-3) and the PRP's results (see Section 6.4.1.4 and Appendix A) can be explained by the use of different assumptions related to contaminant volume, effective pumping rate, contaminant distribution coefficients, and the effect of other remedial action components.

6.2.4.2 Groundwater Treatment

Extracted groundwater would be contaminated and therefore proper disposal would be required. Applicable groundwater disposal options were assessed in Chapter 5 and include discharge to a publicly owned treatment works (Metro), discharge to Mill Creek, discharge to the Green River, and shallow reinjection/infiltration. Each option has treatment requirements and/or limits on the amount of water that can be discharged. Up to 100 gpm can be discharged to Metro under the present Metro discharge permit for the Western Processing site. The treatment requirements for discharge to Metro are less stringent than for other disposal options because the effluent would be subject to additional treatment by Metro.

Discharge to Mill Creek or to the Green River must be done in accordance with NPDES discharge limits. Potential effluent requirements for Metro discharge and for NPDES discharge are shown in Tables 6-4 and 6-5. NPDES discharge is limited

Table 6-3
PREDICTED CONCENTRATIONS OF SELECTED CONTAMINANTS IN GROUNDWATER AFTER PUMPING FOR 30 YEARS[a]

	Expected Average Concentration (μg/L)		Percent
	Initial	After 30 Years	Reduction
Volatile Organics[b]			
Methylene chloride	52,000	0	100
Trichloroethene	16,000	114	99
Trans-1,2-dichloroethene	7,700	0	100
1,1,1-Trichloroethane	8,700	89	99
Chloroform	2,200	0	100
Toluene	820	105	87
Tetrachloroethene	50	14	72
Nonvolatile Organics[b]			
Phenol	42,000	0	100
Naphthalene	15	10	33
Ethylbenzene	10	5	50
Inorganics (Background level)			
Arsenic (17)	19	18	5
Cadmium (2.8)	1,500	800	47
Chromium (13)	2,200	2,065	6
Copper (75)	1,000	970	3
Nickel (<40)[c]	15,000	3,200	79
Lead (23)	290	290	0
Zinc (74)	121,000	79,000	35

[a] Assumes that a RCRA cap is in place (or that unsaturated zone has been excavated to 6 feet) but that no contaminants are removed from the saturated zone and that no diversion barrier is in place.

[b] Background levels for organics are assumed to be zero.

[c] 40 μg/L was detection level for groundwater samples used to determine background.

Table 6-4
POTENTIAL LIMITATIONS FOR DISCHARGE TO
METRO SANITARY SEWER SYSTEM

Compounds	Daily Maximum Concentration (mg/L)
Total oils and greases	100
Cyanide (total)	2.0
Total toxic organics (TTO)	2.13
Arsenic	1.0
Cadmium	1.2
Chromium	6.0
Copper	3.0
Lead	3.0
Mercury	0.1
Nickel	6.0
Zinc	5.0
pH range	5.5-12.5

Table 6-5
POTENTIAL AMBIENT WATER QUALITY CRITERIA
FOR NPDES DISCHARGE[a]

Compound	Maximum Allowable Concentration in Effluent (μg/L)	Maximum Average Concentration at Edge of Mixing Zone (μg/L)
Cadmium	3.02	0.0025
Chromium	21	0.29
Copper	22.2	5.6
Lead	172	3.8
Nickel	1,844	96
Zinc	321	47
Chloroform	28,900	1,240
1,1,1-trichloroethane	18,400	--[b]
Trans-1,2-dichloroethene	11,600	--[b]
Tetrachloroethene	5,280	840
Trichloroethene	45,000	--[b]
Toluene	17,500	--[b]
2,4-dimethylphenol	2,120	--[b]

[a]Assumes hardness to be 100 mg/L as CaCO3.
[b]These compounds have no 24-hour average criteria or chronic toxicity information.

to 15 percent of the surface water flow rate. During summer, Mill Creek discharge would be limited to 135 gpm. A much higher discharge rate is allowable during the winter. The Green River can receive any anticipated groundwater treatment discharge flow rate.

Due to the stringent treatment requirements and treatment costs associated with other disposal options, discharge to Metro appears to be the most desirable option. The discharge limit of 100 gpm appears to be more than adequate for successful operation of the extraction system and to protect Mill Creek from further degradation during pumping.

To meet either of the contaminant discharge limits, the following types of treatment processes should be included in the treatment system:

- o Heavy metals removal
- o Volatile organics removal
- o Non-volatile organics removal

The development of an example treatment system is discussed in Appendix G.

6.2.4.3 Relationship to Other Components

Implementation of other remedial actions could affect the time required for groundwater extraction and treatment. An effective containment barrier could eliminate the need for groundwater extraction. Excavation and/or capping could shorten the groundwater extraction time frame, as could a diversion barrier. The Mill Creek results section of Appendix F illustrates the above points by examining the effects of no action and two other excavation/capping actions on Mill Creek water quality.

6.2.4.4 Cost Considerations

Preliminary cost estimates for groundwater extraction and treatment are presented in Section 6.4.

6.2.5 MILL CREEK

The focus of the Mill Creek remedial action is on the adverse effects of the contamination that has migrated beyond the source area at Western Processing. The primary consideration of this action is to eliminate or reduce the adverse effects that otherwise would not be mitigated by source control remedial actions.

6.2.5.1 Discussion

Mill Creek sediments and water have been contaminated, particularly with metals, as a result of contaminated surface water and groundwater discharges from Western Processing and other sources. As discussed in Chapter 3, concentrations of several dissolved metals increased up to two orders of magnitude in the reach adjacent to Western Processing. Concentrations of dissolved copper, cadmium, lead, and zinc exceeded the maximum allowable ambient water quality criteria concentrations downstream of Western Processing. Organic priority pollutants in Mill Creek water did not exceed criteria values, although volatile organics enter Mill Creek in the Western Processing reach. Sediment concentrations of cadmium, chromium, copper, nickel, and zinc increased one to two orders of magnitude over upstream values as the creek passed Western Processing.

Data on organics in Mill Creek sediments indicate decreased concentrations in more recent samples collected downstream of Western Processing. The highest concentrations of some organics were measured in samples from upstream of Western Processing. The source of other environmental problems in Mill Creek, such as low dissolved oxygen concentrations, was also upstream of Western Processing (Yake 1985).

The endangerment assessment (Chapter 4) discussed contamination in Mill Creek water and sediment as it affects both human health and aquatic organisms. Important items in that discussion are as follows:

- Priority pollutant contamination in Mill Creek does not appear to pose a threat to human health based upon realistic consumption scenarios.
- Concentrations of several dissolved metals exceeded the maximum allowable ambient water quality criteria concentrations for the protection of freshwater aquatic organisms.
- On the basis of data in the criteria documents, the water in Mill Creek is likely to be toxic to a wide variety of aquatic organisms.

Once source control actions have reduced the discharge of contaminants to Mill Creek to a level that would allow Mill Creek water quality to meet cleanup criteria, the contaminated sediments in the creek would still remain as a potential source of continued adverse impacts to aquatic organisms because of the following:

- Contaminants adhering to the sediments in Mill Creek can leach into the water and potentially degrade the water quality to levels that are toxic to aquatic organisms.

- The concentration of source contaminants in the sediments is high enough to be toxic to bottom-dwelling aquatic organisms, which are a food source for other aquatic species; this reduces the potential of this portion of the creek to support a healthy aquatic population.

- Contaminated sediment in the reach of Mill Creek by Western Processing can be transported downstream.

Two example alternatives for the mitigation of sediment contamination in Mill Creek have been selected. They are "no action" and "sediment removal." "No action" would involve leaving the contaminated sediments in place. After source control measures are implemented, continued natural sediment transport processes will gradually move these contaminated sediments downstream of the Western Processing stream reach. As the sediments move downstream, they could be dispersed and diluted, which could reduce adverse impacts previously identified. King County Drainage District No. 1 removes sediment from Mill Creek as part of their maintenance operations. Contaminated sediment removed from the creek and placed on the banks could be a continued source of contamination to Mill Creek.

Sediments could be removed if they were determined to be causing further environmental degradation after source controls have been implemented. Sediment removal would involve diverting and dewatering the creek for a few weeks and removing contaminated sediments. This would destroy the aquatic habitat in the diversion reach. Also, fish may not be able to pass through the diversion system. Diversion of the creek may alter local groundwater migration patterns, but such alteration would be temporary.

6.2.5.2 Relationship to Other Components

The condition of Mill Creek will be greatly affected by the implementation of source control remedial actions. A successful mitigation of contaminant discharge from Western Processing to Mill Creek is necessary before any Mill Creek remedial action can be successful.

6.2.6 MONITORING

Monitoring would be required for all alternatives to ensure that the selected remedial action is performing as expected and that public health and the environment are protected. Groundwater monitoring would require the measurement of water levels and quality at various depths, locations, and times both on and off the property. Caps and landfill liners would be monitored for integrity. Flow rate and quality monitoring would be required for the groundwater extraction and treatment system. Mill Creek water and sediments also would be monitored. Additional items, such as organic vapors and airborne particulates, would be monitored during construction of any alternative.

Monitoring system design, construction, and operating details would be determined during detailed design. Further modifications during implementation of a particular alternative would be likely.

Because the monitoring system would be the same for each example alternative (except no action), it will not be addressed in either Section 6.3, Description of Example Alternatives, or Section 6.4, Evaluation of Example Alternatives.

6.3 DESCRIPTION OF EXAMPLE ALTERNATIVES

As previously identified, the purpose of this chapter is to present a range of example alternatives available to mitigate contamination at Western Processing. The specific example alternatives presented here are not intended to describe the only alternatives that could be implemented at Western Processing or to describe a preferred alternative or a final design. Additional example alternatives can be developed using data contained in this report. The range of alternatives facilitates comparisons of the relative benefits and adverse impacts of each alternative. Example Alternative 4 was developed and evaluated by the Potentially Responsible Parties (PRP's).

6.3.1 EXAMPLE ALTERNATIVE 1--NO ACTION

Example Alternative 1 is the no action alternative. Under Example Alternative 1, no further action of any kind would be taken at Western Processing. The cost for Example Alternative 1 is zero because the alternative includes no capital or operating expenses.

6.3.2 EXAMPLE ALTERNATIVE 2--SURFACE CAP WITH GROUNDWATER EXTRACTION AND TREATMENT

Example Alternative 2 is intended to reduce contaminated runoff to Mill Creek from Western Processing and adjacent soils, to reduce rainwater infiltration and leaching of contaminated soils, to prevent direct contact with contaminated soils by humans or animals, to improve the groundwater quality in the shallow aquifer beneath Western Processing, and reduce the amount of contamination migrating from Western Processing via groundwater to a level that will eliminate endangerment to human health and to aquatic organisms in Mill Creek.

The site plan and cross-section for Example Alternative 2 are shown in Figures 6-1 and 6-2. In general, Example Alternative 2 includes a multilayer RCRA cap both on and off the property, surface drainage control, and groundwater extraction and treatment. A more detailed description of Example Alternative 2 is given below, organized by component.

6.3.2.1 Excavation

Example Alternative 2 incorporates no excavation or offsite disposal of contaminated soils.

6.3.2.2 Capping

Example Alternative 2 includes a five-layer multimedia cap. The cap would be constructed over Areas I and II and the eastern portion of Area V. From top to bottom, the layers consist of: 24 inches of loam (topsoil), a geotextile filter, 12 inches of sand, a 20- to 40-mil impermeable synthetic membrane, and 24 inches of compacted clay. The cap would be sloped to promote draining and would include interior and perimeter concrete-lined surface ditches and detention basins to provide stormwater collection and discharge. The stormwater system would be designed to comply with the City of Kent stormwater ordinance No. 2130. The cap would be vented to prevent the buildup of vapors.

6.3.2.3 Diversion Barriers

Example Alternative 2 does not include a diversion barrier.

6.3.2.4 Groundwater Extraction and Treatment

Groundwater would be extracted at a rate of 100 gpm by a system of 340 well points, each 30 feet deep, with the bottom 20 feet screened for water collection. Approximately 200 well points would be located in Area I, and 140 would be located in Areas II, V, IX, and X. Groundwater would be extracted by nine centrifugal suction pumps and would be piped to a treatment plant located in the northwest corner of the Western Processing property in an area formerly occupied by a residence (Area VII). The groundwater system would be operated for at least 30 years.

Four technologies have been selected for use in the groundwater treatment system:

- Air stripping for volatile organics
- Lime precipitation for heavy metals and organics removal, followed by filtration

- Chemical oxidation of organics using hydrogen peroxide

- Granular activated carbon adsorption for additional organics removal

A conceptual schematic of the groundwater treatment system is shown in Figure 6-3.

The treated groundwater would be discharged to the Metro sewer through the City of Kent's 8-inch sanitary sewer line on South 196th Street. Based on discussions with Metro personnel, maximum discharge to this outlet would be 140,000 gallons per day (approximately 100 gallons per minute) unless additional hydraulic capacity is added to the sewer system.

6.3.3 EXAMPLE ALTERNATIVE 3--EXCAVATION WITH ONSITE DISPOSAL, GROUNDWATER EXTRACTION AND TREATMENT, SURFACE CAP

Example Alternative 3 is intended to isolate the contaminated soil in the unsaturated zone from rainwater infiltration and leaching, to reduce contaminated runoff to Mill Creek, to prevent direct contact with contaminated soils by humans or animals, to improve the groundwater quality in the shallow aquifer beneath Western Processing, and reduce the amount of contamination migration from Western Processing via groundwater to a level that will eliminate endangerment to human health and to aquatic organisms in Mill Creek.

The site plan and cross-section for Example Alternative 3 are shown in Figures 6-4 and 6-5. In general, Example Alternative 3 includes excavation of soil from the unsaturated zone of Areas I and II and placement of this soil in a lined, onsite landfill. The landfill would be covered with a multimedia cap. In addition, Area II and the eastern portion of Area V would be capped. The capped areas would have surface drainage controls. Groundwater would be extracted and treated.

6.3.3.1 Excavation

The excavation component of this example alternative would include the removal of the unsaturated zone soil (assumed to be the top 6 feet) from Areas I and II and placement of the soil in a double-lined landfill (see Figure 6-4) constructed on Area I. The landfill liner would consist of (top to bottom) a geotextile filter, a sand layer with leachate collection and removal system, a synthetic membrane primary liner, sand with leak detection and backup collection system, synthetic membrane, and a 2-foot-thick clay liner.

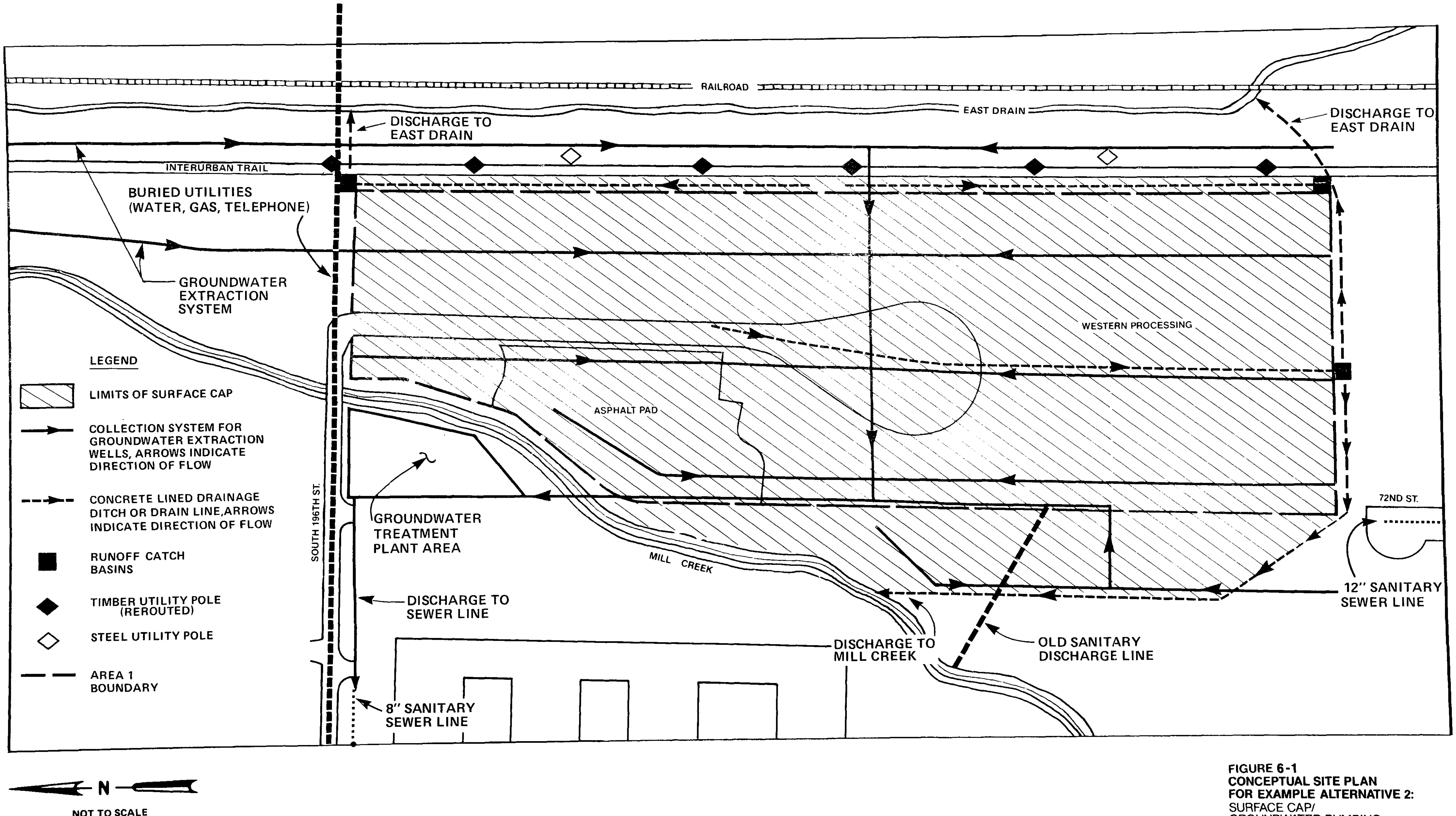
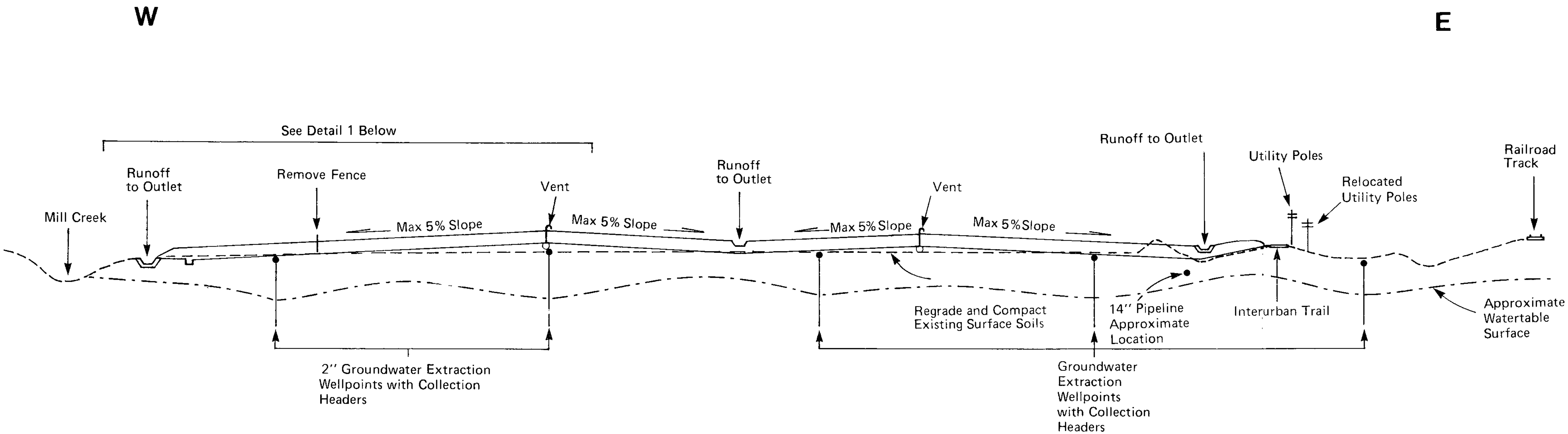
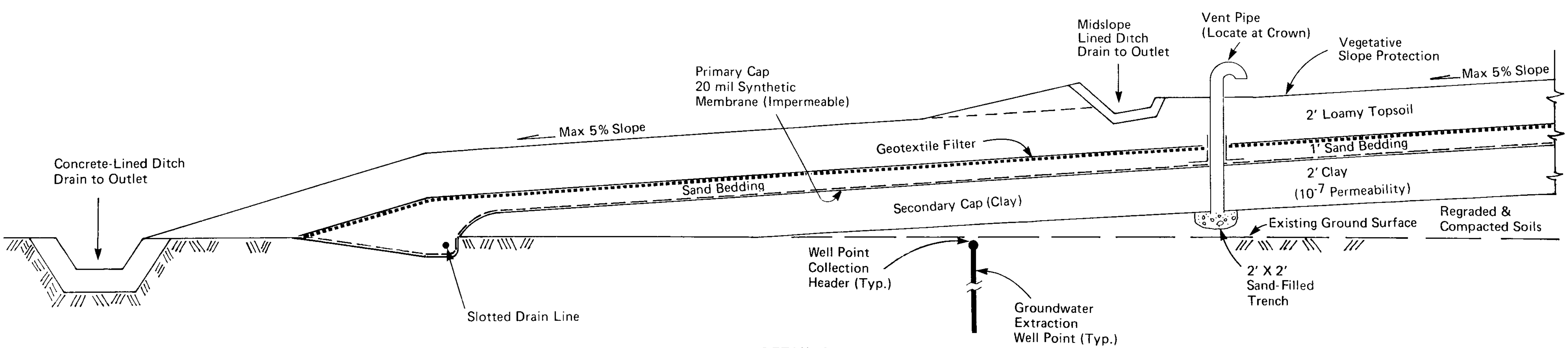


FIGURE 6-1
CONCEPTUAL SITE PLAN
FOR EXAMPLE ALTERNATIVE 2:
SURFACE CAP/
GROUNDWATER PUMPING
AND TREATMENT



GENERALIZED CROSS-SECTION

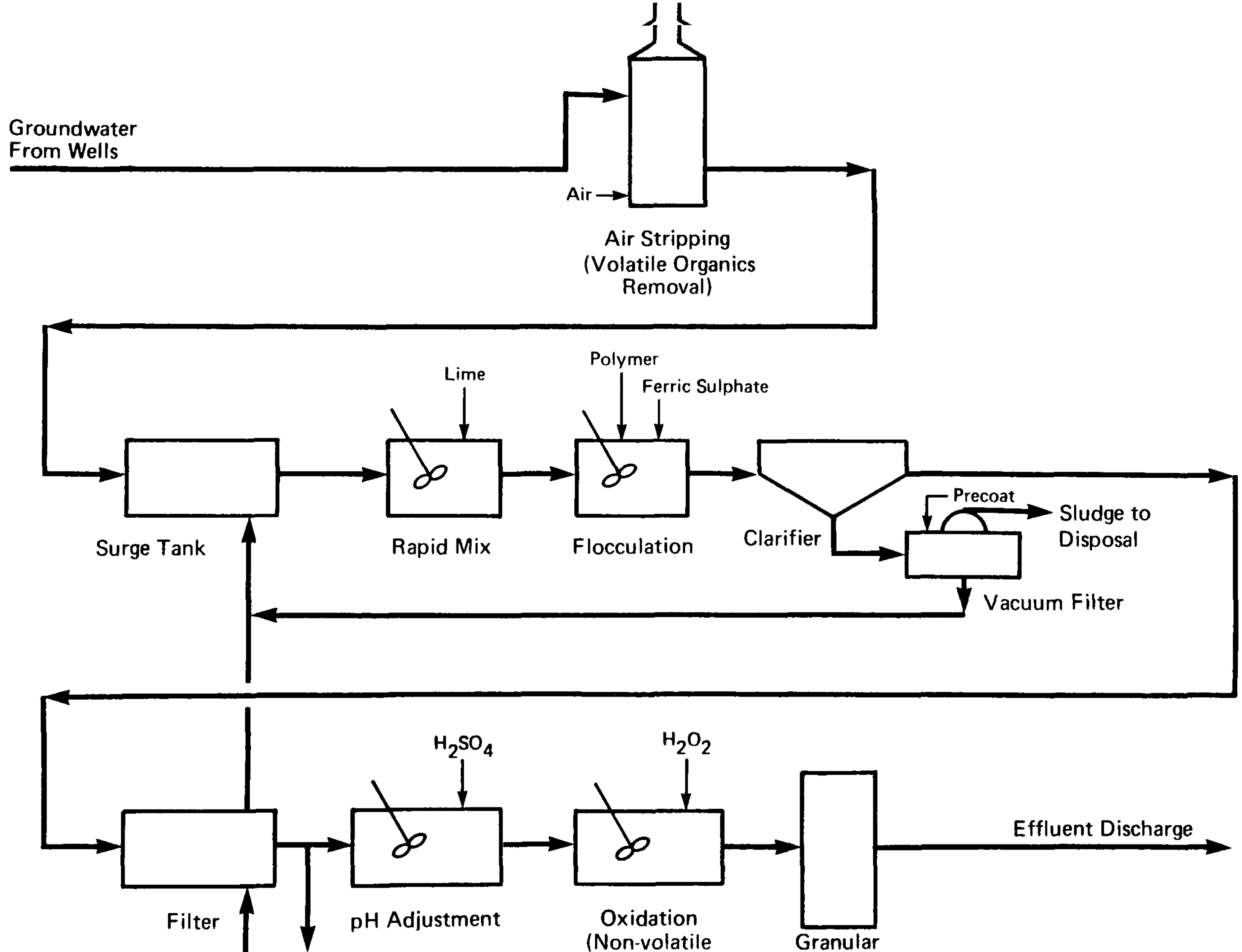
NOT TO SCALE



DETAIL 1
TYPICAL SOIL / MEMBRANE CAP SYSTEM

NOT TO SCALE

FIGURE 6-2
CONCEPTUAL CROSS-SECTION OF EXAMPLE ALTERNATIVE 2:
SURFACE CAP/GROUNDWATER PUMPING AND TREATMENT



Notes:

1. Process configuration shown is based on present knowledge of groundwater composition. Pilot tests will be required to verify process selection. It is possible that additional (or fewer) processes will be required.

2. Sequence of processes is subject to variation based on outcome of pilot tests.

FIGURE 6-3
GROUNDWATER TREATMENT PROCESS FLOW CHART

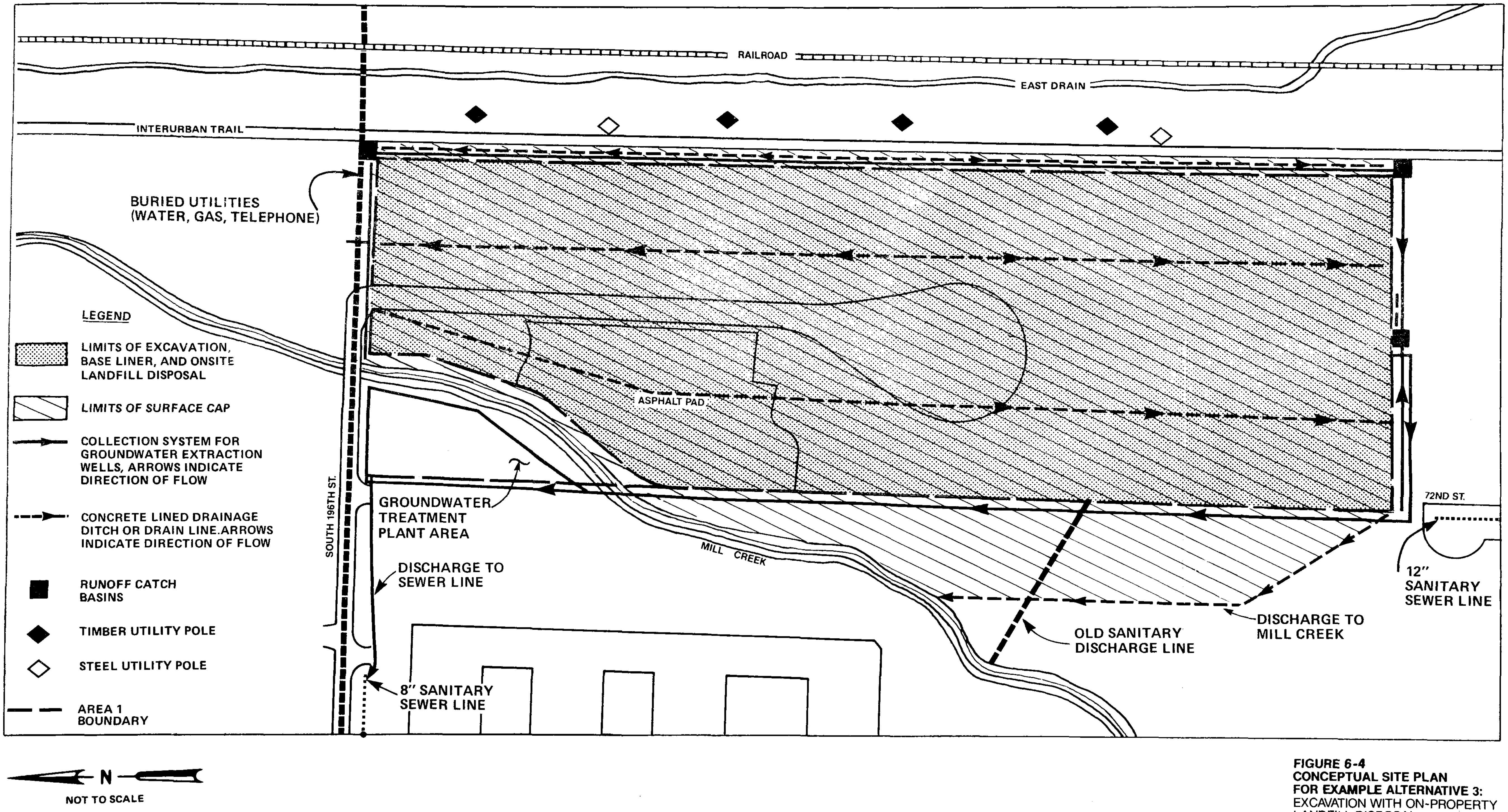
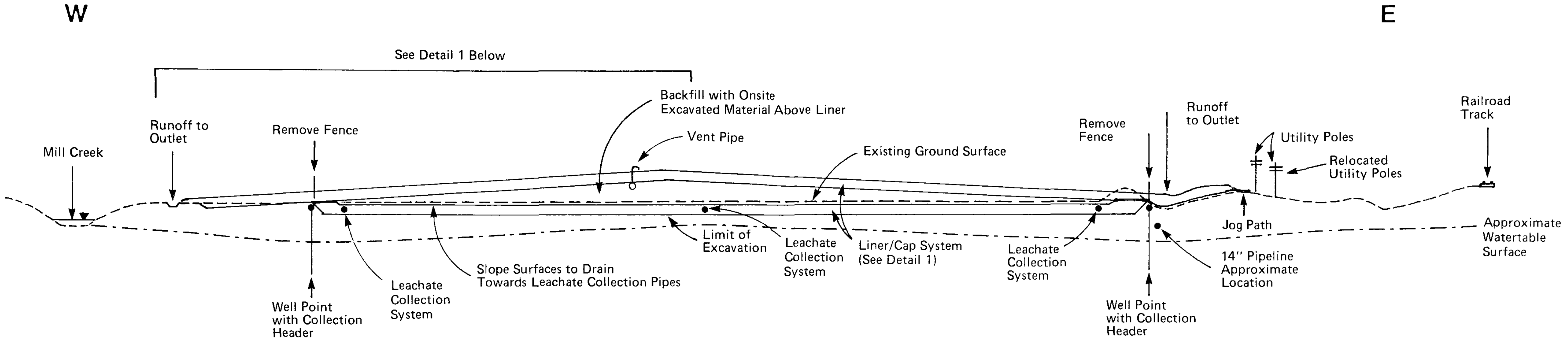
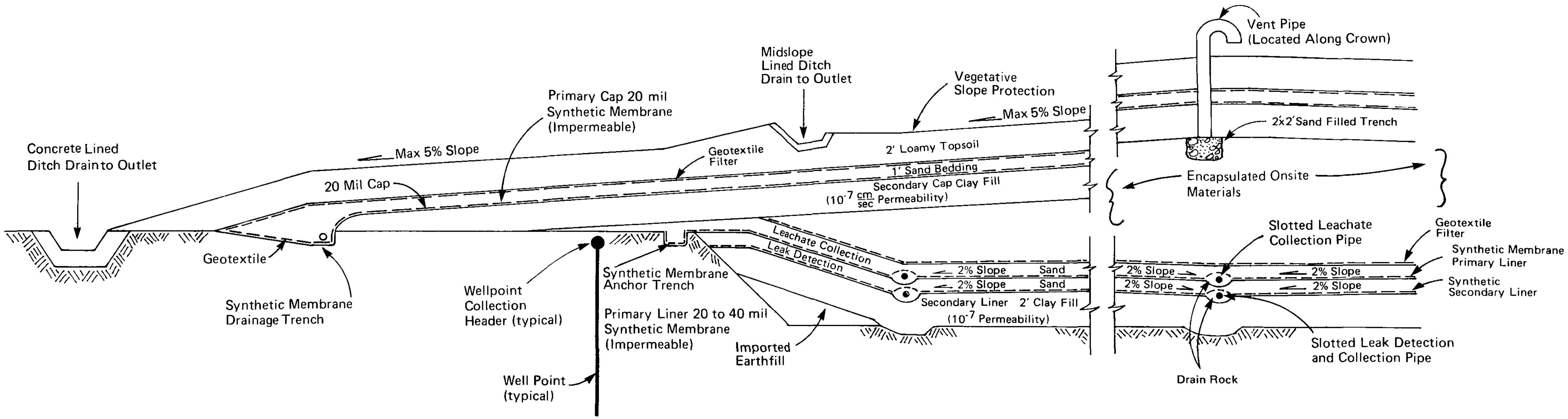


FIGURE 6-4
CONCEPTUAL SITE PLAN FOR EXAMPLE ALTERNATIVE 3:
EXCAVATION WITH ON-PROPERTY LANDFILL DISPOSAL/ GROUNDWATER PUMPING AND TREATMENT/ SURFACE CAP



GENERALIZED CROSS-SECTION

NOT TO SCALE



DETAIL 1
TYPICAL LINER/CAP SYSTEM

NOT TO SCALE

FIGURE 6-5
CONCEPTUAL CROSS-SECTION OF EXAMPLE ALTERNATIVE 3:
EXCAVATION WITH ON-SITE LANDFILL DISPOSAL/ GROUNDWATER PUMPING AND TREATMENT/SURFACE CAP

In addition to the unsaturated zone soils in Areas I and II, soils from a portion of Area VIII would be excavated to a depth of one foot and placed into the onsite landfill. The excavated area would be backfilled.

6.3.3.2 Capping

Example Alternative 3 includes a five-layer, multimedia cap. The cap would be constructed over Areas I and II and eastern portions of Area V. The cap design would be identical to the cap described for Example Alternative 2.

6.3.3.3 Diversion Barriers

Example Alternative 3 does not include a diversion barrier.

6.3.3.4 Groundwater Extraction and Treatment

Groundwater would be extracted at a rate of about 85 gpm by a system of 170 well points, each 30 feet deep with the bottom 20 feet screened for water collection. The well points would encircle the site on 20-foot centers in Areas I, III, IV, V, IX, and X (see Figure 6-4). Groundwater would be extracted by six centrifugal suction pumps and piped to an onsite treatment plant.

The groundwater treatment system design and location and operating period would be similar to the those described as part of Example Alternative 2.

6.3.4 EXAMPLE ALTERNATIVE 4--PRP REMEDIAL ACTION PLAN[1]

The components and technologies of Example Alternative 4, the PRP plan, were developed independently of those developed by USEPA. This alternative is intended to prevent direct human and animal contact with contaminated materials in Area I; to eliminate the release of contaminated runoff from Area I; to remove buried wastes from Area I; to reduce the amount of contamination migrating from Western Processing via groundwater to a level that will eliminate the endangerment to aquatic organisms in Mill Creek; to eliminate the need for long-term monitoring and maintenance of the property as a hazardous waste site; to allow future productive use of the property; and to minimize the potential for long-term liability for the PRP's.

A description of the process by which the PRP plan was selected is provided in Appendix A. Example Alternative 4 is illustrated in Figures 6-6 and 6-7.

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[1] This section has been provided by the PRP's.

In general, Example Alternative 4 includes excavation and offsite disposal of waste materials and soil from the unsaturated zone in Area I, a diversion barrier, groundwater extraction and treatment, a surface water infiltration and drainage control system, and an asphaltic concrete pavement to be installed over Area I after the groundwater extraction system has been dismantled.

The PRP plan also includes the removal of sediments from Mill Creek. Example Alternative 7 and the Mill Creek portion of the PRP plan are essentially the same. Therefore, no further discussion of the PRP cleanup plan for Mill Creek is included in this document.

The PRP plan does not address additional off-property contamination, other than off-property contaminated groundwater which could potentially be removed during the pumping program. Other example alternatives in this feasibility study address the extent of off-property contamination and possible remedial approaches. One of these approaches to off-property contamination control may be applicable and would be one of the subjects of negotiation.

6.3.4.1 Excavation

The excavation component of the PRP plan consists of a variable-depth excavation scheme designed to remove approximately 75,000 cubic yards of waste materials and contaminated soil from the unsaturated zone in Area I and the disposal of this material in an offsite, double-lined, RCRA hazardous waste landfill. Imported soil would be used to backfill the excavations.

6.3.4.2 Groundwater Extraction and Treatment

Groundwater would be removed at a rate of approximately 100 gpm by a system of three rows of well points (see Figure 6-9) installed on the property to an average depth of about 25 feet below the ground surface. Approximately 200 well points would be installed, with individual well points along each row spaced about 20 feet apart. The three rows of well points would be divided into six different operational groups by means of valves installed on the header pipes leading from the well points. Three centrifugal-vacuum pumps would be installed to run the system. All header pipes, valves, and pumps would be installed above the ground surface. The groundwater pumping system would operate for a period of up to 5 years.

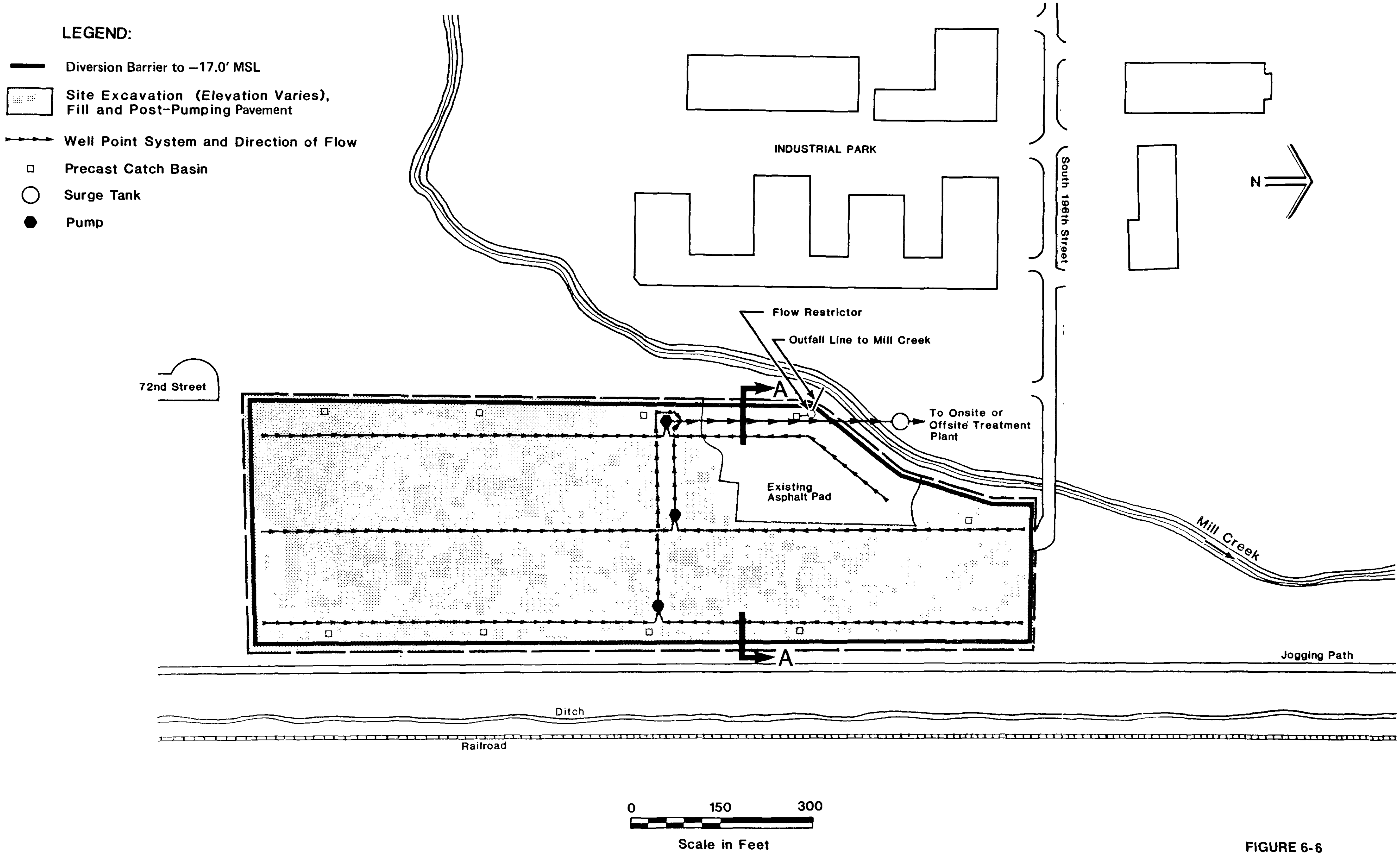


FIGURE 6-6
SITE PLAN FOR
EXAMPLE ALTERNATIVE 4
WESTERN PROCESSING
Kent, Washington

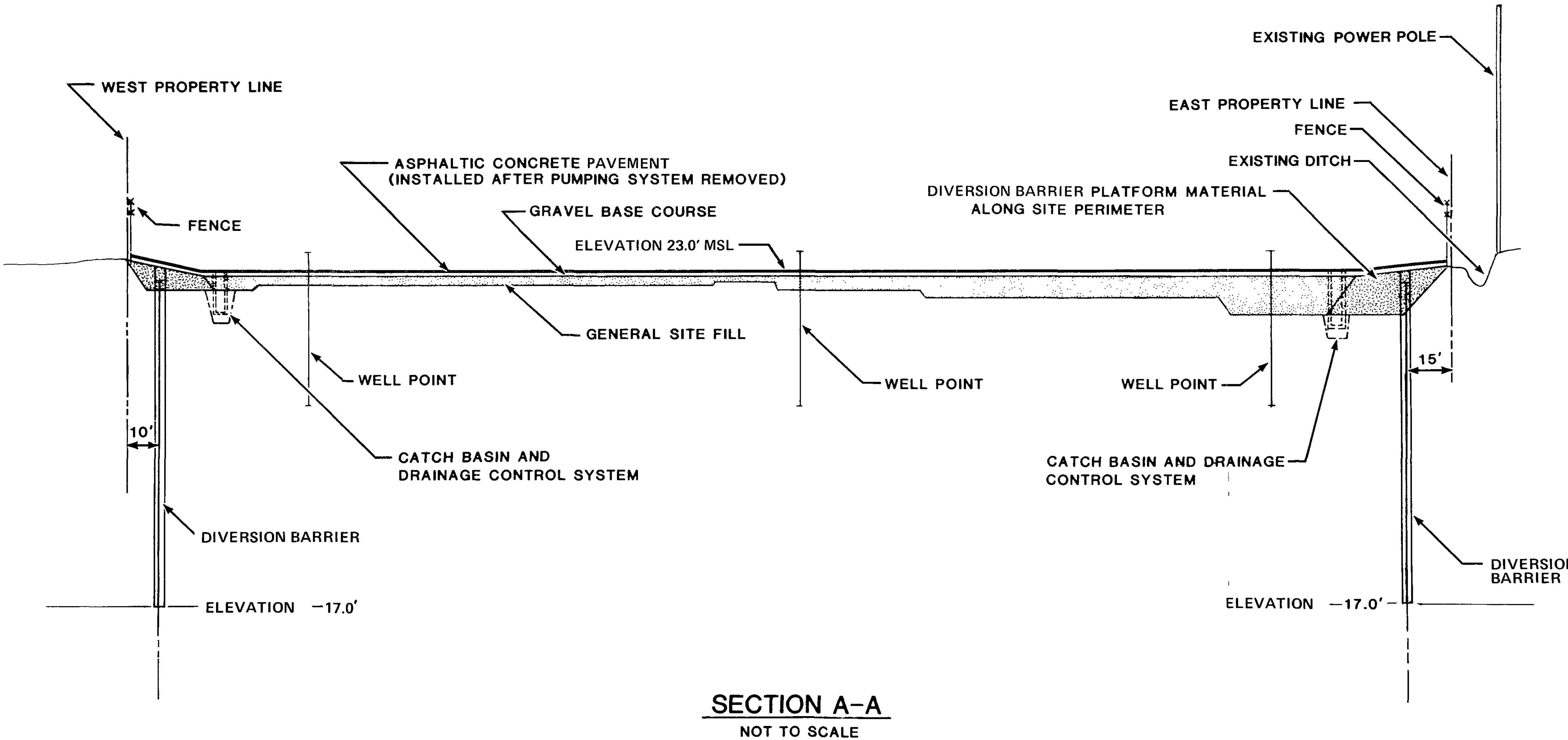


FIGURE 6-7
SITE CROSS-SECTION FOR
EXAMPLE ALTERNATIVE 4
WESTERN PROCESSING
Kent, Washington

During operation of the groundwater pumping and treatment system, precipitation falling on the property would be allowed to infiltrate through a permeable, gravel surface cover. The property would be graded to prevent overland flow from entering or leaving the property. As precipitation infiltrates through contaminated soil between the bottom of the excavations and the groundwater surface, it would pick up contaminants from the soil and transport them to the groundwater for subsequent removal by the pumping and treatment system.

Treatment of groundwater prior to discharge would be provided either by a treatment plant constructed on the property or by an existing offsite treatment plant. If the offsite treatment plant option is selected, the contaminated groundwater would be transported to the plant by pipeline. Treatment would be similar to that included in Example Alternatives 2 and 3, consisting of metals precipitation, air stripping, chemical oxidation of organics, and carbon treatment. Flow through the facility would be approximately 100 gallons per minute. The treated water would be discharged either to the Green River (on-property treatment plant option only) or to the Metro sewer system (both options).

6.3.4.3 Diversion Barrier

To prevent surface water and shallow groundwater outside the property from being pumped preferentially into the well point system, a diversion barrier would be constructed along the perimeter of Area I to a depth of 40 feet. While the pumping system is operating, this barrier would allow the cleaner, deeper off-property groundwater to be drawn through the contaminated soils, thereby flushing the relatively mobile contaminants from a depth of at least 40 feet. Following completion of the pumping program, the barrier would act to lengthen the travel distance, and hence travel time, for any residual contaminants that might migrate from the property to Mill Creek. Increasing the travel time reduces the rate of contaminant release via groundwater from Area I to Mill Creek.

6.3.4.4. Capping

A relatively impermeable pavement would be installed over the property after the groundwater extraction and treatment program is completed and the pumping system is removed. This system was selected to inhibit the infiltration of precipitation following completion of the groundwater pumping and treatment program. The pavement would consist of asphaltic concrete and would be constructed over an aggregate base (see Figure 6-7). The property would be graded to form nine drainage basins, with each basin routing runoff to an internal catch basin. The nine catch basins would be interconnected using subsurface 12-inch pipes and would route runoff to an oil separator and flow restrictor. Discharges to Mill Creek from this system would be at or below the rate permitted by the City of Kent.

6.3.5 EXAMPLE ALTERNATIVE 5--EXCAVATION WITH OFFSITE DISPOSAL

Example Alternative 5 is intended to eliminate the potential for discharge of contaminated surface water from the site to Mill Creek, to prevent direct contact with contaminated soils by humans and animals, to return groundwater quality in the shallow aquifer beneath the site to background levels, and to eliminate the potential for endangerment of human health and aquatic organisms in Mill Creek, and endangerment of human health in the groundwater.

Example Alternative 5 is shown in Figures 6-8 and 6-9. The main element in this alternative is the excavation and removal of on-property and certain off-property soils to an offsite, double-lined, RCRA hazardous waste landfill. Excavation is proposed below the local groundwater table for the on-property area. A dewatering system would be needed during this portion of the excavation. The excavated areas would be backfilled and returned to their undeveloped state.

6.3.5.1 Excavation

Soil excavation is the main component of this alternative. Area I and II soils would be excavated to a depth of 15 feet. Soils in portions of Areas V and IX would be excavated to 3 feet; in a portion of Area VIII, soils would be excavated to one foot (as described in Example Alternative 3). The old sanitary discharge line would be removed from Area V. Fill would be imported to replace the excavated soil and return the excavated areas to the approximate former grade.

The local groundwater table is about 6 feet below the ground surface in Area I. A dewatering system would be needed when the excavation depth is near or below the water table and during the placement of clean fill. The dewatering system would consist of well points placed around the excavated area similar to the system described in Alternative 3. Depending on the actual configuration of the excavation in Area II, the petroleum pipeline may require either stabilization or relocation. The required flow rate of the dewatering system cannot be accurately predicted from available data. The effluent from the dewatering system would be treated and discharged as described for Example Alternatives 2 and 3.

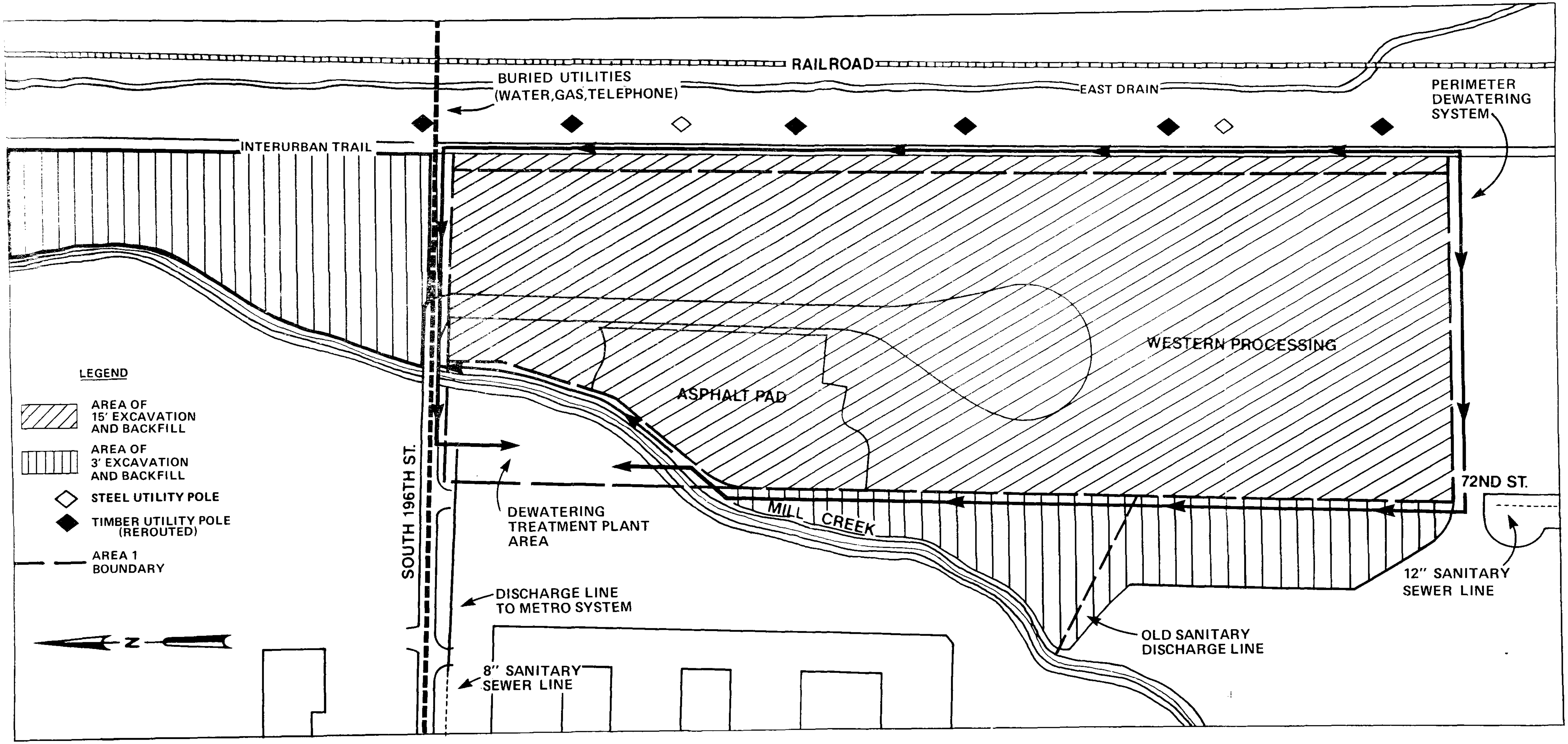
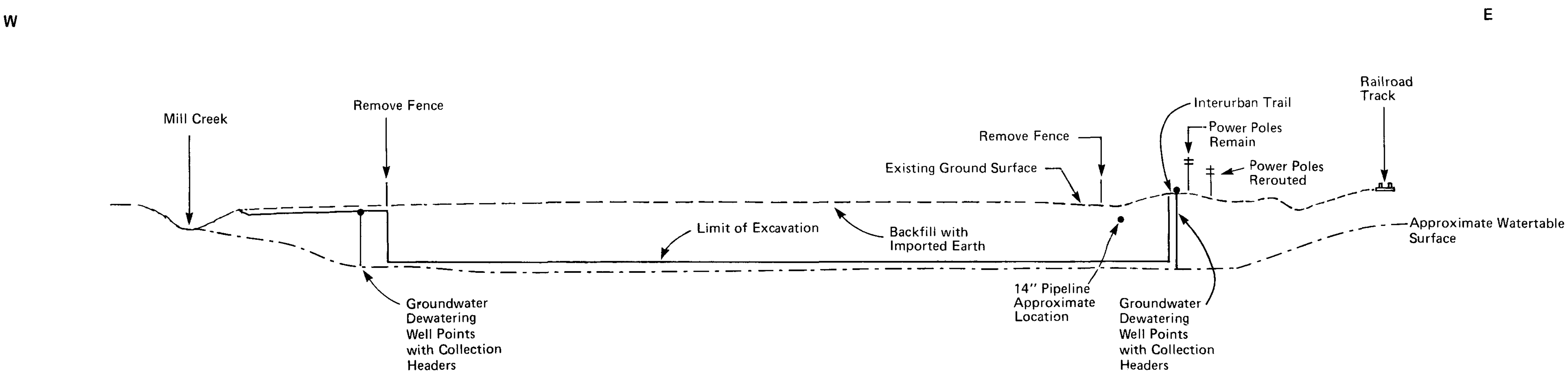


FIGURE 6-8
CONCEPTUAL SITE PLAN
FOR EXAMPLE ALTERNATIVE 5:
EXCAVATION ABOVE AND BELOW
GROUNDWATER TABLE WITH
OFF-SITE DISPOSAL



* Localized dewatering will be used in area of deep excavation.

GENERALIZED CROSS SECTION
Not to Scale

Excavation depth exaggerated to show components.

FIGURE 6-9
CONCEPTUAL CROSS-SECTION OF EXAMPLE ALTERNATIVE 5:
CONTAMINATED SOIL DISPOSAL OFFSITE, ASPHALT SURFACE CAP WITH GROUNDWATER TREATMENT.

For the purposes of sizing and costing, the dewatering system flow rate was assumed to be 100 gpm. This value is consistent with projected groundwater extraction flow rates from Example Alternatives 2 and 3. However, the duration of pumping would be limited to the time required for excavation and fill operations (approximately 4 years).

6.3.5.2 Capping

Example Alternative 5 does not contain a capping component.

6.3.5.3 Diversion Barrier

Example Alternative 5 does not contain a diversion barrier component.

6.3.5.4 Groundwater Extraction and Treatment

Example Alternative 5 does not contain a long-term groundwater extraction and treatment component. The construction dewatering system would contain a treatment system similar to that described in Example Alternative 2. The perimeter well array would be similar to that in Example Alternative 3 with added dewatering around the deeper excavation in Areas I and II.

6.3.6 EXAMPLE ALTERNATIVE 6--MILL CREEK-NO ACTION

Under Example Alternative 6, contaminated sediments in Mill Creek would be left in place. No stream diversion action would be taken.

6.3.7 EXAMPLE ALTERNATIVE 7--MILL CREEK SEDIMENT REMOVAL

Example Alternative 7 is intended to remove contaminated sediments from Mill Creek to prevent them from moving downstream and from leaching contaminants into the water of Mill Creek. During the sediment removal process, Mill Creek would be diverted to minimize contaminant resuspension and sediment transport during the sediment removal operation, and to minimize the amount of water that would be removed with the sediment.

Example Alternative 7 is shown in Figures 6-10 and 6-11. In general, Example Alternative 7 entails constructing dikes and installing pumps and pipelines to divert Mill Creek around the Western Processing site while contaminated sediments are being excavated.

6.3.7.1 Diversion Pipeline and Pumping

The diversion period should be between July and October, the historical low-flow season. A maximum capacity of 15 cubic feet per second was selected for the diversion pipeline.

Mill Creek flow is expected to be less than this rate 99 percent of the time in any given year. An 18-inch-diameter pipeline would be installed to transport the diverted water downstream to about 1,000 feet north of the Western Processing property line, for a total diversion of 2,300 feet. Four 1,700-gallon-per-minute pumps would be necessary.

6.3.7.2 Diversion Dikes

Diversion dikes would be provided both upstream and downstream of the reach from which sediment would be removed. These dikes, together with groundwater seepage controls, would keep the work area dry. An example engineered structure is shown in Figure 6-11. The structure consists of a compacted gravel core, an impermeable synthetic membrane, sand bedding, and a geotextile covered with 4-inch-diameter riprap. The upstream berm would be approximately 7.5 feet tall and the downstream berm would be approximately 5 feet tall. Other types of dikes, such as the sheet-pile dikes proposed by the PRP's, could also be an effective means to divert Mill Creek.

6.3.7.3 Excavation of Contaminated Sediments

Sediment would be removed from the bed and banks of Mill Creek to a depth of from six inches to one foot. The width of the excavation is expected to average 40 feet for the entire length of Mill Creek between the two berms. After the sediment has been removed, the stream bed would be rehabilitated with gravel riffles and the stream banks with native vegetation.

For cost estimating, the sediment was assumed to be disposed in an offsite, double-lined, RCRA hazardous waste landfill. Further testing may reveal that the material qualifies for less expensive disposal.

6.4 EVALUATION OF EXAMPLE ALTERNATIVES

The example alternatives described in Section 6.3 were evaluated based on technical feasibility, environmental and public health concerns, institutional requirements, and cost estimates. These evaluations are discussed in this section. Section 6.5 summarizes the results of these evaluations.

The evaluations addressed many different aspects of the existing and potential contaminant migration pathways and releases from Western Processing. One aspect that received particular attention was the contamination of Mill Creek, especially by contaminated groundwater migrating from Western Processing. Other factors are also important in evaluating an example alternative's effectiveness. These include reduction in contaminant concentrations in shallow

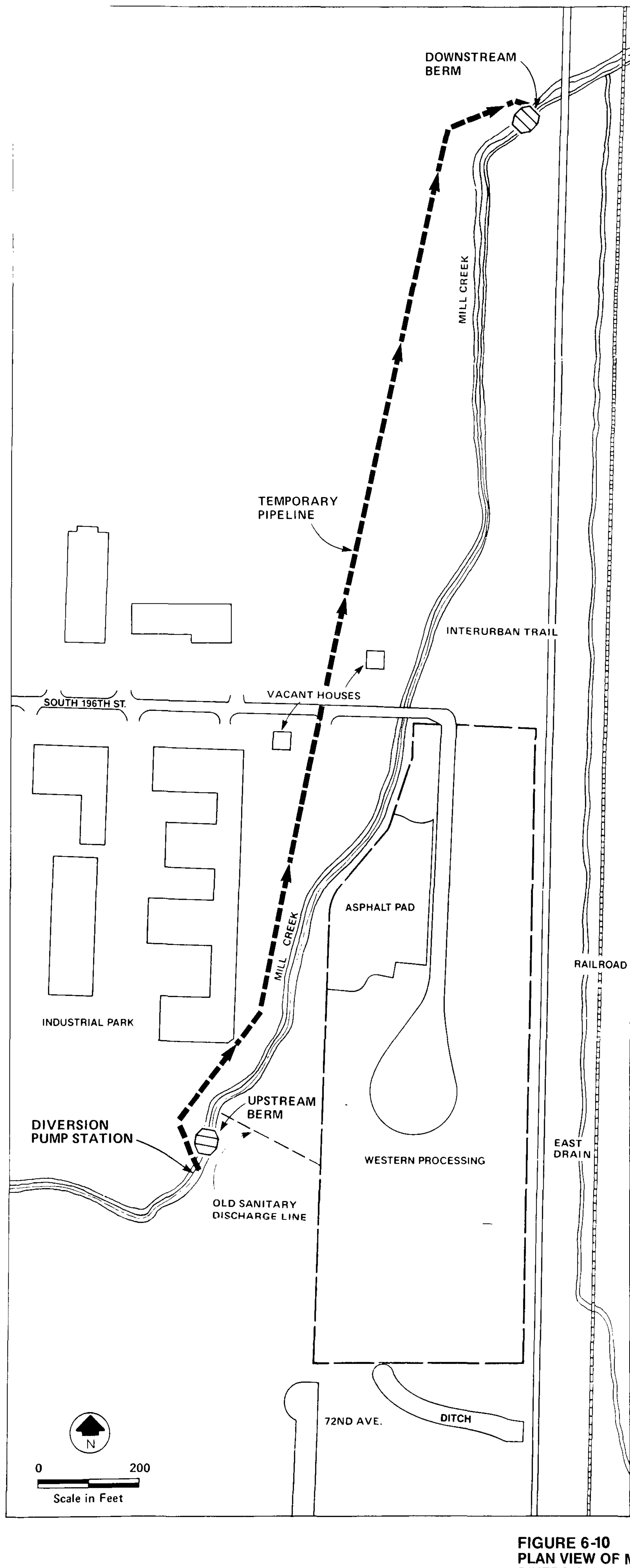
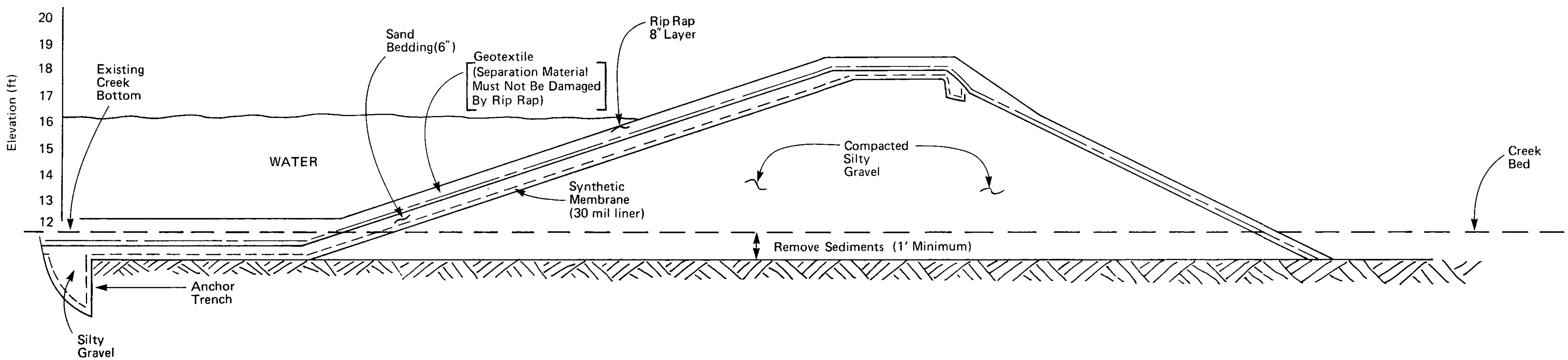


FIGURE 6-10
PLAN VIEW OF MILL CREEK DIVERSION BERMS AND TEMPORARY PIPELINE



Not To Scale

FIGURE 6-11
CROSS-SECTION OF DIVERSION STRUCTURE

groundwater beneath and adjacent to the site (a potential concern if either this groundwater or Mill Creek were ever to be used as a potable water source) and elimination of the potential hazards associated with direct human contact with contaminated soils.

Shallow groundwater and Mill Creek water quality are closely related because local groundwater discharges to the creek. During summer, most of the flow in the creek is supplied by groundwater.

Because the creek and shallow aquifer are not used for water supply, contaminant concentrations in the groundwater and Mill Creek were compared to USEPA ambient water quality criteria (24-hour and maximum) for aquatic organisms. However, background levels near Western Processing, particularly for metals, were higher than the ambient criteria.

Because it is not practical to clean up contaminanted groundwater to levels that are lower than background concentrations, the criteria for evaluating effectiveness were modified by replacing the criteria levels with background levels whenever background was higher than the criteria. These site-specific modified ambient water quality criteria (see Table F-5 in Appendix F) were then used as the basis for evaluating the effectiveness of example alternatives.

In the absence of Western Processing, Mill Creek would probably meet the aquatic water quality criteria for metals, even during the summer low flow periods, despite the relatively high background groundwater metals concentrations. Natural processes in the creek, such as adsorption on sediment and chemical precipitation, reduce the dissolved metal concentrations after groundwater discharges into the creek. Therefore, reducing Western Processing groundwater concentrations to near background concentrations should allow the creek to achieve ambient water quality criteria.

Metals, particularly zinc, were identified as key indicators of present and probable future impacts in Mill Creek for the following reasons:

- Organics are not now, nor are they anticipated to be, a problem in the creek for aquatic organisms, whereas metals are currently above ambient water quality criteria.

- Metals are not easy to remove from the groundwater system.

- Zinc generally exceeds its modified ambient water quality criterion by the largest factors.

- If zinc concentrations in the groundwater were reduced to a level that allows Mill Creek to achieve the modified ambient water quality criterion for zinc, then other indicator metals would similarly achieve the modified criteria.

To address the remote possibility that shallow groundwater beneath the site might be used as a source of drinking water, contaminant concentrations in this groundwater were compared to federal drinking water standards, acceptable daily intake (ADI) levels (assuming an average consumption of 2 liters of water per day), and SNARL's (for longer term use). The federal drinking water standards cover priority pollutant metals and a single indicator organic (chloroform); these standards must be met by public drinking water systems. The ADI's and SNARL's are guidelines only; however, they cover more of the organic priority pollutants found at Western Processing. Chapters 2 and 4 contain a discussion of these standards and guidelines. Appendix F contains additional information on the example alternative evaluations.

6.4.1 TECHNICAL EVALUATION

The technical evaluation addresses the areas of reliability, implementation capability, and safety. Reliability factors include effectiveness, durability, and demonstrated performance. Implementation capability includes ease of installation, time required to implement, and monitoring, operation, and maintenance requirements. Safety includes the relative safety of an example alternative during construction and operation and in the event of a failure of part of the example alternative. Statements concerning the period of groundwater extraction required to achieve a particular water quality are presented to provide a relative assessment only and should not be considered absolute.

6.4.1.1 Example Alternative 1--No Action

The technical evaluation of Example Alternative 1 is shown in Table 6-6. If Example Alternative 1 were implemented, no action would be taken at Western Processing. The contaminants would continue to migrate in an uncontrolled manner via existing migration pathways. It would probably take hundreds of years of natural groundwater flow before zinc concentrations in Mill Creek returned to the modified ambient water quality criterion level. Drinking water standards for cadmium, chromium, and lead would probably never be met in the shallow aquifer beneath the site.

6.4.1.2 Example Alternative 2--Surface Cap with Groundwater Extraction and Treatment

The results of the technical evaluation of Example Alternative 2 are shown in Table 6-7. If Example Alternative 2

Table 6-6
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 1

Category	Comments
Effectiveness	All contaminants would remain in an uncontrolled state. Direct human and animal contact with contaminated materials could occur. Surface water runoff could contact contaminated soil and could carry contaminants from the site and into Mill Creek. Leaching of contaminants from the unsaturated zone to the groundwater would continue. Groundwater quality beneath the site would improve slowly. It would take hundreds of years (if ever) to achieve target levels of metals for human health criteria for drinking water. It would probably take hundreds of years of natural groundwater flow before metals levels in Mill Creek, particularly zinc, were reduced to modified ambient water quality criteria.
Durability	Not applicable.
Demonstrated Performance	Since no action would be taken at the site, this analysis is not applicable. It is assumed that contaminant migration would continue in a manner similar to that which has occurred since Western Processing operations stopped and the surface cleanup was accomplished.
Ease of Installation	Not applicable.
Time to Implement	Not applicable.
Monitoring Requirements	Not applicable.
Operation and Maintenance Requirements	Not applicable.
Safety During Construction and Operation	Not applicable.
Safety in the Event of Failure	Not applicable.

Table 6-7
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 2

Category	Comments
Effectiveness	The RCRA multimedia cap would be effective in minimizing infiltration and leaching of contaminants in the unsaturated zone of Areas I and II and the eastern part of Area V, in preventing contact between surface runoff and the contaminated areas, and in minimizing potential for direct human or animal contact with contaminated soil. Forty years of pumping would lower most organics to below human health target levels for drinking water in Area I/II. Drinking water standards would not be achieved for most indicator metals after 30 years of pumping in Area I/II. The 100 gpm extraction and treatment system should be sufficient to prevent contaminated groundwater flow from Areas I, II, V, and IX to Mill Creek during the period of pumping. Concentrations of indicator metals that could be released to Mill Creek via groundwater (if pumping were stopped after 30 years) would not be low enough to allow Mill Creek water to continue to achieve the modified ambient water quality criterion for zinc. Even if the groundwater pumping system were operated indefinitely, it would not be possible to remove lead to levels that comply with federal drinking water standards. Reducing the zinc released to Mill Creek via groundwater to levels that would allow the creek to meet the modified ambient water quality criterion would take between 60 and 120 years of pumping. Contaminated sediments in Mill Creek would be naturally dispersed downstream and replaced with cleaner upstream sediments; however, the amount of contamination that would continue to enter Mill Creek via groundwater if pumping were stopped after 30 years could recontaminate the creek sediments. Pumping for 60 to 120 years or longer would prevent the sediments from becoming recontaminated. The effectiveness of the groundwater extraction system would be confirmed by field testing and through long-term monitoring. The system would be modified as necessary during operation.

Table 6-7 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 2

Category	Comments
Effectiveness (continued)	The effectiveness of the treatment system would be confirmed by bench- or pilot-scale testing during detailed design, and adjustments would be made as necessary during operation.
Durability	A multimedia cap can be expected to have a cost-effective life-span of 25 to 30 years. Potential sources of degradation include chemical reactions between contaminants and the clay or synthetic liner, cracking and/or joint separation of the synthetic liner, leakage of the surface runoff collection devices, and leakage around vent pipes. These conditions could reduce the effectiveness of the cap.
	The expected life span of equipment in the groundwater extraction, treatment, and monitoring systems varies from 10 to 50 years. For costing purposes, a 15-year life span was assumed. When a particular item reaches its actual life span, that item would be replaced to maintain the effectiveness of this component.
Demonstrated Performance	Long-term experience with multimedia caps in hazardous waste applications is limited; however, this type of cap is considered to be the state-of-the-art technology. Testing would be required prior to installation to determine the compatibility between the capping materials and the chemicals present in the soil. If there is a compatibility problem, different materials or configurations could be used.
	Groundwater extraction and treatment have been used successfully in hazardous waste applications. Because of the uniqueness of each application, monitoring would be required to confirm the effectiveness of any extraction and treatment system. Areas of influence and current groundwater quality are two considerations that would require further analyses prior to implementation.

Table 6-7 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 2

Category	Comments
Ease of Installation	Example Alternative 2 involves the importation of a 67,900-square-yard geotextile filter, a 67,900-square-yard synthetic membrane, 45,200 cubic yards of loam, 45,200 cubic yards of clay, and 22,600 cubic yards of sand. Approximately 2,900 feet of concrete-lined ditches and 8 catch basins would be required. These materials have been presumed to be available locally in these quantities. The cap would require careful, labor-intensive construction around the required venting. The surface cap would have to be designed to withstand settling and any subsidence caused by the groundwater extraction system. Long-term access to Areas I, II, V, and VII and temporary access to Areas IX and X would be required. The adjacent section of the Interurban Trail would be closed during the construction period. The distribution power line in Area II would require relocation to the east side of the Interurban Trail. Construction of the groundwater extraction system treatment plant, after pilot testing has been completed and the unit processes selected, would involve conventional materials and equipment. Only minor construction would be required to connect the groundwater treatment plant to the sewer discharge line.
Time to Implement	Eight months would be required for the construction phase of this example alternative, not including time for additional studies, pilot testing, and final design. A pumping period of 30 years has been assumed for evaluation and costing of this example alternative.

Table 6-7 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 2

Category	Comments
Monitoring Requirements	The surface cap would require annual inspections to ensure that it is effectively impermeable.
	The surface cap and surrounding structures would require periodic inspections for the effects of subsidence.
	The groundwater extraction and treatment system would require daily monitoring by trained personnel.
	A monitoring well system would be installed and Mill Creek monitored to evaluate the effectiveness of the remedial action.
Operation and Maintenance Requirements	The groundwater extraction and treatment system would require daily operation and maintenance by trained personnel.
	The groundwater treatment system would require the following chemical quantities in the first year: precoat--250 tons, lime--165 tons, ferric sulfate--4 tons, hydrogen peroxide--440 tons, polymer--one ton, and granular activated carbon--10 tons. (These numbers are based on the conceptual treatment system shown in Figure 6-6 at 100 gpm.)
	Approximately 1,300 tons of hazardous sludge would be generated in the first year by the treatment system. This sludge would require disposal at a RCRA double-lined hazardous waste landfill. This amount would be expected to decline over time.
	The vegetative cover on the surface cap would require periodic maintenance.
Safety During Construction and Operation	A health and safety plan would be prepared before any construction is undertaken at Western Processing. This plan would include onsite monitoring and perimeter monitoring of contaminants.

Table 6-7 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 2

Category	Comments
Safety During Construction and Operation (continued)	All personnel would be properly trained in accordance with federal, state, and local regulations.
	During site grading and cap construction, dust would be controlled by appropriate measures.
	Any equipment exposed to hazardous materials would be decontaminated.
	Federal, state, King County, and City of Kent officials would be involved in contingency and emergency response planning.
	The effluent from the groundwater treatment system would be monitored to ensure that it meets discharge requirements.
	During cap construction, stormwater would be controlled to prevent the discharge of contaminated surface water and would be treated as necessary.
	The surface cap would be vented to prevent buildup of volatile gases.
Safety in the Event of Failure	The surface cap would contain two relatively impermeable layers. In the event of a failure of one of the layers or the stormwater system, the second layer and the slope of the cap should continue to effectively reduce water infiltration. Human contact with contaminated soils under the cap would be unlikely even if the cap should fail to prevent infiltration. Damaged portions of the cap or stormwater system would be repaired.
	The groundwater treatment system would include storage facilities so that any effluent not meeting discharge limits could be retreated.

Table 6-7 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 2

Category	Comments
Safety in the Event of Failure (continued)	The large number of well points in the groundwater extraction system would provide a redundancy. The failure of individual well points would not adversely affect the performance of the system. Additional well points could be added to the system if necessary. In the event of a complete treatment system failure, the extraction system could be turned off.

were implemented, a multimedia RCRA cap would be installed over Areas I and II and the eastern portion of Area V. The cap should accomplish the following:

- o Prevent direct contact with contaminated soils by humans and animals
- o Prevent surface water runoff from contacting contaminated soils
- o Prevent infiltration and leaching of contaminated materials in the unsaturated zone

A groundwater extraction and treatment system would also be installed under Example Alternative 2. It would reduce the concentrations of organic contaminants in the groundwater in Area I/II to drinking water standards in less than 15 years, and to the SNARL for longer term use in approximately 40 years. Forty years of pumping would also reduce the lifetime excess cancer risk for organics to 1×10^{-5} for the worker scenario.

Example Alternative 2 or 3 would not be effective in achieving drinking water standards for some metals. The lead and chromium (if hexavalent) concentrations in Area I/II groundwater would for all practical purposes never be reduced to drinking water standards, and cadmium would require more than 120 years of pumping. Zinc and nickel water quality criteria are below background groundwater concentrations. Therefore backgrounds were used as the appropriate target levels. Approximately 120 years of pumping would reduce zinc and nickel concentrations to background.

During the pumping period, groundwater beneath the site would no longer flow toward Mill Creek; therefore, contaminated groundwater from the site would no longer discharge into the creek. Zinc and other contaminant concentrations in the creek would be able to meet the modified ambient water quality criteria after the start of pumping. If pumping were stopped after 30 years, inorganic contaminants not removed from the groundwater beneath the site would migrate toward and into Mill Creek, and the resulting concentrations in the creek water would exceed the modified criteria levels. An additional 30 to 90 years of pumping would be required before zinc and other inorganic contaminant levels in the groundwater would be sufficiently reduced to allow Mill Creek to meet the modified criteria.

Installation of the surface cap would require careful, labor-intensive construction and the importation of large quantities of materials. Eight months would be required for construction. During site grading and cap construction there would be a potential for human exposure to airborne contaminants.

6.4.1.3 Example Alternative 3--Excavation with Onsite Disposal, Groundwater Extraction and Treatment, Surface Cap

The technical evaluation of Example Alternative 3 is shown in Table 6-8. The effectiveness of Example Alternative 3 in reducing groundwater contaminant levels and in protecting Mill Creek from zinc and other inorganic contamination is similar to that of Example Alternative 2. Example Alternative 3 should be more reliable than Example Alternative 2 because the contaminants in the unsaturated zone of Area I would be excavated and isolated from the environment in the landfill. The volume of these materials is estimated to be 108,000 cubic yards.

Example Alternative 3 would be much more difficult to implement than Example Alternative 2. Installation of the landfill would require staged excavation and construction. Forty-eight months would be required for the construction phase.

This example alternative would also create safety concerns not associated with Example Alternative 2. These concerns are related to the excavation, stockpiling, and replacement of contaminated soils. An advantage of Example Alternative 3 (as well as Example Alternatives 4 and 5) is that the excavation operation would allow drums and other wastes known to be buried at the site in the unsaturated zone to be removed and disposed of properly.

6.4.1.4 Example Alternative 4--PRP Remedial Action Plan[1]

The results of the technical evaluation of Example Alternative 4 are shown in Table 6-9. If Example Alternative 4 were implemented, approximately 75,000 cubic yards of contaminated material would be excavated from the unsaturated zone of Area I and transported offsite for disposal in a double-lined, RCRA hazardous waste landfill. The excavated areas would be backfilled with 60,000 cubic yards of imported soil. A diversion barrier and groundwater extraction and treatment system would be installed. Following up to five years of groundwater pumping, the property would be capped with an asphaltic concrete pavement.

The multi-depth excavation scheme included under Example Alternative 4 would remove approximately 69 percent of the total average amount of zinc and approximately 47 percent of the total average amount of organic contaminants present in Area I soil and groundwater. By removing contaminated surface material and replacing it with imported fill, Example

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[1] This section was prepared by the PRP's.

Table 6-8
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 3

Category	Comments
Effectiveness	A total of approximately 108,000 cubic yards of contaminated materials would be excavated from Areas I and II and a small part of Area VIII as described in Section 6.3.3. The material would be disposed of in an onsite, double-lined RCRA landfill. This action would isolate approximately 60 percent of the metal contamination including zinc. The effectiveness of the RCRA multimedia cap would be similar to the effectiveness of the cap discussed as part of Example Alternative 2. The effectiveness of the groundwater extraction system would be similar to the effectiveness of the system discussed as part of Example Alternative 2. While the landfill would further reduce potential for leaching of contaminants compared to Example Alternative 2 because of the excavation and isolation, Example Alternative 3 contains fewer well points and a slightly lower groundwater extraction rate. The 85-gpm groundwater extraction rate should be sufficient to prevent contaminated groundwater from flowing to Mill Creek from Areas I, II, V, and IX during the period of pumping. The effectiveness of the groundwater extraction and treatment systems would be confirmed as in Example Alternative 2.
Durability	Hazardous waste landfills with double liners and leachate collection and detection systems have not been in existence long enough to determine their useful life. The surface cap would be expected to have a useful life similar to the life of the cap discussed in Example Alternative 2. The expected life span of equipment in the groundwater extraction and treatment systems is similar to that discussed as part of Example Alternative 2.

Table 6-8 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 3

Category	Comments
Durability (continued)	When a particular item reaches its actual life span, that item would be replaced to maintain the effectiveness of the example alternative. The landfill liner would require replacement if it were determined to be vital to the continued effectiveness of this Example Alternative at the time of failure.
Demonstrated Performance	Long-term experience with synthetic membrane/clay, double-lined landfills in hazardous waste applications is limited; however, this technology is considered to be the state of the art. Testing would be required prior to installation as discussed in Example Alternative 2.
Ease of Installation	Example Alternative 3 would involve the staged construction of a double-lined landfill. To accomplish this, approximately 108,000 cubic yards would be excavated in stages. The excavated material in each stage would be stored onsite temporarily prior to placing in the landfill. Because the available area (Area I) is only 11 acres, this would be difficult, but it is expected to be feasible. All Area I underground utilities would be removed and disposed of in the landfill. Example Alternative 3 would involve importation of approximately 122,000 square yards of geotextile filter, 122,000 square yards of synthetic membrane material, 47,000 cubic yards of loam, 81,000 cubic yards of clay, and 58,000 cubic yards of sand. Approximately 2,900 feet of concrete lined ditches, 8 catch basins, and 4,200 feet of primary drainpipe would be required. It is not known whether these materials would be available locally in these quantities. The bottom liner and cap would require careful, labor-intensive construction procedures. Clay could be handled only during the dry season.

Table 6-8 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 3

Category	Comments
Ease of Installation (continued)	Permanent access to Areas I, II, and V would be required. Long-term access would be required to Area VII. Temporary access to Areas III, IV, VIII, IX, and X would be required. The adjacent sections of the Interurban Trail would be closed during excavation and landfill construction. Adjacent underground utilities would require protection during excavation activities. Construction of the groundwater extraction system would involve conventional materials and equipment. Construction of the groundwater treatment plant, after pilot testing has been completed and the unit processes selected, would involve conventional materials and equipment. Only minor construction is required to connect the groundwater treatment plant to the sewer discharge line.
Time to Implement	Forty-eight months would be required for the construction phase of this example alternative, not including time for additional studies, pilot testing, and final design. The length of the construction phase is caused by the need to phase the construction and by seasonal limitations A pumping period of 30 years has been assumed for evaluation and costing for this example alternative.
Monitoring Requirements	The monitoring requirements for Example Alternative 3 are similar to those discussed as part of Example Alternative 2. In addition, the leachate collection and detection systems would be monitored to ensure proper functioning. This would require frequent inspections by trained personnel.

Table 6-8 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 3

Category	Comments
Operation and Maintenance Requirements	The operation and maintenance requirements for Example Alternative 3 would be similar to those discussed as part of Example Alternative 2. The chemical requirements and quantity of sludge produced by the treatment system would be slightly lower due to the slightly lower flow rate of the extraction system (85 gpm). If the leachate detection system showed the presence of a leak from the primary liner, an extensive maintenance procedure could be required.
Safety During Construction and Operation	A Health and Safety Plan would be prepared before any excavation or construction is undertaken at Western Processing. Safety considerations would include onsite and perimeter monitoring of contaminants. The excavation would create added safety concerns due to the potential for airborne releases of contaminated materials during the excavation, stockpiling, and replacement activities. All personnel would be properly trained in accordance with federal, state, and local regulations. Dust control measures would be implemented during the construction phase. Equipment exposed to hazardous materials would be decontaminated. Federal, state, King County, and City of Kent officials would be involved in contingency and emergency response planning. During excavation and landfill construction, stormwater would be controlled to prevent the discharge of contaminated surface water runoff.

Table 6-8 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 3

Category	Comments
Safety During Construction and Operation (continued)	During excavation and landfill construction, the sides of the excavated areas would be sloped to prevent collapse. The angle of the slopes would be determined during detailed design, should this example alternative be implemented. If buried wastes are uncovered during excavation the material would be evaluated for compatibility with landfill liners and design. Certain excavated wastes such as PCB's, buried drums, and concentrated wastes may require special handling and possibly special disposal procedures. The safety concerns for the groundwater extraction and treatment systems would be similar to those discussed under Example Alternative 2.
Safety in the Event of Failure	The safety concerns in the event of the failure of the cap and associated stormwater system, groundwater extraction, and treatment system portions of Example Alternative 3 are similar to those discussed for Example Alternative 2. The bottom liner consists of four elements: a leachate collection system, a primary synthetic liner, a leak detection and collection system, and a secondary clay liner. The two collection systems and both liners would have to fail to potentially release leachate to the local groundwater. Because the cap would have prevented infiltration and because leachate from soil drainage would be captured by the leachate collection system, contaminated soil in the landfill would be relatively dry within a few years of landfill installation. Consequently, the landfill cap would have to fail before complete failure of the bottom lining system would result in the release of leachate from the landfill.

Table 6-9
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 4 (PRP PLAN)*

Category	Comments
Effectiveness	Approximately 75,000 cubic yards of buried waste materials and contaminated soil would be excavated from Area I and be transported offsite for disposal in a double-lined RCRA landfill. The excavated area would be backfilled with imported soil. This action would eliminate the potential for direct contact with contaminated soil by humans and animals, as well as prevent surface water runoff from contacting contaminated soil. Approximately 69 percent of the total zinc contamination in Area I would be removed by this action. The groundwater pumping and treatment program would remove approximately 7 percent more zinc from Area I and improve the overall quality of the shallow groundwater beneath Area I. However, the analysis of indicator parameters indicates that federal drinking water standards for certain metals would not be achieved even if the pumping program is operated for an indefinite period of time. During the pumping period, the release of contaminants from Area I to Mill Creek via groundwater would be prevented. Following the completion of pumping, Area I would be capped with an asphaltic concrete pavement, which would inhibit surface water infiltration and leaching of residual contaminants from the unexcavated soil of the unsaturated zone. In addition, the diversion barrier would slow the rate of movement of contaminants that might be released from Area I via groundwater and migrate to Mill Creek. However, the combined effect of the excavation and pumping program, the surface pavement, and the diversion barrier would sufficiently reduce the amount of contamination entering Mill Creek so that water quality within the creek could meet modified ambient water quality criteria.

*This table prepared by the PRP's.

Table 6-9 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 4 (PRP PLAN)

Category	Comments
Effectiveness (continued)	The effectiveness of the groundwater extraction system as measured by flow to Mill Creek would be confirmed by monitoring during operation; the system could be modified during design and during operation, as necessary.
	The effectiveness of the treatment system would be confirmed by bench or pilot-scale testing during detailed design, and adjustments would be made as necessary during operation.
Durability	The expected life span of equipment in the groundwater extraction, treatment, and monitoring systems varies from 10 to 50 years, which is greater than the maximum operating period of Example Alternative 4.
	The potential life span of the diversion barrier is not known at this time but is expected to be significantly longer than the maximum duration of the groundwater pumping program. Factors that could limit the durability of the diversion barrier are chemical attack and physical disruption. These are subsequently addressed below under the "Safety in Event of Failure" category.
	The asphaltic concrete pavement that would be installed over the site at the conclusion of the groundwater extraction and treatment program would have a useful life of approximately 20 to 30 years, after which resurfacing would be required. Because the excavation and groundwater extraction components would remove the majority of the contamination from the site, the pavement must only minimize rather than eliminate surface water infiltration. Minor deterioration in the pavement would not significantly reduce the overall effectiveness of this component. Repavement to control surface water infiltration may not be necessary after 20 to 30 years.

Table 6-9 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 4 (PRP PLAN)

Category	Comments
Demonstrated Performance	Each of the components included in Example Alternative 4 has been used successfully in the past to perform the function for which it would be used at the Western Processing site. Not all have been used at a site having the physical and chemical complexity of Western Processing, however. Therefore, field, laboratory, and bench-scale testing would be required before final system configurations and designs could be selected. The performance of the installed systems would be monitored to allow further adjustments, if necessary, following installation.
Ease of Installation	With the exception of the asphalt emulsion diversion barrier, which is one of the two types of construction materials being considered by the PRP's, all structures and facilities would be constructed using standard techniques and equipment. Dismantling, where included, would also use standard techniques and equipment.
	Approximately 60,000 cubic yards of soil would be required to backfill the excavations. This fill material would have to meet specific design requirements related to permeability and grain size because enhanced precipitation infiltration is a component of Example Alternative 4 during operation of the groundwater extraction program. Approximately 9,200 cubic yards of gravel would be required for the permeable surface cover during the groundwater extraction period. Other construction requirements would include approximately 3,300 linear feet of either a soil-bentonite slurry or an asphalt emulsion for the diversion barrier; approximately 2,370 linear feet of piping and 9 catch basins for the stormwater control system; and approximately 55,660 square yards of asphaltic concrete for the surface cover (pavement). With the exception of the bentonite, all the construction materials are expected to be available locally.

Table 6-9 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 4 (PRP PLAN)

Category	Comments
Ease of Installation (continued)	During excavation and diversion barrier installation activities, the contractor would be required to protect utilities to the north and east of the Western Processing property. Onsite buried utilities would be removed during the excavation process. If a soil-bentonite type of slurry is selected to construct the diversion barrier, large areas of the site would be required for stockpiling soil and for slurry mixing impoundments. The installation of the barrier would need to be scheduled so that these space requirements would not interfere with other activities. If an asphalt emulsion system is selected to construct the diversion barrier, special equipment would be required. More complex installation procedures would be associated with this type of barrier, and a more rigorous quality control program would need to be implemented. However, this system would require much less area for installation because no soil stockpiling or impoundments would be needed and less soil would be excavated to install the barrier. The adjacent sections of the Interurban Trail would be closed during excavation of contaminated soil.
Time to Implement	A minimum of 24 months would be required for the diversion barrier installation, site excavation, groundwater extraction system installation, and (if selected) onsite treatment plant construction. Approximately 8 years would be required for the entire remedial action, including dismantling of structures and installation of the surface pavement assuming that the pumping program would be operated for the full 5 years.
Monitoring Requirements	The groundwater extraction system would require daily monitoring by trained personnel. Effluent from the onsite treatment plant (if constructed) would be monitored prior to discharge.

Table 6-9 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 4 (PRP PLAN)

Category	Comments
Monitoring Requirements (continued)	A monitoring well system would be used to evaluate the effectiveness of the remedial action.
	After the remedial action is completed, inspection of the surface pavement and stormwater control system would be the responsibility of the site owner.
Operation and Maintenance Requirements	The groundwater extraction system that would be installed under Example Alternative 4 was selected for ease and flexibility of operation and maintenance. Routine operation and maintenance could be performed by a properly trained individual under the direction of an engineering professional. If an onsite treatment plant is constructed, a qualified plant operator would be required.
	Chemical supply and treatment sludge quantities associated with an onsite treatment plant would be similar to those identified under Example Alternative 2.
Safety During Construction and Operation	A Health and Safety Plan would be prepared and implemented before any activities associated with Example Alternative 4 were begun. This plan would include onsite and perimeter monitoring for contaminants.
	All personnel would be properly trained in accordance with federal, state, and local regulations.
	Dust control measures would be implemented during construction activities.
	Any equipment exposed to hazardous materials would be decontaminated.
	Federal, state, King County, and City of Kent officials would be involved in contingency and emergency response planning.

Table 6-9 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 4 (PRP PLAN)

Category	Comments
Safety During Construction and Operation (continued)	The safety concerns for the groundwater extraction and treatment systems would be similar to those discussed under Example Alternative 2. During excavation and operation, stormwater would be controlled to prevent the discharge of contaminated surface water runoff. Trucking of excavated materials to an offsite hazardous waste landfill would be conducted according to a transportation plan designed to minimize potential transportation risks.
Safety in the Event of Failure	The groundwater extraction system that would be installed under Example Alternative 4 would be expected to experience both routine and unplanned down time. The system would be designed so that such downtime would not adversely impact the overall effectiveness of the system. Failure of the diversion barrier would potentially reduce the effectiveness of the groundwater extraction program. Failure of the barrier could result from disruption of the barrier by earthquake or from improper installation. The monitoring system that would be installed at the site would indicate such a failure, which could then be corrected. The effectiveness of the barrier could be reduced if the barrier materials were made significantly more permeable as a result of chemical attack. However, the barrier materials would be selected on the basis of chemical compatibility testing prior to installation. Some increase in permeability could be tolerated, particularly after completion of the groundwater extraction program. However, if the permeability of the diversion barrier increased to about 10^{-4} cm/sec, the effect of the barrier would be essentially eliminated.

Table 6-9 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 4 (PRP PLAN)

Category	Comments
Safety in the Event of Failure (continued)	Monitoring would be used to track the effectiveness of the barrier during pumping system operation. Structural failure of the barrier, or the gradually increasing permeability that would be associated with chemical attack, would be detected by the monitoring system, and measures to correct the problem could be taken as necessary. Deterioration of the surface pavement and stormwater management system would be expected with time. The asphaltic concrete pavement is potentially more susceptible to deterioration, cracking, or other failure than a multimedia RCRA cap but is easier to repair and maintain. Significant deterioration of the pavement could result in infiltration; however, because the majority of contamination would have been removed from the unsaturated zone, leaching of residual contamination from unexcavated soil in the unsaturated zone is expected to be minor. The diversion barrier would serve to slow the release of leached residual contaminants from the property via groundwater. Failure of the stormwater management system could cause flooding of the property, release of stormwater to the subsurface, or more rapid release of stormwater to Mill Creek than would be allowed under the City of Kent stormwater management ordinance, depending on the nature of the facility. Maintenance and repair of the stormwater system would be the responsibility of the site owner.

Alternative 4 would prevent direct contact with contaminated soils by humans and animals. The potential for contaminated surface water runoff would also be eliminated by the excavation/backfill action; additional protection would be afforded by the surface pavement.

The groundwater pumping and treatment program would remove an additional 7 percent of the total average amount of zinc, and an additional 38 to 48 percent of the total average amount of organics estimated to be in Area I at present. During the groundwater pumping period, surface water would be allowed to infiltrate the contaminated soil not removed from the unsaturated zone during the excavation program. The water would pick up contaminants from this soil and carry them into the saturated zone, where they would be removed by the pumping system. This action would supplement the source removal action provided by excavation alone.

Groundwater quality beneath the property would be significantly improved by this alternative. However, drinking water standards for cadmium, chromium, and lead would not be met at the conclusion of the pumping program. It would probably take hundreds of years of pumping before these standards could be met, if ever.

The groundwater pumping program would prevent contaminated groundwater from migrating from the property and discharging into Mill Creek. Once the pumping program is completed, the diversion barrier would continue to affect local shallow groundwater flow patterns.

Contaminants remaining in the saturated zone following the conclusion of the pumping program could be carried from the property and discharged into Mill Creek via groundwater. However, the combined effect of the following factors would be sufficient to reduce the amount of contaminants entering Mill Creek to a level that would allow creek water to meet modified ambient water quality criteria:

- The surface pavement would minimize infiltration and leaching of the residual contamination in the unsaturated zone.

- The excavation and pumping program would have removed approximately 76 percent of the zinc contamination from the unsaturated and saturated zones.

- The diversion barrier would slow the rate of contaminant release from the property and thus the rate of discharge into Mill Creek.

The following table summarizes the estimated reductions in the zinc loading to Mill Creek just downstream of the Western Processing site achieved by the remedial action components of Example Alternative 4. The reductions are a result of the actual removal of zinc mass from Area I by the excavation and groundwater extraction programs and the reduction in groundwater flow from the site to Mill Creek caused by the presence of the diversion barrier.

	In Soil (lb)	In Groundwater (lb)	Total (lb)	Reduction
1. Existing zinc mass	2,263,157	39,614	2,302,771	-
2. Zinc mass after Ex. Alt. 4 excavation	665,558	39,614	705,172	69.4%
3. Zinc mass after Ex. Alt. 4 groundwater extraction	532,447	31,691	564,138	75.5%

The 75.5 percent reduction in Area I zinc mass is assumed to cause an identical reduction in zinc loading to the creek.

In addition to the removal of mass, the presence of the diversion barrier will force residual contamination migrating from Area I to follow a longer flow path to Mill Creek and to move vertically through zones of relatively lower hydraulic conductivity. The result is a 50 to 60 percent lower rate of release of residual contamination to the creek than without the barrier, hence a similar reduction in loading to the creek.

The estimated reduction in zinc loading to Mill Creek from all of these factors is calculated as follows:

$$(75.5\%)+(.5)(100\%-75.5\%) = 87.8\% \text{ (or approximately 88\%)}$$

As noted above, the diversion barrier would cause residual contaminants in the groundwater beneath Area I to migrate vertically before they move beyond the wall. Because the barrier depth corresponds to the depth at which regional (as opposed to local) flow patterns begin to influence groundwater beneath Area I, these residual contaminants could enter the regional pattern. If this occurs, they would move beneath, rather than into, Mill Creek and toward more distant receptors such as the Green River. However, the amount of contamination, if any, leaving the local flow system would be very minor.

Unlike Example Alternatives 2 and 3, Example Alternative 4 would not require long-term operation and maintenance (except groundwater monitoring); approximately 8 years would be involved in the construction and operation of the components. The diversion barrier would require no maintenance. The pavement and stormwater management system would need to be maintained by the site owner with the same level of care normally followed at paved industrial or commercial facilities. The safety concerns of this example alternative would be similar to those of Example Alternative 3, with the exception of the increased truck traffic associated with offsite disposal of contaminated soil.

6.4.1.5 Example Alternative 5--Excavation with Offsite Disposal

The technical evaluation of Example Alternative 5 is shown in Table 6-10. Example Alternative 5 would involve the removal of approximately 300,000 cubic yards of contaminated soil and waste material from Areas I and II and portions of Areas V, VIII, and IX, and replacement with clean fill. Example Alternative 5 would remove approximately 95 percent of all contaminants from Areas I, II, V, and IX, including approximately 95 percent of the zinc contamination. By removing all the surface soils in the excavation areas, Example Alternative 5 prevents direct contact of stormwater, humans, and animals with the contaminated soils in these areas and removes most of the unsaturated zone materials in these areas including all unsaturated zone materials from Areas I and II. Infiltration through contaminated soil in Areas V and IX would be minimal.

Groundwater would be extracted and treated during the construction of this alternative. This action, combined with soils removal, is expected to improve local shallow groundwater quality. Excavation would lower the concentrations of lead, chloroform, tetrachloroethene, toluene, and 1,1,1-trichloroethane in Area I/II to below the federal drinking water standards or SNARL's. Excavation and groundwater extraction would reduce trichloroethene and trans 1,2-dichloroethene concentrations to below the SNARL's. Cadmium and chromium (if hexavalent) may not be reduced sufficiently by Example Alternative 5 to achieve federal drinking water standards. The source reduction by itself would be sufficient to allow zinc and other inorganics concentrations in Mill Creek to meet the modified ambient water quality criteria after the 4-year excavation and dewatering program. Unlike Example Alternatives 2 and 3, Example Alternative 5 would not require long-term operation and maintenance.

Forty-eight months would be required for the completion of this example alternative. The safety concerns of this example alternative would be similar to those of Example Alternative 4, except that truck traffic related to offsite

Table 6-10
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 5

Category	Comments
Effectiveness	Example Alternative 5 would involve the removal of approximately 300,000 cubic yards of contaminated materials with their disposal in a RCRA-regulated landfill and replacement of the excavated materials with clean, compacted fill. This alternative would remove approximately 95 percent of all contamination in the soil. Approximately 95 percent of the contaminated material (including zinc) would be removed from Area I/II; 50 percent would be removed from Area V and 20 percent from Area IX. Data are insufficient to estimate the removal percentage from Area VIII. The soil removal program would prevent human, animal, and stormwater contact with contaminated soils in the excavated area. In Areas I and II infiltration would be through the replacement fill material with no leachate generation expected in Areas I and II. Leachate generation in Areas V, VIII, and IX would be reduced substantially. Local shallow groundwater quality would be improved by the combination of source removal and dewatering system operation. Contaminant levels would be reduced to at or near the SNARL for longer term use and to below federal drinking water standards for all contaminants except cadmium and chromium. The soil removal and dewatering program would be sufficient to allow the zinc levels in Mill Creek to meet the modified ambient water quality criteria. The positive effects of the source removal may take some time to measure in Mill Creek. All the contaminated groundwater currently en route to Mill Creek may not be intercepted.
Durability	The dewatering and treatment systems would operate only during the time required for excavation (about 4 years). This is much shorter than the expected equipment life span of 10 to 50 years.

Table 6-10 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 5

Category	Comments
Demonstrated Performance	Soil excavation and removal is a proven method for mitigating soil contamination. The contaminated soils would be disposed of at an offsite double-lined USEPA-permitted hazardous waste landfill. Long-term experience with double-lined landfills in hazardous waste applications is limited; however, it can be expected that double-lined landfills will be more protective of the environment than are unlined or single-lined landfills. The demonstrated performance of the dewatering and treatment systems is similar to the groundwater extraction and treatment system.
Ease of Installation	Example Alternative 5 would involve the removal of approximately 300,000 cubic yards of contaminated soil and its replacement with compacted, clean fill. This would create heavy truck traffic on the surrounding roads. The availability of clean fill and of disposal space at USEPA-permitted double-lined landfills has not been confirmed.
	The depth of the Area I/II excavation (15 feet) would be well below the groundwater table. Therefore, the excavation would require dewatering and sheet piling for that portion of the excavation. The excavation is anticipated to be done in stages.
	Temporary access to Areas I and II and portions of V, VII, VIII, IX, and X would be required.
	The Interurban Trail would be closed adjacent to Western Processing during all excavation and refilling operations.
	The above-ground powerline in Area II would be relocated to Area X.
	The excavation operation would involve the use of conventional materials and equipment; utilities in the contaminated areas could be removed. The oil line in Area II would cause construction problems and require appropriate protection.

Table 6-10 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 5

Category	Comments
Time to Implement	Forty-eight months would be required for the construction phase of this example alternative, not including time for additional studies, pilot testing, and final design. The approximate 4-year implementation time presumes normal weather conditions. As with any major earthmoving operation, prolonged adverse, wet weather could extend the schedule beyond the 4-year period. Conversely, an extended period of dry weather could shorten the anticipated construction period.
Monitoring Requirements	During excavation, the effluent from the dewatering and treatment system would be monitored to ensure that it meets discharge limits. Monitoring requirements for groundwater and Mill Creek would be similar to Example Alternative 2.
Operation and Maintenance Requirements	During the construction period, the dewatering and treatment systems would require daily operation and maintenance by trained personnel. The chemical usage requirements for the dewatering system would be similar to those described for Example Alternative 2. Decontamination water may require additional treatment for precipitation of fines. Approximately 1,600 tons of hazardous sludge would be generated per year by the treatment system. This sludge would require disposal at a double-lined, RCRA hazardous waste landfill. There would be no operation and maintenance requirements after 4 years, except monitoring.

Table 6-10 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 5

Category	Comments
Safety During Construction and Operation	General safety concerns and procedures would be similar to those discussed for Example Alternative 3.
	A Health and Safety Plan (including a transportation safety plan) would be prepared before any excavation or construction is undertaken at Western Processing.
	Any equipment exposed to hazardous materials would be decontaminated.
	Federal, state, King County, and City of Kent officials would be involved in contingency and emergency response planning.
	During excavation, the sides of the deeper excavated areas would be supported by steel sheet piling and monitored.
	Certain excavated materials such as PCB's, buried drums, and concentrated wastes would require special handling and possibly disposal procedures.
	The safety concerns for the dewatering and treatment systems would be similar to those discussed for the extraction and treatment systems in Example Alternative 2.
Safety in the Event of Failure	Should the dewatering system fail, excavation below the water table would be suspended pending repairs.
	Should the effluent from the treatment system fail to meet discharge limits, the water would be stored for recycling through the plant.

disposal of contaminated materials would extend over a considerably longer period of time.

6.4.1.6 Example Alternative 6--Mill Creek--No Action

The results of the technical evaluation of Example Alternative 6 are shown in Table 6-11. If no action were taken in Mill Creek, the contaminated sediments would be free to migrate downstream. No action combined with an effective source control action (i.e., one that sufficiently reduced groundwater contamination) would result in the gradual dispersal of contaminated sediments from the Western Processing reach of the creek. There would be no installation, operation, or maintenance requirements.

6.4.1.7 Example Alternative 7--Mill Creek Sediment Removal

The results of the technical evaluation of the sediment removal program that constitutes Example Alternative 7 are shown in Table 6-12. Example Alternative 7 should effectively prevent water quality degradation from, and the continued migration of, contaminated sediments, provided the flow of contaminated groundwater from the site to Mill Creek is halted by a source control action.

Approximately one month would be required to complete the sediment removal procedure. Safety concerns would be similar to those of other soil excavation alternatives. In addition, flooding due to an unexpectedly severe storm could cause the release of contaminated sediments if the downstream diversion dike is overtopped.

6.4.2 ENVIRONMENTAL EVALUATION

Each of the example alternatives was evaluated to determine its possible effects on human health and the environment. Tables 6-13 through 6-19 describe the impacts of the example alternatives on all elements of the environment except the following:

Historic and Cultural Resources: No such resources are known to exist in the areas affected by the alternatives.

Endangered Species: No such species are known to exist in the areas affected by the alternatives.

Wetlands: No properties that would be affected by the alternatives are designated as wetlands.

Utilities: None of the alternatives would adversely affect the availability of current public water supplies, nonhazardous solid waste disposal, telephone service, or natural

Table 6-11
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 6

Category	Comments
Effectiveness	Example Alternative 6 would not remove the contaminated sediments from Mill Creek. The contaminated sediments in the creek would remain in an uncontrolled state and would be moved downstream by natural processes. Modification of Mill Creek (e.g., dredging, detention, or re-routing) above Western Processing as part of Kent's Drainage Master Plan could change the effectiveness of this example alternative, as could the introduction of new upstream sources of contaminants. Without an effective source control action, contaminated groundwater would continue to discharge from Western Processing to Mill Creek, causing continued water quality and sediment degradation. This process would continue for well beyond 100 years. With an effective source control action, it would take from 5 to 10 years for the contaminated sediments to be transported out of the local stream reach.
Durability	Not applicable.
Demonstrated Performance	Not applicable.
Ease of Installation	Not applicable
Time to Implement	Not applicable
Monitoring Requirements	Mill Creek would be monitored in conjunction with the implementation of the source control alternative.
Operation and Maintenance Requirements	Not applicable.
Safety During Construction and Operation	Not applicable.
Safety in the Event of Failure	Not applicable.

Table 6-12
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 7

Category	Comments
Effectiveness	Example Alternative 7 would remove the contaminated sediments (nominally estimated at one foot thick) in a 2,300-foot-long reach adjacent to and downstream of the Western Processing site (estimated volume 1,700 cubic yards). This action removes these materials as a potential source of organic and inorganic (metallic) pollutants to the creek. Without some source control action (Example Alternatives 2 through 5), sediments in the creek would become recontaminated, particularly by metals, due to the discharge to the creek of contaminated groundwater from Western Processing. Modification of Mill Creek (e.g., dredging, detention ponds, or rerouting) above Western Processing as part of Kent's Drainage Master Plan could change the effectiveness of this example alternative, as could upstream sources of contaminants.
Durability	This example alternative would remain effective for as long as contaminated groundwater is prevented from flowing into the creek.
Demonstrated Performance	Excavation is the only component in this alternative and is a common method of reducing contamination.
Ease of Installation	Removal of the contaminated sediments would involve the temporary diversion of Mill Creek (diversion structure and piping) in addition to the excavation of the contaminated sediments. Depending on the water content upon removal, the sediments may require dewatering prior to transportation and disposal. The diversion structure and piping should be easy to place. Further testing can further define disposal alternatives.
Time to Implement	Example Alternative 7 would require approximately one month to complete and should be performed during the dry season (July to October).

Table 6-12 (continued)
TECHNICAL EVALUATION--EXAMPLE ALTERNATIVE 7

Category	Comments
Monitoring Requirements	Monitoring of Mill Creek waters and sediments and groundwater quality and flow near the creek would be necessary to determine the optimum time to remove the contaminated sediments. Monitoring would also be done to determine the effectiveness of the excavation.
Operation and Maintenance Requirements	Example Alternative 7 has no systems that would require long-term operating and maintenance.
Safety During Operation	Example Alternative 7 would be implemented under a Health and Safety Plan. This plan would consider general safety precautions, the potential for overtopping the diversion structure, and the potential for worker exposure to hazardous materials.
Safety in the Event of Failure	Example Alternative 7 does not contain any long-term components. Failure of the diversion structure would be the major consideration during implementation. This would be considered in the Health and Safety Plan. If creek sediment excavation did not solve the problem, the creek could be reexcavated at some future time.

Table 6-13
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 1--NO ACTION

Element of the Environment	Short-Term Effects	Long-Term Effects
Human Health:		
Soils	Same as long-term	Long-term health effects could result from exposure to soils at Western Processing. ADI's for lead, chromium (if all chromium is in the hexavalent state), and cadmium would be exceeded (depending on the assumed quantity of soil ingested and the measured contaminant concentrations). Exposure to carcinogens could lead to an excess lifetime cancer risk of from 1 x 10^{-2} to 5 x 10^{-7} depending on the length and frequency of exposure.
Groundwater	Same as long-term	Shallow groundwater in the area is not currently used for human consumption. The current concentrations of organic and inorganic contaminants in the groundwater beneath the site exceed federal drinking water standards and the suggested no adverse response levels (SNARL's) for long-term use. If the groundwater were consumed at a rate of 2 liters/day, ADI's for phenol, cadmium, chromium (if all hexavalent), lead, and nickel would be exceeded. For a similar consumption rate over a 40- to 70-year period, the excess lifetime cancer risk would be from 5 x 10^{-1} to 8 x 10^{-5}.
Surface water (Mill Creek)	Recreational use of Mill Creek does not pose a threat to human health. Mill Creek is not used as a drinking water source.	Mill Creek is not used as a drinking water source. However, if it were, contaminants in Mill Creek could cause an excess lifetime cancer risk of about 10^{-4}, assuming consumption of 2 L/day for 40 years. Given the maximum concentrations of contaminants found and a consumption rate of 2 L/day, the ADI's for the metals and organics of primary concern would not be exceeded.
Air	Same as long-term	Inhalation of contaminated dust could cause health effects. This effect was not quantified. Taking in soil via air could add an additional exposure to the health effects of soils described above.

Table 6-13 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 1--NO ACTION

Element of the Environment	Short-Term Effects	Long-Term Effects
Aquatic Organisms in Mill Creek:	The modified ambient water quality criteria would continue to be exceeded in Mill Creek water, which would adversely affect aquatic life. Both chronic and acute criteria for metals are currently exceeded.	Mill Creek water quality would gradually improve as the discharge of contaminants to the creek via groundwater is reduced with time. At some future date, estimated to be hundreds of years, water quality in the creek would return to background levels.
Groundwater:		
Quantity and flow	Groundwater would continue to flow from the site to Mill Creek and the east drain at the rate of approximately 50 to 70 gpm. Regional groundwater flow (below 60 feet) would continue to flow to the northwest at about 50 to 100 feet per year, ultimately discharging to the Green River.	Same as short-term impacts.
Quality	Groundwater quality would continue to exceed federal drinking water standards for cadmium, lead, and chromium.	Local groundwater quality would improve gradually as contaminants are discharged into Mill Creek and the east drain. Many contaminants would be removed from the groundwater naturally in less than 100 years. However, it would take hundreds of years, if ever, for local groundwater to return to federal drinking water standards for cadmium, lead, and chromium.
Stormwater:		
Quantity and flow	Stormwater runoff in Area I would generally pond onsite and infiltrate into the groundwater. Stormwater runoff in other areas would infiltrate or run off into Mill Creek or drainage ditches.	The natural drainage pattern to Mill Creek could resume in the future. Berms would gradually deteriorate and Area I runoff could discharge directly into Mill Creek.
Quality	Contaminated surface soils would continue to impart contaminants to groundwater and surface waters.	Same as short-term impacts, plus additional contaminated stormwater may enter Mill Creek as the berms deteriorate.

Table 6-13 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 1--NO ACTION

Element of the Environment	Short-Term Effects	Long-Term Effects
Mill Creek and East Drain:		
Quantity and flow	No impacts to the quantity and flow of Mill Creek.	Same as short-term impacts.
Quality	Contaminants would continue to be discharged into Mill Creek via groundwater. Levels of zinc, chromium (if all hexavalent) and cadmium would greatly exceed modified ambient water quality criteria in Mill Creek. Surface water runoff in Area I is controlled and would not discharge to Mill Creek.	After hundreds of years, the discharge of heavy metals via groundwater (especially cadmium, lead, and chromium) would be reduced to levels meeting modified ambient water quality criteria. Past stormwater drainage patterns could resume within several years, causing the discharge of contaminated surface water into Mill Creek.
Sediment quality	Dissolved contaminants discharged via groundwater or surface water would continue to be adsorbed by sediments.	Contaminant levels in Mill Creek sediments would gradually be reduced as the source is depleted and contaminated sediments are transported downstream.
Terrestrial Wildlife	Because of human activity and lack of vegetation, the site has not been significantly used by wildlife.	If vegetation develops, some wildlife may be attracted to the site. The potential for harmful effects on wildlife resulting from their use of the site cannot be predicted.
Soils and Topography (excavation, removal)	No impacts to soils or topography.	Same as short-term impacts.
Noise	No noise impacts.	Same as short-term impacts.
Air Quality (odor, dust)	Contaminated dust could originate from the site during dry periods. If vegetation becomes established, the potential for dust generation would be reduced.	Same as short-term impacts.
Transportation	No transportation impacts.	Same as short-term impacts.
Flood Plains	No impacts to flood plains. According to FEMA maps, a 100-year flood would inundate small areas adjacent to Mill Creek and the east drain.	Same as short-term impacts.
Land Use	Land use might be restricted by federal, state, or local agencies in order to protect public health. Monitoring could be used to determine what development restrictions should be applied to the various analysis areas.	Same as short-term impacts.

Table 6-14
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 2--SURFACE CAP WITH GROUNDWATER EXTRACTION AND TREATMENT

Element of the Environment	Short-Term Effects	Long-Term Effects
Human Health:		
Soils	Exposure of workers and the general public to contaminated soil would be controlled by the provisions of the Health and Safety Plan.	Placement and maintenance of the cap would eliminate human exposure to contaminated soils in Areas I, II, and V. Exposure and ingestion potential would remain for Area VIII, where the ADI for lead could be exceeded, and for Area IX, where the potential excess lifetime cancer risk could vary from 3×10^{-5} to 3×10^{-3}, depending on the length and frequency of exposure.
Groundwater	Groundwater beneath Western Processing does not present a hazard to human health because it is not currently a water supply source.	Because of low yield, poor regional water quality, and the presence of adequate alternate water supplies, the local shallow aquifer is not a likely candidate for development. The proposed well point system and cap generally preclude development of a supply well in and around Western Processing. While a 15-year groundwater extraction and treatment operation should reduce chloroform concentrations to less than the federal drinking water standard, and 40 years of pumping should reduce other organic concentrations to SNARL's for longer term use, it would take hundreds of years, if ever, of pumping and treatment to reduce cadmium, chromium, and lead to drinking water standards.
Mill Creek	Recreational use of Mill Creek does not pose a threat to human health. Mill Creek is not used as a drinking water source.	Long-term recreational use would not pose a threat to human health. Mill Creek is not planned for development as a drinking water source. If it were to be developed, the potential lifetime excess cancer risk would decrease over time as the groundwater extraction system isolated the creek from the contaminated groundwater and removed the organic contaminants that contribute to the cancer risk.
Air	See Soils, above.	The groundwater treatment process would release volatile organics. However, the system would be designed and operated to meet emissions standards, thus reducing the potential for adverse impact from these releases.

Table 6-14 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 2--SURFACE CAP WITH GROUNDWATER EXTRACTION AND TREATMENT

Element of the Environment	Short-Term Effects	Long-Term Effects
Aquatic Organisms in Mill Creek	During construction, stormwater in construction areas would be collected and treated prior to discharge to Metro. This would minimize the potential for discharge of contaminated stormwater runoff into Mill Creek.	Groundwater discharges from Areas I, II, V, and IX into Mill Creek would be eliminated after pumping begins, thus improving water quality in Mill Creek. As the water quality in Mill Creek improves, the potential for adverse impacts to aquatic organisms would decrease. If groundwater pumping stops after 30 years, groundwater from Western Processing would again flow into Mill Creek. With the return of groundwater flow to the creek, metals levels (particularly zinc) would probably rise above modified ambient water quality criteria. Sixty to 120 years of pumping would be necessary to allow metals levels in Mill Creek to stay below modified ambient water quality criteria.
Groundwater:		
Quantity and flow	Local groundwater would continue to flow to Mill Creek until the groundwater extraction and treatment system is operating. During this time, quantity and flow would remain unchanged.	The local groundwater would be pumped at about 100 gpm. During that time, the groundwater table would be drawn down an average of 5 to 10 feet between Mill Creek and the east drain. Shallow groundwater flow would no longer discharge to the creek or drain. Regional flow patterns would not be significantly affected. Pumping would not affect water supplies in the area. After pumping, groundwater would again discharge to Mill Creek and the east drain. The cap over Areas I, II, and V would limit groundwater recharge from precipitation infiltration and would reduce slightly local groundwater discharge to Mill Creek. The creek would continue to receive groundwater from uncapped areas and the regional system.

Table 6-14 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 2--SURFACE CAP WITH GROUNDWATER EXTRACTION AND TREATMENT

Element of the Environment	Short-Term Effects	Long-Term Effects
Quality	Local groundwater quality would continue to be controlled by natural processes until the groundwater extraction and treatment system was operating.	During groundwater pumping, groundwater quality would gradually improve. The contaminant levels would depend on the length of time groundwater extraction has been in progress and on which contaminant is being considered. During pumping, contaminated groundwater would not discharge to Mill Creek or the east drain from Areas I, II, V, and IX. A 30-year pumping program would not reduce cadmium, chromium, and lead concentrations below federal drinking water standards. It would take hundreds of years of pumping for the concentrations of these metals in groundwater beneath the site to meet the drinking water standards, if ever. As previously noted, the shallow aquifer that flows beneath Western Processing is not used as a drinking water source.
Stormwater:		
Quantity and quality	During site regrading and cap construction, stormwater runoff patterns could be affected. Temporary control measures could mitigate adverse impacts. Contaminated stormwater in construction areas would be collected, treated as necessary, and discharged to Metro.	Uncontaminated stormwater would be collected off the cap in Areas I, II, and V and discharged into Mill Creek. Stormwater in other areas will continue to infiltrate and/or discharge into Mill Creek.
Mill Creek:		
Quantity and flow	During construction, Mill Creek quantity and flow would remain similar to existing conditions. Groundwater would continue to discharge to the creek. Surface water in the construction areas would be routed away from the creek. As portions of the cap were completed, its stormwater system would become operational.	Groundwater extraction would intercept groundwater that otherwise would discharge to Mill Creek and the east drain. Groundwater discharge to Mill Creek and the east drain would resume after pumping ceases. Groundwater discharge quantity would be reduced slightly by the presence of the cap.

Table 6-14 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 2--SURFACE CAP WITH GROUNDWATER EXTRACTION AND TREATMENT

Element of the Environment	Short-Term Effects	Long-Term Effects
Quality	During construction of Example Alternative 2, Mill Creek water quality would be similar to current conditions.	During pumping, no contaminants from Western Processing would be discharged via groundwater to Mill Creek. The water quality of Mill Creek would gradually improve. If pumping was stopped after 30 years, metals contamination would be reintroduced to Mill Creek, with the resultant levels exceeding the modified ambient water quality criteria. Sixty to 120 years of groundwater extraction and treatment would be required to sufficiently reduce the level of metals contamination entering Mill Creek from Western Processing to allow modified ambient water quality criteria to be met in the creek.
Sediment quality	Contaminated sediments could continue to be a source of contamination to Mill Creek water.	The contaminant levels in Mill Creek sediment would gradually decline as the source of sediment contamination (contaminated groundwater) is eliminated. If pumping were stopped after 30 years, sediments would again be exposed to metals contamination via groundwater. Sixty to 120 years of groundwater extraction and treatment would be required to reduce influent groundwater metals concentrations to levels that would allow Mill Creek water to meet modified ambient water quality criteria.
Terrestrial Wildlife	Terrestrial wildlife and wildlife habitat in the construction areas would be destroyed.	The vegetative cover over the cap may provide limited habitat. Long-term effects to wildlife inhabiting other areas is not known. The industrial/ commercial developments around the site are reducing wildlife habitat.
Soils and Topography (excavation, removal)	No soils would be excavated. Grading and construction of the cap over Areas I, II, and V would change the topography of these areas. An offsite source of about 112,000 cubic yards (total) of clay, loam, and gravel would be necessary for the construction of the cap.	The topography of Areas I, II, and V would be changed by the installation of the surface cap.

Table 6-14 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 2--SURFACE CAP WITH GROUNDWATER EXTRACTION AND TREATMENT

Element of the Environment	Short-Term Effects	Long-Term Effects
Noise	Construction would last for 8 months. During this time, noise levels in the area would be increased due to grading activities and construction of the cap, groundwater treatment facility, and extraction system. Additional traffic would also generate noise. Timing and good construction practices could mitigate adverse impacts.	The groundwater treatment plant would increase noise levels slightly in the area. Mitigation is not expected to be necessary because the surrounding property is under industrial use and would not be sensitive to the minor noise increases.
Air Quality (odor, dust)	Dust could be generated during site grading and cap construction; however, dust control measures would be implemented to mitigate this impact.	The groundwater treatment process would release volatile organics. However, the system would be designed and operated to meet emissions standards that would reduce the potential for adverse impacts from these releases. The long-term potential for dust generation would be reduced by the vegetative cover over the capped areas.
Transportation	Truck traffic would be generated by trucks hauling construction materials. Employee trips would also generate additional traffic. This could cause traffic congestion on S. 196th Street. The impacts of the increased traffic could be mitigated by staggering arrival and departure times.	No significant long-term transportation impacts.
Flood Plains	This alternative could involve construction on or near the designated flood hazard areas adjacent to Mill Creek and the east drain. Avoiding construction of erosion-prone or flood-sensitive facilities in these areas could effectively mitigate adverse impacts.	No long-term impacts expected.
Land Use	Construction of this alternative would limit the use of the areas where construction occurs. The adjacent segment of the Interurban Trail might have to be closed during construction periods.	Future use of the capped areas would be prohibited because of the need to maintain the impermeability of the RCRA cap. Land use for areas where extraction and treatment system components are located would be restricted during the operating period. Some subsidence may occur over the pumping period in those areas where the groundwater table has been drawn down. Land use of areas not capped (such as VIII and IX) could be restricted by local government agencies, depending on the soil contamination levels.

Table 6-15
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 3--EXCAVATION WITH ONSITE DISPOSAL, GROUNDWATER EXTRACTION AND TREATMENT, SURFACE CAP

Element of the Environment	Short-Term Effects	Long-Term Effects
Human Health:		
Soils	Same as Example Alternative 2, except that more stringent safety procedures would be necessary during construction because there would be a greater potential for exposure to contaminated soils. Waste containers known to be buried within the excavation areas would be disposed onsite if they meet compatibility criteria.	The construction of the on-property landfill would lead to long-term impacts that are similar to those described for Example Alternative 2, with the additional benefit that contaminated surface soil would be removed from a portion of Area VIII.
Groundwater	Same as Example Alternative 2.	Same as Example Alternative 2.
Mill Creek	Same as Example Alternative 2.	Same as Example Alternative 2.
Air	See soils, above.	Same as Example Alternative 2.
Aquatic Organisms in Mill Creek	Same as Example Alternative 2.	Same as Example Alternative 2.
Groundwater:		
Quantity and flow	Same as Example Alternative 2.	Same as Example Alternative 2, except groundwater would be pumped at a slightly slower rate (about 85 gpm) because there would be fewer well points. There also would be slightly less drawdown.
Quality	Same as Example Alternative 2.	Same as Example Alternative 2, except the rate of contaminant removal would be slightly lower. The difference between the effectiveness of Example Alterantives 2 and 3 in removing contaminants is expected to be minor and cannot be quantified. Excavation of the unsaturated zone soils in Areas I and II would further reduce the potential for contaminant migration via leaching from soils above the water table.

Table 6-15 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 3--EXCAVATION WITH ONSITE DISPOSAL, GROUNDWATER EXTRACTION AND TREATMENT, SURFACE CAP

Element of the Environment	Short-Term Effects	Long-Term Effects
Stormwater:		
Quantity and quality	Same as Example Alternative 2, except that the increased soils handling and excavation would increase the potential for erosion of uncovered soils. Stormwater from Areas I and II would be collected, treated as necessary, and discharged to Metro during construction.	Same as Example Alternative 2, except that contaminated surface soils in a portion of Area VIII would be removed, eliminating their potential to be a source of stormwater contamination.
Mill Creek:		
Quantity and flow	Same as Example Alternative 2.	Same as Example Alternative 2.
Quality	Same as Example Alternative 2.	Same as Example Alternative 2.
Sediment quality	Same as Example Alternative 2.	Same as Example Alternative 2.
Terrestrial Wildlife	Same as Example Alternative 2.	Same as Example Alternative 2.
Soil and Topography (excavation and removal)	Approximately 108,000 cubic yards of soil would be excavated from Areas I and II and a portion of Area VIII and placed in an on-property landfill. Approximately 186,000 cubic yards (total) of loam, sand, and clay would be needed for construction of the cap and liner. The grading, landfilling, and/or capping of Areas I and II and a portion of Area V would change the topography of these areas.	No additional impacts. The topography of Areas I and II and a portion of Area V would be changed permanently.
Noise	Construction would last for 48 months. During that time, noise levels would be increased due to excavation activities and construction of the cap, liner, groundwater treatment facility, and extraction system. Additional traffic would also generate noise. Timing and good construction practices could effectively mitigate adverse impacts.	Same as Example Alternative 2.

Table 6-15 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 3--EXCAVATION WITH ONSITE DISPOSAL, GROUNDWATER EXTRACTION AND TREATMENT, SURFACE CAP

Element of the Environment	Short-Term Effects	Long-Term Effects
Air Quality (odor, dust)	The impacts would be similar to Example Alternative 2 but they would be more extensive because more soil would be moved, and contaminated soils must be stockpiled onsite prior to placement in the lined area. Also, the impacts would last over a longer period because construction would be longer. Good construction practices, covering the piles, wetting the soil, or using sealants could mitigate adverse impacts. Odors may be generated when volatile organics are released from the soil during excavation. Organic levels and conditions that might affect their release would be continuously monitored, and corrective measures would be taken if it appears that levels might become hazardous.	Same as Example Alternative 2.
Transportation	Heavy truck traffic would result from hauling construction materials to the site. Employee trips would generate additional traffic. Traffic generated by this alternative would be greater than Example Alternative 2 because more construction materials would be necessary. It would, however, generate less traffic than Example Alternatives 4 and 5, which involve off-site transport of excavated soils and import of replacement soils.	No significant long-term transportation impacts.
Flood Plains	Same as Example Alternative 2.	Same as Example Alternative 2.
Land Use	Same as Example Alternative 2, except that the segment of the Interurban Trail next to the site would be closed for a longer period than under Example Alternative 2.	Same as Example Alternative 2, except that Area VIII may be analyzed to have different restriction needs.

Table 6-16
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 4--PRP'S REMEDIAL ACTION PLAN
(This table prepared by the PRP's)

Element of the Environment	Short-Term Effects	Long-Term Effects
Human Health:		
Soils	Exposure of workers and the general public to contaminated soil would be controlled by a Health and Safety Plan.	Following excavation, imported soil would be placed over Area I (minimum depth one foot) and a gravel cover would be laid over the soil. Unexcavated contaminated soil would thus be isolated and the potential for direct human exposure eliminated. The groundwater extraction program would further reduce residual soil contamination, and the surface cover (pavement) would further isolate residual contamination following completion of the pumping program.
Groundwater	Groundwater beneath Western Processing does not present a hazard to human health because it is not currently a water supply source.	Because an adequate, alternate water supply source is present in the area, the local, shallow aquifer is not a likely candidate for development. While the 5-year pumping program should reduce chloroform concentrations to less than the the federal drinking water standard, the concentrations of lead, cadmium, and chromium would not be reduced to the levels specified by the drinking water standards. It would take hundreds of years of pumping before the concentrations of these three contaminants in groundwater beneath the property could meet the drinking water standards.
Mill Creek	Same as Example Alternative 2	Same as Example Alternative 2
Air	Same as Example Alternative 3	Same as Example Alternative 2.
Aquatic Organisms in Mill Creek	No increase in contaminant releases to Mill Creek would occur during construction.	Groundwater discharges from Area I into Mill Creek would be eliminated after pumping begins, thus allowing water quality in Mill Creek to achieve the modified ambient water quality criteria. As the water quality in Mill Creek improves, the potential for adverse impacts to aquatic organisms would decrease. When groundwater pumping stops after 5 years, contaminant concentrations in Mill Creek would not increase above the modified criteria levels as a result of groundwater discharge to the creek from Area I.

Table 6-16 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 4--PRP'S REMEDIAL ACTION PLAN

Element of the Environment	Short-Term Effects	Long-Term Effects
Groundwater:		
Quantity and flow	Construction of the diversion barrier would alter local groundwater flow patterns. The rate of groundwater discharge to Mill Creek from the Western Processing area would begin to be reduced.	During groundwater pumping, groundwater levels on the property would be reduced. Some of the groundwater immediately around the property and below the depth of the diversion barrier would flow toward and into the well points. Once the pumping program is completed, local groundwater flow patterns would continue to be modified by the diversion barrier. Groundwater flow from Area I into Mill Creek would resume, but at a slower rate than prior to the installation of the diversion barrier. Groundwater levels within the confines of the diversion barrier would stabilize and undergo relatively little fluctuation as a result of the inhibition of surface water infiltration.
Quality	Onsite groundwater quality is not expected to improve during the construction period. Off-property groundwater quality could begin to improve following installation of the diversion barrier.	Effects on groundwater quality in terms of human health and Mill Creek water and sediment quality are discussed under the Human Health and Mill Creek elements. The diversion barrier would cause escaping residual contamination to enter the groundwater at a depth that could allow some of the residual contamination to bypass Mill Creek and be introduced into the regional groundwater flow system.
Stormwater:		
Quantity and flow	There would be no discharge of stormwater from Area I during the construction period.	During operation of the groundwater pumping program, Area I stormwater would be allowed to infiltrate the site as part of the contaminant flushing process. Following completion of the subsurface cleanup activities, stormwater would be collected in the stormwater management system and discharged to Mill Creek at a controlled rate in accordance with the requirements of Kent stormwater ordinance No. 2130.

Table 6-16 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 4--PRP'S REMEDIAL ACTION PLAN

Element of the Environment	Short-Term Effects	Long-Term Effects
Quality	Contaminated on-property surface water would be collected as necessary and appropriately treated and discharged.	All surface water discharged from Area I would be free of contaminants associated with the previous use of the property as a waste recycling facility.
Mill Creek:		
Quantity and flow	The diversion barrier would reduce the rate of groundwater flow to Mill Creek from the site.	No groundwater would flow to Mill Creek from the property during operation of the groundwater extraction system. Following completion of the extraction program, groundwater flows to Mill Creek from the property would resume, but at a lower rate than at present because of the effect of the diversion barrier, which will remain in place.
Quality	Mill Creek water quality would begin to improve before the pumping program is initiated as a result of installing the diversion barrier.	During the pumping period, the amount of contaminants entering Mill Creek via groundwater from the site would drop off to a level that should allow Mill Creek water quality to meet modified ambient water quality criteria levels. The remedial action (consisting of excavation, groundwater extraction and treatment, diversion barrier, and surface pavement) would reduce overall Area I contamination by approximately 70 percent. Zinc concentrations would be reduced 69 percent by the excavation program and an additional 7 percent by the groundwater pumping program. The diversion barrier would effectively reduce the amount of contamination entering Mill Creek at any one time by at least an additional 12 percent. The combined zinc removal achieved by the remedial action would be at least 88 percent.

Table 6-16 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 4--PRP'S REMEDIAL ACTION PLAN

Element of the Environment	Short-Term Effects	Long-Term Effects
Sediment quality	No significant improvement in the amount of contaminated sediments in Mill Creek would occur during the relatively short (24-month) construction period.	Because Mill Creek water quality should be able to return to levels specified by the modified ambient water quality criteria as a result of Example Alternative 4, no further degradation of Mill Creek sediments should be caused by groundwater discharge to the creek from Western Processing.
Green River	No impact	No impact
Terrestrial Wildlife	No wildlife are known to have previously used the property. The property would not be available for wildlife use during the construction period.	Because Area I will be paved, it will remain unsuitable for wildlife use following completion of the groundwater extraction program.
Soils and Topography (excavation, removal)	Contaminated soils would be excavated and replaced with more permeable soil from an offsite source. The Area I surface will be regraded to prevent surface flows from entering or leaving the property.	Following the completion of groundwater extraction, additional grading would be performed and the surface paved. No significant difference between on- and off-property topography would result.
Noise	Same as Example Alternative 2 but over a construction period of 24 months.	Noise impacts for groundwater extraction and treatment would be the same as for Example Alternative 2 except that the duration is only 5 years. Following completion of the extraction process, activities associated with facilities dismantling and installation of the surface cover (pavement) and stormwater management system would generate additional noise but for only a relatively short (one- to 3-month) period.
Air Quality (odor, dust)	Similar to Example Alternative 3, except no onsite stockpiling would occur, and the construction period would be 24 months.	Same as Example Alternative 2, except that during paving of Area I, the characteristic asphalt odor would be present during the relatively short paving period. After capping, dust generation would not occur.

Table 6-16 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 4--PRP'S REMEDIAL ACTION PLAN

Element of the Environment	Short-Term Effects	Long-Term Effects
Transportation	Personal vehicle and heavy truck traffic would significantly increase during the construction period. Heavy truck traffic would be associated with transporting excavated materials from the property and construction materials to the property. Traffic levels would be higher than for Example Alternatives 2 and 3 because of the large volume of contaminated soil to be transported offsite, but less than for Example Alternative 5. Transportation activities would create a volume of decontamination water that could require appropriate treatment before either reuse or disposal.	During the relatively brief facilities dismantling and site paving phase, personal vehicle and truck traffic will again increase but only slightly. No transportation impacts will occur following capping of Area I.
Flood Plains	Same as Example Alternative 2	Final grading, paving, and facilities dismantling would have no adverse impact on flood-prone areas along Mill Creek.
Land Use	The property would remain unavailable for use during the construction period.	The property would remain unavailable for redevelopment until it is paved following completion of groundwater extraction and treatment. Thereafter, it would be available for redevelopment consistent with site zoning and adjacent existing and planned uses.

Table 6-17
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 5--EXCAVATION WITH OFFSITE DISPOSAL

Element of the Environment	Short-Term Effects	Long-Term Effects
Human Health:		
Soils	Exposure of workers and the general public to contaminated soil would be controlled by the provisions of the Health and Safety Plan.	No impacts because all contaminated surface soils would be removed. No land use limitations would be necessary.
Groundwater	During construction activities, the dewatering system operation would draw down the local, shallow aquifer.	The soil removal and dewatering actions for Example Alternative 5 should be sufficient to reduce most groundwater contaminant concentrations to achieve federal drinking water standards, ADI'S, and SNARL's except for cadmium and chromium.
Mill Creek	Same as Example Alternative 2	The excavation action and associated dewatering would yield long-term improvements similar to those indicated for Example Alternative 2 but in a shorter period of time.
Air	See Soils, above.	No adverse impact because all contaminated surface solids would be removed.
Aquatic Organisms in Mill Creek	The construction dewatering program would reduce contaminated groundwater flow to Mill Creek. Depending on the amount of reduction, the sediments would begin to self-clean, yielding a reduction in the exposure of aquatic organisms to metals contamination.	The discharge of contaminants to Mill Creek via groundwater originating from Areas I, II, V, and IX would be reduced by the removal of about 95 percent of the contaminated soils over the 4-year excavation period and the operation of the dewatering system. The result of these actions would be to allow Mill Creek to meet modified ambient water quality criteria.
Groundwater:		
Quantity and flow	The dewatering for the 15-foot excavation in Areas I and II would cause a localized depression in the groundwater table. 100 gpm has been used as the baseline estimate for dewatering.	No long-term changes are expected to the groundwater flow system from this alternative.

Table 6-17 (continued)
ENVIRONMENTAL EVALUATION--EXAMPLE ALTERNATIVE 5

Element of the Environment	Short-Term Effects	Long-Term Effects
Quality	Groundwater quality would begin to improve as contaminated soils are removed and contaminated groundwater is removed by the dewatering system. Extracted groundwater would be treated and discharged to the Metro system.	Groundwater quality would improve to meet human health targets (except for cadmium and chromium) with the removal of the majority of the contaminated soils (95 percent of the contaminated mass). Long-term effects of groundwater quality in terms of human health and Mill Creek water and sediment quality are discussed above under Human Health.
Stormwater:		
Quantity and quality	Same as Example Alternative 3	Example Alternative 5 would remove all contaminated surface soils from Areas I, II, V, VIII, and IX thereby eliminating contaminated stormwater discharge from these areas.
Mill Creek and East Drain:		
Quantity and flow	Mill Creek flow would be reduced by the amount of groundwater flow diverted by the dewatering system.	Example Alternative 5 should not have a long-term effect on Mill Creek as it involves no capping or long-term groundwater extraction or diversion barrier.
Quality	Mill Creek water quality should improve during construction of Example Alternative 5 as groundwater is diverted.	The discharge of contaminated groundwater to Mill Creek from Western Processing would be greatly reduced after the soil excavation and accompanying dewatering system are completed. Levels of zinc in the groundwater reaching Mill Creek would be low enough to allow the creek to meet modified ambient water quality criteria due to the removal of 95 percent of the zinc from the excavated areas.
Sediment quality	Sediment contamination levels should decrease as groundwater flow is diverted and the natural sediment transport mechanisms replace contaminated sediments with upstream sediments.	Because the source of inorganic contamination would be removed from the local, shallow groundwater, Mill Creek sediment quality would be expected to improve.
Terrestrial Wildlife	Use of Areas I, II, V, VIII, and IX by terrestrial wildlife would be negligible during construction activities.	Long-term impact would be a function of ultimate use of the property.

Table 6-17 (continued)
ENVIRONMENTAL EVALUATION--EXAMPLE ALTERNATIVE 5

Element of the Environment	Short-Term Effects	Long-Term Effects
Soils and Topography (excavation, removal, and backfill)	Excavated areas (I, II, V, VIII, and IX) would be disturbed for the duration of construction activities (4 years).	Backfill with imported soil to approximately existing grades would be a positive benefit for these areas.
Noise	Noise levels would be increased during excavation activities. Primary sources would be excavation equipment, truck traffic, and the treatment plant. Timing and good construction practices could mitigate adverse impacts.	No long-term noise impacts.
Air Quality (odor, dust)	Same as Example Alternative 3	Contaminated dust would not be a problem because contaminated surface soils would be removed.
Transportation	Approximately 40,000 truck trips would be needed to accomplish the excavation and fill operations. Additional trips would be needed for workers and equipment deliveries. Traffic impacts could be mitigated by staggering arrival and departure times and avoiding peak traffic periods. Transportation activities would create a volume of decontamination water that could require appropriate treatment before either reuse or disposal.	No long-term transportation impacts.
Flood Plains	Same as Example Alternative 2.	Same as example Alternative 2.
Land Use	Excavation and fill activities in Areas I, II, V, VIII, and IX would restrict land use until they are completed.	No major long-term land use impacts would result. The site could be returned to productive use. Monitoring wells could restrict placement of some structures.

Table 6-18
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 6--MILL CREEK NO ACTION

Element of the Environment	Short-Term Effects	Long-Term Effects
Human Health	Contaminants in Mill Creek sediment are not a hazard to human health.	Same as short-term.
Aquatic Organisms in Mill Creek	Toxic metals in Mill Creek water and sediments would continue to pose a hazard to aquatic organisms.	Over time, if onsite sources were reduced, levels of contamination in Mill Creek and the potential for toxic effects on aquatic organisms would be reduced.
Groundwater:		
Quantity and flow	No effects	No effects
Quality	No effects	No effects
Mill Creek:		
Quantity and flow	No effects	No effects
Quality	Contaminated sediment may continue to leach toxic metals to Mill Creek.	Contamination from sediment would gradually decrease as contaminated sediment is carried downstream and replaced with cleaner material.
Sediment quality	There would be no short-term changes in sediment quality.	Over time, depending on the degree of source control and the quality of upstream sediment and water, sediment quality in Mill Creek would improve as leachable materials are carried away by the surface water and cleaner sediment moves past Western Processing from upstream. If contaminated groundwater discharge from Western Processing ceases, it would take an estimated 5 to 10 years for the contaminated sediments to be dispersed.
Terrestrial Wildlife	No effects	No effects

Note: Evaluation assumes implementation of Example Alternative 2, 3, 4, or 5.

Table 6-18 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 6--MILL CREEK NO ACTION

Element of the Environment	Short-Term Effects	Long-Term Effects
Soils and Topography (excavation, removal)	No effects	No effects
Noise	No effects	No effects
Air Quality (odor, dust)	No effects	No effects
Transportation	No effects	No effects
Flood Plains	No effects	No effects
Land Use	No effects	No effects

Table 6-19
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 7--MILL CREEK SEDIMENT REMOVAL

Element of the Environment	Short-Term Effects	Long-Term Effects
Human Health	Sediments in Mill Creek are not a hazard to human health.	Same as short term.
Aquatic Organisms in Mill Creek	Aquatic organisms in the reach of Mill Creek from which sediment is removed (about 2,300 feet) would be destroyed. There could be adverse effects on aquatic organisms downstream if contaminated water and sediment were to escape the diked-off construction area. Fish migration would be blocked during the time that Mill Creek flows are diverted (about one month).	Aquatic organisms would benefit from improved water quality and habitat in Mill Creek. Other, upstream, sources of contaminants may still limit water and habitat quality.
Groundwater:		
Quantity and flow	No effects	No effects
Quality	No effects	No effects
Mill Creek:		
Quantity and flow	During construction (an approximately one-month period) Mill Creek flows would be diverted into a pipe. 2,300 feet of Mill Creek would be dewatered during this period.	No effects
Quality	There could be temporary decreases in the quality of water in Mill Creek if water draining into the construction area is discharged downstream. In the event of a high flow topping both diversion dams, contaminated water and sediment would be carried downstream. The diversion system would be designed to safely handle a continuous flow of 15 cfs.	There would be a long-term improvement in water quality in Mill Creek resulting from the removal of contaminated sediment and from revegetation of the construction area.
Sediment quality	Contaminated sediment could be released to downstream areas if an extreme storm flow overtopped the diversion dams.	Removal of contaminated sediment would quickly improve sediment quality. The sediment quality would continue to be good as long as contaminated water or groundwater does not enter Mill Creek.

Note: Evaluation assumes implementation of Example Alternative 2, 3, 4, or 5.

Table 6-19 (continued)
ENVIRONMENTAL EVALUATION
EXAMPLE ALTERNATIVE 7--MILL CREEK SEDIMENT REMOVAL

Element of the Environment	Short-Term Effects	Long-Term Effects
Terrestrial Wildlife	Terrestrial habitat in the construction area would be destroyed.	There would be no long-term effects because the area would be revegetated.
Soils and Topography (excavation, removal)	The topography of Mill Creek would be slightly altered. Approximately 1,700 cubic yards of sediment would be removed from Mill Creek.	Gravel riffles would allow the creek bed to agrade to its previous elevation as sediment from upstream is deposited.
Noise	There would be temporary increases in noise during diversion system construction, excavation, and pumping.	No effects
Air Quality (odor, dust)	Removal of sediment from Mill Creek may cause temporary increases in dust and odors.	No effects
Transportation	Removal of sediment would generate about 225 truck trips if the material is disposed of offsite. There would also be increases in traffic due to construction workers and hauling equipment. There would be short blockages of South 196th Street during construction and removal of the pipeline.	No effects
Flood Plains	There would be a remote possibility of increased flooding upstream if an unexpectedly severe storm were to occur during the time that Mill Creek is diverted.	No effects
Land Use	There should be no significant short-term impacts on land use. The properties affected by construction activities are presently undeveloped.	No effects

gas supplies. Some alternatives will use electricity and sewer lines.

Tables 6-13 through 6-19 describe the short-term and long-term impacts of the example alternatives. Short-term is defined as the construction period. Impacts expected during and after the operation period are included in the long-term discussions. However, for the no action alternatives, short-term is defined as the first 5 years after selecting this alternative. Major beneficial and adverse impacts are summarized in Table 6-20.

6.4.3 INSTITUTIONAL EVALUATION

Institutional considerations discussed here are federal, state, and local environmental regulations, guidelines, ordinances, and advisories that may be applicable to the implementation of the example remedial action alternatives. Each of the seven example alternatives identified for the Western Processing site has different implications under the various standards. Table 6-21 lists the laws, regulations, and standards that are evaluated for each alternative.

The WDOE cleanup policy and the USEPA groundwater protection strategy (GWPS) could require cleanup of the contaminated area or groundwater to background levels or to levels that would protect human health. However, considerations such as technical feasibility and cost effectiveness may affect the determination of the level of cleanup that must be achieved. It is not known at this time what cleanup levels will be acceptable for Western Processing and, therefore, which example alternatives would be in compliance with these policies.

USEPA draft policy on CERCLA remedial actions requires that feasibility studies examine alternatives that comply with applicable sections of other federal environmental and public health laws. It is also a USEPA policy that compliance with state and local standards should be examined in CERCLA feasibility studies. Factors such as fund balancing, technical impracticability, enforcement considerations, and environmental impacts may affect the selection of the final remedial action. State (and local) standards that are more stringent than federal standards may form the basis for a Superfund-financed remedy only if the remedy is (1) consistent with the cost-effective remedy based on federal standards, or (2) the state pays the additional cost.

Proposed revisions to the National Oil and Hazardous Substances Pollution Contingency Plan were published in the Federal Register on January 28, 1985. These revisions clarify that, while standards must be considered, federal, state, and local public health or environmental permits are not

Table 6-20
SUMMARY OF MAJOR BENEFICIAL AND
ADVERSE ENVIRONMENTAL IMPACTS

Example Alternative 1--No Action

Beneficial	Adverse
Short-term construction related impacts would be avoided.	Groundwater quality beneath the site would improve only very slowly because of the continued leaching of contaminants from soils and from the mass of contaminants below the water table.
	Contaminated groundwater would continue to discharge into Mill Creek.
	It would take hundreds of years, if ever, for groundwater quality to improve to target levels of metals for human health for drinking water.
	Aquatic organisms in Mill Creek would continue to be adversely affected by contaminated water and sediment.
	The potential risks to human health due to ingestion of contaminated dust and soil would continue.
	Future land use could be restricted because of the need to limit contact with contaminated soil on and off the property.
	Without maintenance, Area I stormwater control berms could deteriorate, allowing contaminated stormwater to discharge to adjacent areas and Mill Creek.

Table 6-20
(continued)

Example Alternative 2--Cap, Pump, and Treat	
Beneficial	**Adverse**
The surface cap over Areas I and II and portions of Area V would eliminate the potential for human and stormwater contact with the contaminated soils in these areas.	Short-term, construction related impacts (noise, traffic, etc.) would occur in the area for eight months. Most of these impacts could be effectively mitigated.
The surface cap would prevent leaching of contaminants to the groundwater from the unsaturated zone in Areas I, II, and V.	The potential would remain for human ingestion of contaminated surface soils from Areas VIII and IX.
Groundwater pumping and treatment for 30 years would reduce all but one indicator organic compound in the groundwater to levels below drinking water quality criteria.	A 30-year pumping and treatment program would not reduce lead, cadmium, and chromium concentrations in groundwater beneath Area I to levels that would meet federal drinking water standards. Hundreds of years of pumping would be required before these standards could be met, if ever.
Contaminated groundwater from Western Processing would not discharge into Mill Creek during the pumping period.	Sixty to 120 years of groundwater pumping and treatment would be required before modified ambient water quality criteria for metals could be achieved in Mill Creek after pumping ceases. Future use of the capped areas would be prohibited.

Example Alternative 3--Onproperty Landfill, Offproperty Cap, Pump, and Treat	
Beneficial	**Adverse**
The contaminated soil in the unsaturated zone from Areas I, II, V, and VIII would be isolated in the onsite landfill or capped and thus would not be available for leaching to the groundwater.	Short-term, construction related impacts would occur in the area for 44 months. Most of these impacts could be effectively mitigated.

Table 6-20
(continued)

Example Alternative 3, Continued	
Beneficial	Adverse
The cap, liner, and excavation would eliminate the potential for human and stormwater contact with contaminated soils in Areas I, II, V, and VIII. Groundwater pumping and treatment for 30 years would reduce all but one indicator organic compound in the groundwater to levels below drinking water quality criteria. Contaminated groundwater from Western Processing would not discharge into Mill Creek during pumping.	See Example Alternative 2 discussion for adverse groundwater quality effects on human health and Mill Creek. Future use of the property would be prohibited because it would be a RCRA landfill. Future use of the off-property, capped areas would be similarly restricted.

Example Alternative 4--PRP Plan (Excavate, Diversion Barrier, Pump and Treat, Cap) (Prepared by the PRP's)	
Beneficial	Adverse
Approximately 70 percent of the contamination (including zinc) from Area I would be removed by the excavation and groundwater pumping programs. Soil excavation and back filling with imported soil would eliminate the potential for human and stormwater contact with contaminated surface soils in Area I. The surface cap would inhibit infiltration and leaching of residual contamination from unexcavated soil in the unsaturated zone of Area I.	Short-term, construction related impacts would occur during the 24-month construction period. The up to 5-year pumping and treatment program would not reduce lead, cadmium, and chromium concentrations in groundwater beneath Area I to levels that would meet federal drinking water standards. An indefinitely long period of pumping would be required before these standards could be met, if ever.

Table 6-20
(continued)

Example Alternative 4, Continued	
Beneficial	**Adverse**
Groundwater pumping for up to 5 years would reduce all but one indicator organic compound in the groundwater beneath Area I to levels below drinking water quality criteria.	
Groundwater contamination would be sufficiently reduced after up to 5 years of pumping to allow contaminant concentrations in Mill Creek to return to modified ambient water quality criteria levels.	
The property would be available for redevelopment consistent with local land uses following the completion of the groundwater pumping program and paving of the surface.	

Example Alternative 5--Excavate and Dewater	
Beneficial	**Adverse**
95 percent of the contaminant material, including zinc, would be excavated and removed from Areas I, II, V, VIII, and IX. This source removal would be sufficient to allow metal contaminant levels in Mill Creek to meet the modified water quality criteria.	Short-term, construction related impacts would occur in the area for 5 months out of each of the 4 years required to complete the excavation program. Most of these impacts could be effectively mitigated.
Soil removal would eliminate the potential for human and stormwater contact with contaminated surface soils in Areas I, II, V, VIII, and IX.	

Table 6-20
(continued)

Example Alternative 5, Continued	
Beneficial	**Adverse**
All of the contaminated soils in the unsaturated zone of Area I and significant amounts from Areas V and IX would be removed. Therefore, contaminants available for leaching would be reduced significantly. Future site use of the site would not be restricted.	

Example Alternative 6--No Action in Mill Creek	
Beneficial	**Adverse**
Short-term, construction related impacts would be avoided.	Contaminated sediment could continue to leach toxic metals into Mill Creek water for 5 to 10 years after flow of contaminated groundwater to Mill Creek ceases. Aquatic organisms in Mill Creek could continue to be adversely affected by contaminated water.

Example Alternative 7--Sediment Removal in Mill Creek	
Beneficial	**Adverse**
Removal of contaminated sediments would improve the quality of water in Mill Creek, which would provide long-term benefits to aquatic organisms.	Short-term, construction related impacts would occur in the area for one month, including the potential for resuspenion of contaminated sediments. Fish passage could also be blocked for one month. Aquatic organisms in the reach of Mill Creek from which sediment is removed would be destroyed.

Table 6-21
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO WESTERN PROCESSING

Law or Regulation	Source of Regulation	Example Alternative Affected
FEDERAL		
*Federal Resource Conservation and Recovery Act (RCRA)	RCRA Section 3001, 3004, 3005, 40 CFR 264, 265	All example alternatives
Federal Manifest for Transport of Hazardous Waste	RCRA Section 3002(5), 40 CFR 262	All example alternatives involving interstate transport of hazardous materials.
Toxic Substances Control Act (TSCA)	40 CFR Parts 702 to 775	These regulations apply to 2,3,7,8 TCDD or PCB's at greater than 50 ppm and intended for disposal and PCB's that have migrated from the original source of contamination. For purposes of evaluation in this study, it has been assumed that only PCB levels above 50 ppm require special disposal.
Underground Injection Control (UIC) Program: Criteria and Standards	40 CFR Part 146	Not applicable. No underground injection is proposed.
Permits for Structures in or Work Affecting Navigable Waters of the U.S (Section 10 permit)	33 CFR 322	Not applicable. Mill Creek is not considered a navigable water.

*Indicates regulations that are discussed in Appendix B.

Table 6-21 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO WESTERN PROCESSING

Law or Regulation	Source of Regulation	Example Alternative Affected
Permits for Discharges of Dredged or Fill Material Into Waters of the U.S. (Section 404 permit)	33 CFR 323	Alternative 7 only.
*Response in a Floodplain or Wetlands	Appendix A to 40 CFR Part 6	All example alternatives involving construction in designated flood hazard area.
*National Emissions Standards for Hazardous Air Pollutants	Clean Air Act, Section 112; State Implementation Plan	These regulations would apply to air stripping equipment used for groundwater treatment (administered by Puget Sound Air Pollution Control Agency--PSAPCA).
*National Environmental Policy Act (NEPA)	NEPA Section 102(2)(c)	CERCLA actions are exempt because EPA's decisionmaking process represents the functional equivalency of the analysis performed under NEPA.
*Intergovernmental Review of Federal Programs	40 CFR 29	All example alternatives requiring federal funds, state funds, or a cooperative agreement between the state and federal agencies.

*Indicates regulations that are discussed in Appendix B.

Table 6-21 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO WESTERN PROCESSING

Law or Regulation	Source of Regulation	Example Alternative Affected
*Relocation Assistance and Property Acquisition	Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1979, 40 CFR 4	All example alternatives involving federal property acquisition.
Worker Safety and Health Protection	Occupational Safety and Health Administration (OSHA)	All example alternatives involving workers on property. Industrial safety and health regulations are administered under the Washington Industrial Safety and Health Act (WISHA).
*National Pollutant Discharge Elimination System (NPDES) Permit	CWA Section 402, 40 CFR 122, 125 Subchapter N	All example alternatives involving discharges into Mill Creek or the Green River (administered by the WDOE).
*Effluent Guidelines and Standards	40 CFR 400 Subchapter N, FWPCA	All example alternatives involving discharge to Metro (administered by Metro).
Federal Standards for Toxic Pollutant Effluent	40 CFR 129	All example alternatives involving discharge into Mill Creek or the Green River (usually regulated by the NPDES permit).

*Indicates regulations that are discussed in Appendix B.

Table 6-21 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO WESTERN PROCESSING

Law or Regulation	Source of Regulation	Example Alternative Affected
*Hazardous Materials Regulations	49 CFR 170 to 179	All example alternatives involving interstate transport of hazardous materials.
*EPA Groundwater Protection Strategy	EPA Policy Statement	All example alternatives.
Conservation of Wildlife Resources	Fish and Wildlife Coordination Act	All example alternatives except no action. This act requires agency consultation prior to modifying any body of water
Preservation of Scientific, Historic, or Archaeological Data	Archaeological and Historic Preservation Act of 1974	Not applicable. No such resources are expected to be affected by the alternatives.
Preservation of Rivers on the National Inventory	Wild and Scenic Rivers Act 40 CFR Part 6.302	Not applicable. No rivers affected by the alternatives are so designated.
Protection of Threatened or Endangered Species and Their Habitats	Endangered Species Act 50 CFR Part 402	All example alternatives except no action. This act requires that the agencies request information on endangered species in any area affected by a proposed action.

*Indicates regulations that are discussed in Appendix B.

Table 6-21 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO WESTERN PROCESSING

Law or Regulation	Source of Regulation	Example Alternative Affected
Overall Compliance With the Clean Air Act	Clean Air Act 40 CFR Part 6.303	These regulations would apply to air stripping equipment used for groundwater treatment (administered by PSAPCA).
Federal Ocean Dumping Requirements	40 CFR 220-224 33 CFR 220, 224	Not applicable. None of the alternatives involve ocean dumping.
STATE		
*Washington State Dangerous Waste Regulations	WAC 173-303-420	All example alternatives.
State Approval of Shorelines Use	Coastal Zone Management Act of 1972	All alternatives involving construction within 200 feet of the Green River.
State Requirements for the Transport of Hazardous Substances	WAC 412-195	All example alternatives involving the intrastate transport of hazardous substances.
*State Water Quality Standards	WAC 123-201	All example alternatives involving discharge into Mill Creek or the Green River (usually regulated by the NPDES permit).3

*Indicates regulations that are discussed in Appendix B.

Table 6-21 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO WESTERN PROCESSING

Law or Regulation	Source of Regulation	Example Alternative Affected
*Hydraulics Permit	RCW 75-20.100, WAC 220-110	All example alternatives involving work within the ordinary high water line of Mill Creek or the Green River.
State Environmental Impact Statement	State Environmental Policy Act (SEPA)	The WDOE will determine how SEPA applies to the example alternatives.
*State Flood Control Zone Permit	RCW 86.16	All example alternatives involving construction in flood hazard areas.
*Washington Industrial Safety and Health Act (WISHA)	WAC 296-62 WAC 296-64	All example alternatives except no action.
National Pollutant Discharge Elimination System (NPDES) Permit	WAC 173-220	All example alternatives involving a discharge to Mill Creek or the Green River.
*WDOE Final Cleanup Policy	Policy Statement	All example alternatives.
REGIONAL		
*Metro Industrial Waste Discharge Permit	Resolution 33774	All example alternatives involving discharge to Metro.

*Indicates regulations that are discussed in Appendix B.

Table 6-21 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO WESTERN PROCESSING

Law or Regulation	Source of Regulation	Example Alternative Affected
*Puget Sound Air Pollution Control Authority	Regulations 1 and 2	All example alternatives involving regulated emissions.
Seattle-King County Public Health Department	Rules and Regulations VIII	Not applicable. None of the example alternatives involve construction of a landfill for material not classified as a dangerous waste or extremely hazardous waste in WAC 173-303.
LOCAL		
*Land Use Approval	Kent Zoning Code	All example alternatives involving building construction.
*Stormwater and Erosion Control Requirements	Kent City Code (Reviewed by King County)	All example alternatives involving construction.
*Grade and Fill Permit	Kent City Code, Chapter 12	All example alternatives involving excavation and/or construction.
*Street Use and Street Cut Permit	Kent City Code	All example alternatives involving heavy street use.

*Indicates regulations that are discussed in Appendix B.

Table 6-21 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO WESTERN PROCESSING

Law or Regulation	Source of Regulation	Example Alternative Affected
Stormwater Ordinance	Kent City Ordinance No. 2130 (Reviewed by King County)	All example alternatives involving construction.
City of Kent Surface Drainage Utility, Drainage Master Plan	Proposed Plan	The plan is scheduled for adoption in spring 1985. It might affect alternatives involving Mill Creek.

*Indicates regulations that are discussed in Appendix B.

required for Superfund-financed remedial actions or for remedial actions taken pursuant to federal action under Section 106 of CERCLA. However, storage, treatment, or disposal of hazardous substances removed from CERCLA sites can only occur at offsite facilities that are operating under appropriate federal or state permits or authorizations.

6.4.3.1 Example Alternative 1--No Action

Table 6-22 shows how laws, regulations, and policies apply to Example Alternative 1. Generally, the laws and regulations do not apply to the no action alternative because they primarily regulate existing facilities or proposed actions.

However, three laws and policies that address existing conditions rather than proposed actions are RCRA, the USEPA Groundwater Protection Strategy, and the WDOE Final Cleanup Policy. These all require corrective action in the event that hazardous materials are released into the environment. The no action alternative proposes no corrective action, and therefore could not be consistent with these laws and policies.

6.4.3.2 Example Alternative 2--Surface Cap with Groundwater Extraction and Treatment

Table 6-23 shows the relationship between this example alternative and governmental laws, regulations, and policies. In general, this alternative may comply with RCRA, which allows surface capping and groundwater extraction and treatment for closure of existing land disposal units if the facilities meet certain design standards and the required monitoring procedures are followed. A less complex cap, such as a clay cap without a synthetic membrane, may also comply with RCRA as long as the cap is less permeable than the soil underneath. The WDOE Dangerous Waste Regulations are similar to RCRA regulations in that they allow capping of a site.

6.4.3.3 Example Alternative 3--Excavation with Onsite Disposal, Surface Cap, and Groundwater Extraction and Treatment

Table 6-24 shows the relationship between this example alternative and government laws, regulations, and policies. Generally, the table shows that the example alternative would be consistent with RCRA if the landfill is designed to RCRA standards for a new land disposal facility (double liner, leachate collection and detection systems, properly closed and maintained). This example alternative may not be consistent with the WDOE Dangerous Waste Regulations and RCW 75.105, which prohibit land disposal of "Extremely Hazardous Waste" (as opposed to "Dangerous Waste") anywhere in the State of Washington (except at the Hanford landfill which is not yet constructed). The contaminated soil at the site has not been classified under the WDOE system. If it is

Table 6-22
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO
ALTERNATIVE 1--NO ACTION

Law or Regulation	Analysis
FEDERAL	
Resource Conservation and Recovery Act (RCRA)	This alternative would not be consistent with the RCRA closure performance standard and the corrective action standard.
USEPA Groundwater Protection Strategy (GWPS)	This site is located over a Class II groundwater aquifer according to the USEPA GWPS Groundwater Protection Strategy. The GWPS states: "As a general rule, Class II aquifers will receive levels of protection consistent with those now provided for groundwater under EPA's existing statutes.... Cleanup of contamination will usually be to background levels or drinking water statndards but alternative procedures may be applied for potential sources drinking water.... In these cases the contamination may be managed in order to avoid migration into a current source of drinking water or to avoid widespread damage."
STATE	
WDOE Final Cleanup Policy	WDOE's cleanup policy allows the required level of cleanup to be defined on a site-specific basis according to established guidelines. The WDOE would decide if this example alternative complies with the policy.
Washington State Dangerous Waste Regulations (WAC 173-303)	WAC 173-303-050 provides authority to the WDOE to conduct cleanups of dangerous waste where there is a potential for discharge or release. Under this authority, the WDOE may choose to agree or disagree that the no action alternative is acceptable.
REGIONAL	
PSAPCA Regulations	PSAPCA regulations would not apply if no action were taken at the site.
LOCAL	
Land Use Approval	The City of Kent and/or the Seattle-King County Health Department may determine that future use of the site should be restricted based on hazardous conditions that may continue to be present under this alternative.

Note: See Appendix B for a discussion of some of the laws and regulations cited in this table.

Table 6-23
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 2
SURFACE CAP/GROUNDWATER PUMP AND TREAT

Law or Regulation	Analysis
FEDERAL	
Resource Conservation and Recovery Act (RCRA)	Under the closure performance standard of RCRA, capping hazardous waste in place is acceptable. The capped facility must be fully maintained during the post-closure period (normally up to 30 years). Under the groundwater protection standard of RCRA, pumping and treatment is an acceptable means to meet the corrective action standard.
EPA Groundwater Protection Strategy	This site is located over a Class II groundwater according to the USEPA Groundwater Protection Strategy. The GWPS states: "As a general rule, Class II aquifers will receive levels of protection consistent with those now provided for groundwater under EPA's existing statutes.... Cleanup of contamination will usually be to background levels or drinking water standards but alternative procedures may be applied for potential sources of drinking water.... In these cases the contamination may be managed in order to avoid migration into a current source of drinking water or to avoid widespread damage."
Department of Transportation (DOT)	DOT regulations under 49 CFR 172 regulate all interstate shipments of hazardous materials. This alternative may involve transport of sludge generated by the groundwater treatment facility. These materials must be transported according to DOT regulations.
Clean Air Act (CAA)	Air stripping equipment used for groundwater treatment would be considered a source of air emissions and would therefore be regulated by the CAA.
Floodplains and Wetlands	Portions of Mill Creek and drainage ditches to the east and south are designated flood hazard areas. The eastern drainage has been changed since the flood study was completed, and the east and south ditches may no longer be flood hazard areas. An analysis of the impacts of all construction in these areas will be done consistent with 40 CFR Part 6, Appendix A.
Relocation Assistance and Property Aquisition	This regulation requires payment of just compensation to property owners whose property is purchased by federal agencies. This alternative could involve such a purchase.
Protection of Threatened and Endangered Species	This regulation requires that agencies request information on endangered species in any area affected by a proposed action. This alternative would require requesting such information although endangered species are not expected to be present in the area.

Note: See Appendix B for a discussion of some of the laws and regulations cited in this table.

Table 6-23 (continued)
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 2

Law or Regulation	Analysis
STATE	
WDOE Final Cleanup Policy	WDOE's cleanup policy allows the required level of cleanup to be defined on a site-specific basis according to established guidelines. The WDOE will decide if the cleanup achieved by this example alternative complies with the policy.
Washington State Dangerous Waste Regulations (WAC 173-303)	WAC 173-303-050 provides authority to the WDOE to conduct cleanups of dangerous waste where there is a potential for discharge or release. Under this authority, the WDOE may choose to agree or disagree that this alternative is acceptable.
National Pollutant Discharge Elimination System (NPDES) Permit (State Administered Program)	Although not currently proposed, the discharge of treated groundwater into Mill Creek would require compliance with the NPDES Water Quality Standards. The applicable standards are those listed in the Federal Register, November 28, 1980, for pollutants. Standards for pollutants not found in the Federal Register would be developed by WDOE. NPDES permit standards would have to be met for the discharge of stormwater from capped areas.
Washington Industrial Safety and Health Act	This example alternative would require compliance with Chapters 296-62 and 262-24 WAC, which regulate the work environment and require a site safety plan, hazard evaluation, worker training programs, protective equipment for workers, and emergency equipment.
Flood Control Zone Permit	Portions of Mill Creek and drainage ditches to the east and south are designated flood hazard areas. These standards could apply to construction in these areas. See also Floodplains and Wetlands (under Federal above) for potential changes in the designated flood hazard areas.
REGIONAL	
Metro Regulations (Industrial Waste Discharge)	The discharge of treated groundwater to the Metro system would require compliance with industrial waste discharge regulations regarding quantities discharged and prohibited and restricted substances.
Puget Sound Air Pollution Control Agency (PSAPCA)	Air stripping equipment for groundwater treatment is a regulated source of air emissions and may require a Notice of Construction to PSAPCA. PSAPCA will determine whether emissions from the equipment or from other sources such as dust are violating PSAPCA regulations. PSAPCA regulations incorporate state and federal regulations and PSAPCA is responsible for enforcing the types of air emissions standards that apply to this site.

Table 6-23 (continued)
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 2

Law or Regulation	Analysis
LOCAL	
Land Use Approval	This example alternative may require a special use permit for construction of the surface cap and groundwater treatment facility.
Sewer Use Permit (City of Kent)	The discharge of treated groundwater into the Kent city sewer system (which then enters the Metro sewer system) may require a Kent sewer use permit. This permit is based on the sewer's capacity to handle the system's discharge. Under the existing Metro discharge permit, the maximum allowable discharge is 140,000 gpd.
Construction Permits	Building construction may require the following permits. o Building o Grade and fill o Street use and street cut o Plumbing o Mechanical
Stormwater Ordinance No. 2130	This ordinance requires that stormwater detention facilities be provided to handle stormwater volumes generated during a 25-year storm, and discharge from the site is to be limited to the predevelopment release rate during a 10-year storm. The stormwater control system would be designed to meet this standard.

Table 6-24

LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 3
EXCAVATION WITH ONSITE DISPOSAL, GROUNDWATER PUMP AND TREAT, AND SURFACE CAP

Law or Regulation	Analysis
FEDERAL	
Resource Conservation and Recovery Act (RCRA)	Under the requirements of RCRA, a landfill such as that proposed (double liner, leachate collection, properly closed and maintained) would be acceptable. The leachate from such a landfill would be considered hazardous waste and would be fully subject to RCRA. Under the groundwater protection standard of RCRA, pumping and treatment is an acceptable means to meet the corrective action standard.
EPA Groundwater Protection Strategy (GWPS)	This site is located over Class II groundwater according to the USEPA GWPS. The GWPS states: "As a general rule, Class II aquifers will receive levels of protection consistent with those now provided for groundwater under EPA's existing statutes.... Cleanup of contamination will usually be to background levels or drinking water standards but alternative procedures may be applied for potential sources of drinking water.... In these cases the contamination may be managed in order to avoid migration into a current source of drinking water or to avoid widespread damage."
Department of Transportation (DOT)	DOT regulations under 49 CFR 172 regulate all interstate shipments of hazardous materials. This alternative may involve transport of sludge generated by the groundwater treatment facility. These materials must be transported according to DOT regulations.
Clean Air Act (CAA)	Air stripping equipment used for groundwater treatment would be considered a source of air emissions and would therefore be regulated by the CAA.
Floodplains and Wetlands	See Alternative 2
Relocation Assistance and Property Acquisition	This regulation requires payment of just compensation to property owners whose property is purchased by federal agencies. This alternative may involve such a purchase.
Protection of Threatened and Endangered Species	This regulation requires that agencies request information on endangered species in any area affected by a proposed action. This alternative would require requesting such information, although it is not expected that endangered species are present in the area.

Note: See Appendix B for a discussion of some of the laws and regulations cited in this table.

Table 6-24 (continued)
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 3

Law or Regulation	Analysis
STATE	
WDOE Final Cleanup Policy	WDOE's cleanup policy allows the required level of cleanup to be defined on a site-specific basis according to established guidelines. The WDOE will decide if the cleanup achieved by this example alternative complies with the policy.
Washington State Dangerous Waste Regulations (WAC 173-303)	The WDOE prohibits the land disposal of "extremely hazardous waste" (EHW) anywhere in the state except at the Hanford landfill, which is not yet constructed. The classification of the wastes at the site has not been determined and it may be possible to dispose of "Dangerous Waste" (DW) in a landfill at the site. If the leachate from the landfill or sludge from the treatment plant were classified as EHW, it would face the same disposal restrictions. If the sludge or leachate were dangerous waste of any type (DW or EHW), it would be fully regulated.
National Pollutant Discharge Elimination System (NPDES) Permit	Although not currently proposed, the discharge of treated groundwater into Mill Creek would require compliance with the NPDES water quality standards. The applicable standards are those listed in the Federal Register, November 28, 1980, for 64 toxic pollutants. Standards for pollutants not found in the Federal Register would be developed by WSDOE. NPDES standards would also have to be met for the discharge of stormwater from capped areas.
Washington Industrial Safety and Health Act	This example alternative would require compliance with Chapters 296-62 and 296-24 WAC, which regulate the work environment and require a site safety plan, hazard evaluation, worker training programs, use of protective equipment by workers, and emergency equipment on site.
Flood Control Zone Permit	See Alternative 2.
REGIONAL	
Metro Regulations (Industrial Waste Discharge)	The discharge of treated groundwater to the Metro system would require compliance with industrial waste discharge regulations regarding quantities discharged and prohibited and restricted substances.
Puget Sound Air Pollution Control Agency (PSAPCA) Regulations	Air stripping equipment for groundwater treatment is a regulated source of air emissions and may require a Notice of Construction to PSAPCA. PSAPCA will determine whether emissions from the equipment or from other sources such as dust are occurring in violation of PSAPCA regulations. PSAPCA regulations incorporate state and federal regulations and PSAPCA is responsible for enforcing the types of air emissions standards that apply to this site.

Table 6-24 (continued)
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 3

Law or Regulation	Analysis
Seattle King County Department of Public Health	This agency regulates the construction of landfills for solid waste not classified under the WDOE Dangerous Waste Regulations. The regulations of this agency would apply to this alternative if the facility is considered a landfill and if the material deposited into the landfill is not considered DW or EHW. However, the material is expected to be classified as DW or EHW.
<u>LOCAL</u>	
Land Use Approvals	This example alternative may require a special use permit for the construction of a landfill and groundwater treatment facility.
Sewer Use Permit (City of Kent)	The discharge of treated groundwater into the Kent city sewer system (which then enters the Metro system) may require a Kent sewer use permit. This permit is based on the system's capacity to handle the discharge. Under the existing Metro discharge permit, the allowable discharge into the system is 140,000 gpd.
Construction Permits	Building construction may require the following permits: o Building o Grade and fill o Street use and street cut o Plumbing o Mechanical
Stormwater Ordinance No. 2130	This ordinance requires that stormwater detention facilities be provided to handle stormwater volumes generated during a 25-year storm, and discharge from the site is to be limited to the predevelopment release rate during a 10-year storm. The stormwater control system would be designed to meet this standard.

classified as "dangerous waste," it may be possible to dispose of it in an onsite landfill.

6.4.3.4 Example Alternative 4--PRP Remedial Action[1]

Table 6-25 shows how laws, regulations, and policies apply to Example Alternative 4. In general, the table shows that this alternative may be consistent with RCRA and WDOE Dangerous Waste Regulations, which allow contaminant removal by soil excavation and groundwater extraction.

This example alternative would involve removing large quantities of contaminated soil from the property. Transport of the contaminated soil would be subject to the Department of Transportation regulations (interstate transport), WDOE regulations (intrastate transport), and the generator and transporter standards under RCRA.

6.4.3.5 Example Alternative 5--Excavation with Offsite Disposal

Table 6-26 shows the relationship between this example alternative and governmental laws, regulations, and policies. In general, the table shows that this alternative may be consistent with RCRA, which allows removal of wastes, contaminated soils, and groundwater to background or *de minimus* levels. The WDOE Dangerous Waste Regulations would also allow contaminant removal for offsite disposal.

This example alternative also involves removing large quantities of contaminated soil from the site. Transport of the contaminated soil may be subject to the Department of Transportation regulations (interstate transport), WDOE regulations (intrastate transport), and the generator and transporter standards under RCRA.

6.4.3.6 Example Alternative 6--Mill Creek No Action

Table 6-27 shows the laws, regulations, and policies that apply to Example Alternative 6.

The dangerous waste regulations (WAC 173-303-050) provide authority to the WDOE to conduct cleanups of dangerous waste where there is a potential for discharge or release. Based on this authority and the guidance provided on cleanup levels in the WDOE cleanup policy, the WDOE would determine whether the no action alternative is acceptable.

The City of Kent has been evaluating stormwater drainage control measures that can be taken to reduce flooding in the

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[1] Section provided by PRP's.

Table 6-25
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 4
THE PRP ALTERNATIVE: EXCAVATION WITH OFFSITE DISPOSAL, DIVERSION WALL, GROUNDWATER PUMP AND TREAT, AND SURFACE CAP

Law or Regulation	Analysis
FEDERAL	
Resource Conservation and Recovery Act (RCRA)	RCRA standards related to corrective action under the groundwater protection standards, hazardous waste generation and transportation standards, and closure standards may apply to this example alternative. The excavation, groundwater extraction and treatment, surface cover, and groundwater monitoring components of this alternative may be consistent with these standards.
USEPA Groundwater Protection Strategy	This site is located over a Class II aquifer according to USEPA *Groundwater Protection Strategy. The GWPS states: "As a general* rule, Class II aquifers will receive levels of protection consistent with those now provided for groundwater under EPA's existing statutes.... Cleanup of contamination will usually be to background levels or drinking water standards but alternative procedures may be applied for potential sources of drinking water.... In these cases the contamination may be managed in order to avoid migration into a current source of drinking water or to avoid widespread damage."
Department of Transportation (DOT)	DOT regulations under 49 CFR 172 regulate all interstate shipments of hazardous materials. This example alternative would require shipment of contaminated soils to an offsite disposal site. These materials must be transported according to DOT regulations.
Clean Air Act (CAA)	Air stripping equipment used for groundwater treatment would be considered a source of air emissions and would therefore be regulated under the CAA.
Floodplains and Wetlands	See Alternative 2.
Relocation Assistance and Property Aquisition	No relocation or property purchase is required by this alternative.
Protection of Threatened and Endangered Species	This regulation requires that agencies request information on endangered species in any area affected by a proposed action. This alternative would require requesting such information, although it is not expected that endangered species are present in the area.

Notes: See Appendix B for a discussion of some of the laws and regulations cited in this table.
This table was prepared by the PRP's.

Table 6-25 (continued)
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 4

Law or Regulation	Analysis
STATE	
WDOE Final Cleanup Policy	WDOE's cleanup policy allows the required level of cleanup to be defined on a site-specific basis according to established guidelines. The excavation and groundwater extraction and treatment components of this example alternative are consistent with cleanup measures contemplated by the policy. The WDOE will decide if the cleanup achieved by this example alternative complies with the policy guidelines.
Washington State Dangerous Waste Regulations (WAC 173-303)	The Dangerous Waste Regulations would allow excavation and offsite disposal of wastes.
National Pollutant Discharge Elimination System (NPDES) Permit (State Administered Program)	The discharge of treated water into the Green River, if this option is selected, would require compliance with the NPDES water quality standards. The applicable standards are those printed in the Federal Register November 28, 1980, for 64 toxic pollutants. Standards for those pollutants not listed in the Federal Register would be developed by WDOE. An NPDES permit may also be required for the discharge of stormwater from capped areas.
Washington Industrial Safety and Health Act	This example alternative would require compliance with Chapters 296-62 and 296-24 WAC, which regulate the work environment and require a site safety plan, hazard evaluation, worker training programs, use of protective equipment by workers, and emergency equipment on site.
Flood Control Zone Permit	See Alternative 2.
Coastal Zone Management Act (CZM)	This regulation applies to construction within shorelines designated under the CZM as shorelines of statewide significance. Construction of an outfall to the Green River would require a shoreline substantial development permit to be issued by King County or the City of Kent, depending on where the outfall was located.
REGIONAL	
Metro Regulations (Industrial Waste Discharge)	If the option of discharging treated groundwater to the Metro system were selected, compliance would be required with industrial waste discharge regulations regarding quantities discharged and prohibited and restricted substances.

Table 6-25 (continued)
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 4

Law or Regulation	Analysis
Puget Sound Air Pollution Control Agency (PSAPCA) Regulations	PSAPCA will determine whether emissions from the equipment or from other sources such as dust are occurring in violation of PSAPCA regulations. PSAPCA regulations incorporate state and federal regulations and PSAPCA is responsible for enforcing the state and federal emissions standards that apply to this site. Air stripping equipment for groundwater treatment is a regulated source of air emissions and would require a Notice of Construction to PSAPCA.
<u>LOCAL</u>	
Land Use Approval	This example alternative may require a special use permit for construction of the surface cap and, if constructed, the groundwater treatment facility.
Sewer Use Permit (City of Kent)	If the treated groundwater is discharged into the Kent city sewer system (which then enters the Metro system) a Kent sewer use permit would be required. This permit is based on the system's capacity to handle the discharge. Under the existing Metro discharge permit, the maximum allowable discharge into the system is 140,000 gpd.
Construction Permits	Building construction may require the following permits: o Building o Grade and fill o Street use and street cut o Plumbing o Mechanical
Stormwater Ordinance No. 2130	This ordinance requires that stormwater detention facilities be provided to handle stormwater volumes generated during a 25-year storm, and discharge from the site is to be limited to the pre-development release rate during a 10-year storm. The stormwater management system included in this example alternative would comply with the ordinance.

Table 6-26
LAWS, REGULATIONS, STANDARDS APPLICABLE TO ALTERNATIVE 5
15-FOOT-DEEP EXCAVATION

Law or Regulation	Analysis
FEDERAL	
Resource Conservation and Recovery Act (RCRA)	Under RCRA, removal of wastes, contaminated soils, and groundwater to background or de minimus levels could be considered acceptable under the closure performance and corrective action standards. Shipment offsite would have to be tested under Part 261 and, if hazardous, handled in accordance with Parts 262 and 263.
EPA Groundwater Protection Strategy	This site is located over a Class II aquifer according to USEPA Groundwater Protection Strategy. The GWPS states "As a general rule, Class II aquifers will receive levels of protection consistent with those now provided for groundwater under EPA's existing statutes.... Cleanup of contamination will usually be to background levels or drinking water standards but alternative procedures may be applied for potential sources of drinking water.... In these cases the contamination may be managed in order to avoid migration into a current source of drinking water or to avoid widespread damage".
Department of Transportation (DOT)	DOT regulations under 49 CFR 172 regulate all interstate shipments of hazardous materials. This example alternative would require shipment of contaminated soils to an offsite disposal site. These materials must be transported according to DOT regulations.
Clean Air Act (CAA)	Air stripping equipment used for groundwater treatment would be considered a source of air emissions and would therefore be regulated under the CAA.
Floodplains and Wetlands	See Alternative 2.
Relocation Assistance and Property Aquisition	This regulation requires payment of just compensation to property owners whose property is purchased by agencies. This alternative could involve such a purchase.
Protection of Threatened and Endangered Species	This regulation requires that agencies request information on endangered species in any area affected by a proposed action. This alternative would require requesting such information although it is not expected that endangered species are present in the area.

Note: See Appendix B for a discussion of some of the laws and regulations cited in this table.

Table 6-26 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO ALTERNATIVE 5

Law or Regulation	Analysis
STATE	
WDOE Final Cleanup Policy	WDOE's cleanup policy allows the required level of cleanup to be defined on a site-specific basis according to established guidelines. The WDOE will decide if the cleanup achieved by this example alternative complies with this policy.
Washington State Dangerous Waste Regulations (WAC 173-303)	The Dangerous Waste Regulations would allow excavation and offsite disposal of wastes.
National Pollutant Discharge Elimination System (NPDES) Permit (State Administered Program)	Although not currently proposed, the discharge of treated groundwater into Mill Creek would require compliance with the NPDES water quality standards. The applicable standards are those printed in the Federal Register, November 28, 1980, for 64 toxic pollutants. Standards for those pollutants not listed in the Federal Register would be developed by WDOE.
Washington Industrial Safety and Health Act	This example alternative would require compliance with Chapters 296-62 and 296-24 WAC, which regulate the work environment and require a site safety plan, hazard evaluation, worker training programs, use of protective equipment by workers, and emergency equipment on site.
Flood Control Zone Permit	See Alternative 2.
REGIONAL	
Metro Regulations (Industrial Waste Discharge)	The discharge of treated groundwater to the Metro system would require compliance with industrial waste discharge regulations regarding quantities discharged and prohibited and restricted substances.
Puget Sound Air Pollution Control Agency (PSAPCA) Regulations	PSAPCA will determine whether emissions from the equipment or from other sources such as dust are occurring in violation of PSAPCA regulations. PSAPCA regulations incorporate state and federal regulations, and PSAPCA is responsible for enforcing the state and federal emissions standards that apply to this site. Air stripping equipment for groundwater treatment is a regulated source of air emissions and would require a Notice of Construction to PSAPCA.

Table 6-26 (continued)
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO ALTERNATIVE 5

Law or Regulation	Analysis
LOCAL	
Land Use Approval	This example alternative may require a special use permit for the groundwater treatment facility.
Sewer Use Permit (City of Kent)	The discharge of treated groundwater into the Kent city sewer system (which then enters the Metro system) would require a Kent sewer use permit. This permit is based on the system's capacity to handle the discharge. Under the existing Metro discharge permit, the maximum allowable discharge into the system is 140,000 gpd.
Construction Permits	Building construction may require the following permits: o Building o Grade and fill o Street use and street cut o Plumbing o Mechanical
Stormwater Ordinance No. 2130	This ordinance requires that stormwater detention facilities be provided to handle stormwater volumes generated during a 25-year storm, and discharge from the site is to be limited to the predevelopment release rate during a 10 year storm. The stormwater control system would be designed to meet this standard.

Table 6-27
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO ALTERNATIVE 6--MILL CREEK/NO ACTION

Law or Regulation	Analysis
FEDERAL	
Resource Conservation and Recovery Act (RCRA)	The November 1984 RCRA reauthorization considers corrective actions for areas such as Mill Creek that have been affected by RCRA regulated facilities.
USEPA Groundwater Protection Strategy (GWPS)	Mill Creek is located over a Class II groundwater according to the GWPS. Contaminant concentration limits for Class II groundwater must be met to satisfy the goals of the strategy. Mill Creek is a discharge zone for the local groundwater.
STATE	
WDOE Final Cleanup Policy	WDOE's cleanup policy allows the required level of cleanup to be defined on a site-specific basis according to established guidelines. The WDOE would decide if the cleanup achieved by this example alternative complies with the policy.
Washington State Dangerous Waste Regulations	WAC 173-303-050 provides authority to the WDOE to conduct cleanups of dangerous waste where there is a potential for discharge or release. Under this authority the WDOE may choose to agree or disagree that the no action alternative is acceptable.
LOCAL	
City of Kent Drainage Master Plan	The plan has not been adopted. It is not known how this plan would affect this alternative.

Note: See Appendix B for a discussion of some of the laws and regulations cited in this table.

valley. A drainage master plan will be adopted in spring 1985, and at this time it is not known how Example Alternative 6 would be affected by this plan.

6.4.3.7 Example Alternative 7--Mill Creek Sediment Removal

Table 6-28 shows the relationship between this example alternative and governmental laws, regulations, and policies. There are three agencies that issue permits or administer standards for actions such as those proposed for Mill Creek under this alternative: the U.S. Army Corps of Engineers (COE), the Washington State Department of Fisheries (WSDOF), and the Washington State Department of Game (WSDOG). The COE issues permits for structures in or affecting navigable waters (Section 10 permit) and for dredging and filling of water bodies or wetlands (Section 404 permit). Mill Creek is not considered to be a navigable waterway by the COE and therefore work in the creek would not require a Section 10 permit. The proposed diversion of Mill Creek and excavation and filling of the channel may require evaluation under Section 404. Whether the proposed action requires an evaluation will depend on, among other factors, the methods proposed for diverting Mill Creek and the COE's interpretation of the regulations. The COE must be provided with a description of the work proposed in order to make that determination.

Any work within the ordinary high waterline of a creek such as Mill Creek could require a hydraulics project approval (hydraulics permit) from WSDOF and WSDOG. WSDOF and WSDOG also provide a local Indian tribal organization with a list of all hydraulics permits that have been granted. This is done at the request of the Indian organization. The Muckleshoot Indian Tribe has fishing rights in all streams such as Mill Creek that are tributary to the Duwammish.

The Washington State Dangerous Waste Regulations (WAC 173-303-050) authorize the WDOE to conduct cleanups of dangerous waste where there is a potential for discharge or release. Under this authority, the WDOE will evaluate whether this alternative accomplishes the required cleanup.

Transport of the dredged sediments may be subject to state or federal regulations depending on whether transport is interstate or intrastate and whether the sediments are classified as hazardous waste.

Another regulation that could apply to this alternative is the Fish and Wildlife Coordination Act, which requires that a federal agency consult with the appropriate state and federal agencies before modifying any body of water.

Table 6-28
LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO ALTERNATIVE 7--MILL CREEK SEDIMENT REMOVAL

Law or Regulation	Analysis
FEDERAL	
Resource Conservation and Recovery Act (RCRA)	The November 1984 RCRA reauthorization considers corrective actions for areas such as Mill Creek that have been affected by RCRA regulated facilities.
USEPA Groundwater Protection Strategy (GWPS)	Mill Creek is located over a Class II groundwater according to the GWPS. Contaminant concentration limits for Class II groundwater must be met to satisfy the goals of the strategy. Mill Creek has been contaminated by groundwater discharge.
Department of Transportation (DOT)	DOT regulations under 49 CFR 172 regulate all interstate shipments of hazardous materials. Sediment dredged from Mill Creek may be subject to these conditions.
Floodplains and Wetlands	These regulations apply to construction in flood plains or flood hazard areas. The area adjacent to Mill Creek is designated as a flood hazard area. However, the regulations do not state whether they would apply to the type of construction proposed or whether they apply to temporary facilities such as proposed under this alternative. These regulations require an analysis of the impacts of construction in these areas.
Fish and Wildlife Coordination Act (FWCA)	This act requires consultation with the appropriate state and federal agencies for projects involving the modification of water bodies. This alternative would require such consultation.
Protection of Threatened or Endangered Species	This regulation requires that agencies request information on endangered species in any area affected by a proposed action. This alternative would require requesting such information, although it is not expected that endangered species are present in the area.
Permits for Discharge of Dredged or Fill Materials into Waters of the U.S. (Section 404 permit).	The Corps of Engineers will determine whether this approval will be required based on their review of the proposed action.

Note: See Appendix B for a discussion of some of the laws and regulations cited in this table.

Table 6-28 (continued)

LAWS, REGULATIONS, AND STANDARDS APPLICABLE TO ALTERNATIVE 7--MILL CREEK SEDIMENT REMOVAL

Law or Regulation	Analysis
STATE	
WDOE Final Cleanup Policy	WDOE's cleanup policy allows the required level of cleanup to be defined on a site-specific basis according to established guidelines. The WDOE will decide if the cleanup achieved by this example alternative complies with the policy.
Washington State Dangerous Waste Regulations (WAC 173-303)	WAC 173-303-050 provides authority to the WDOE to conduct cleanups of dangerous waste where there is a potential for discharge or release. Under this authority the WDOE may choose to agree or disagree that Mill Creek needs to be cleaned up and that this alternative accomplishes the required level of cleanup.
Washington Industrial Safety and Health Act	This example alternative would require compliance with Chapters 296-62 and 296-24 WAC which regulate the work place environment and require a site safety plan, hazard evaluation, worker training programs, protective equipment for workers and emergency equipment.
Flood Control Zone Permit	This regulation applies to construction in designated flood control zones. There is a designated flood hazard area adjacent to Mill Creek. These regulations may apply to construction in this area.
Hydraulics Permit	A hydraulics permit is required for work within the ordinary high water line of a creek such as Mill Creek.
REGIONAL	
PSAPCA Regulations	Not applicable. This alternative is not expected to generate air emissions from stationary sources.
LOCAL	
Construction Permits	Construction of the Mill Creek diversion and transport of excavated materials may require a grade and fill permit and street use/street cut permit.
Storm Water Ordinance No. 2130	This ordinance requires submission of a stormwater discharge plan when any grading permit is applied for.
City of Kent Drainage Master Plan	The plan has not been adopted. It is not known how this plan would affect this alternative.

The City of Kent's drainage master plan will be adopted in spring 1985. At this time, it is not known how Example Alternative 7 would be affected by this plan.

6.4.5 COST ESTIMATES

The NCP requires that comparative cost estimates be developed for remedial action alternatives. The estimates presented in this section encompass the total scope of each remedial action described in the previous sections of this chapter. They include all currently identified direct and indirect costs associated with each component of each example alternative. Changes in the components, knowledge of site conditions, work scope, disposal facility siting, and/or cleanup criteria for an alternative will affect the estimated costs.

The cost estimates for the example alternatives were developed using unit costs derived from previous experience on other hazardous waste management projects, from quotations of industry sources for specialized items, and from cost information contained in the Compendium of Cost of Remedial Technologies of Hazardous Waste Sites. Tables 6-29 through 6-33 present the cost estimates for Example Alternatives 2, 3, 4, 5, and 7 (all except the two no action alternatives). The cost estimates presented have an accuracy range of +50 percent to -30 percent.

6.4.4.1 Cost Estimating Approach

The total cost of a remedial action includes all the capital and operating costs known to be associated with that example alternative. Capital costs include costs for equipment, site development, and buildings, and percent additions to cover contractor overheads; health, safety, and decontamination; engineering and legal services; and contingencies. Operation and maintenance costs include costs for labor, laboratory analyses, energy, chemicals for groundwater treatment, and sludge transportation and disposal. Direct costs such as soil removal, personnel protection, onsite construction, transport, storage, and treatment and disposal costs are included. Indirect costs are also a major part of a remedial action cost and include items such as decontamination stations, perimeter fencing, traffic control, additional soil testing, rebuilding local roads, public relations, groundwater monitoring, and pilot testing costs.

Because this feasibility study is conceptual, a contingency allowance has also been included. This allowance includes a limited amount for normal process refinement, unknown site conditions, engineering, administrative costs, and other contingencies. Allowances for inflation, additional material

Table 6-29
COST ESTIMATE FOR EXAMPLE ALTERNATIVE 2
(in thousands of dollars)

CAPITAL COSTS:

Elements	Costs
Groundwater Pumping System	$330
Surface Cap	3,628
Groundwater Treatment Facility	1,832
Decontamination Facility	24
Buffer Zone	89
Monitoring Wells	66
Subtotal	$5,969
Contractor Mobilization(5%)	298
Contractor Bond and Insurance(3%)	188
Health, Safety, and Decontamination(15%)	895
Subtotal	$7,351
Contingency(30%)	2,205
Subtotal	$9,556
Engineering and Legal(20%)	1,911
Sales Tax(8.1%)	774
TOTAL CAPITAL COST	$12,200

OPERATION AND MAINTENANCE COSTS(Year One):	$ per year
Monitoring	$540
Labor	350
Power	31
Chemicals	687
Sludge disposal	118
Maintenance	24
Sewer service charge	150
TOTAL O&M COST	$1,900

Table 6-29
(continued)

Example Alternative 2

PRESENT WORTH ANALYSIS:

Year	Plant Cost	Annual O&M	Replacements	Total	Present Worth
1985	$12,241			$12,241	$12,241
1986		$1,900		1,900	1,727
1987		1,872		1,872	1,547
1988		1,870		1,870	1,405
1989		1,869		1,869	1,277
1990		1,869		1,869	1,161
1991		1,869		1,869	1,055
1992		1,869		1,869	959
1993		1,869		1,869	872
1994		1,869		1,869	793
1995		1,869		1,869	721
1996		1,869		1,869	655
1997		1,869		1,869	596
1998		1,869		1,869	541
1999		1,869		1,869	492
2000		1,869	1,153	3,022	723
2001		1,869		1,869	407
2002		1,869		1,869	370
2003		1,869		1,869	336
2004		1,869		1,869	306
2005		1,869		1,869	278
2006		1,869		1,869	253
2007		1,869		1,869	230
2008		1,869		1,869	209
2009		1,869		1,869	190
2010		1,869		1,869	173
2011		1,869		1,869	157
2012		1,869		1,869	143
2013		1,869		1,869	130
2014		1,869		1,869	118
2015		1,869		1,869	107
TOTALS				$69,500	$30,200

Table 6-30
COST ESTIMATE FOR EXAMPLE ALTERNATIVE 3
(in thousands of dollars)

CAPITAL COSTS:

Elements	Costs
Groundwater Pumping System	$204
Surface Cap	3,628
Groundwater Treatment	1,664
Excavation	1,108
Landfill	1,851
Decontamination Facility	302
Buffer Zone	89
Monitoring Wells	66
Subtotal	$8,912
Contractor Mobilization(5%)	446
Contractor Bond and Insurance(3%)	281
Health, Safety, and Decontamination(15%)	1,337
Subtotal	$10,975
Contingency(30%)	3,293
Subtotal	$14,268
Engineering and Legal(20%)	2,854
Sales Tax(8.1%)	1,156
TOTAL CAPITAL COST	$18,300

ANNUAL OPERATION AND MAINTENANCE COSTS:

Elements	Costs
Monitoring	$540
Labor	320
Power	26
Chemicals	585
Sludge disposal	101
Maintenance	22
Sewer service charge	128
TOTAL O&M COST(First Year)	$1,722

Note that O & M costs decrease during the initial years of operation.

Example Alternative 3

Table 6-30 (continued)

PRESENT WORTH ANALYSIS:

Year	Plant Cost	Annual O&M	Replacements	Total	Present Worth
1985	$5,006			$5,424	$5,424
1986	5,424			5,424	4,931
1987	5,846			5,846	4,831
1988	6,269			6,269	4,710
1989		1,694		1,694	1,157
1990		1,694		1,694	1,052
1991		1,694		1,694	956
1992		1,694		1,694	869
1993		1,694		1,694	790
1994		1,694		1,694	718
1995		1,694		1,694	653
1996		1,694		1,694	594
1997		1,694		1,694	540
1998		1,694		1,694	491
1999		1,694		1,694	446
2000		1,694	1,038	2,732	654
2001		1,694		1,694	369
2002		1,694		1,694	335
2003		1,694		1,694	305
2004		1,694		1,694	277
2005		1,694		1,694	252
2006		1,694		1,694	229
2007		1,694		1,694	208
2008		1,694		1,694	189
2009		1,694		1,694	172
2010		1,694		1,694	156
2011		1,694		1,694	142
2012		1,694		1,694	129
2013		1,694		1,694	117
2014		1,694		1,694	107
2015		1,694		1,694	97
TOTALS				$69,700	$31,900

Table 6-31
COST ESTIMATE FOR EXAMPLE ALTERNATIVE 4
(in thousands of dollars)

CAPITAL COSTS:

Elements	Costs
Diversion barrier	$986
Groundwater pumping system	202
Treatment facility	1,832
Excavation with offsite disposal	17,558
Infiltration System	50
Fill	490
Asphaltic concrete pavement(cap)	582
Decontamination Facility	302
Buffer Zone	89
Monitoring wells	66
Subtotal	$22,157
Contractor Mobilization(5%)	1,108
Contractor Bond and Insurance(3%)	698
Health, Safety, and Decontamination(15%)	3,324
Subtotal	$27,286
Contingency(30%)	8,186
Subtotal	$35,472
Engineering and Legal(20%)	7,094
Sales Tax(8.1%)	2,873
TOTAL CAPITAL COST	$45,400

ANNUAL OPERATION AND MAINTENANCE COSTS:

Elements	Costs
Monitoring	$540
Labor	350
Power	31
Chemicals	663
Sludge disposal	142
Maintenance	24
Sewer service charge	150
TOTAL O&M COST	$1,900

Note: These estimates were prepared using EPA cost bases and do not reflect the PRP cost assumptions.

Example Alternative 4

Table 6-31 (continued)

PRESENT WORTH ANALYSIS:

Year	Plant Cost	Annual O&M	Replacements	Total	Present Worth
1985	$22,135	$0		$22,130	$22,130
1986	22,130	0		22,130	20,118
1987		1,900		1,900	1,570
1988		1,900		1,900	1,427
1989		1,900		1,900	1,298
1990	1,135	1,900		3,035	1,884
1991				0	0
1992				0	0
1993				0	0
1994				0	0
1995				0	0
1996				0	0
1997				0	0
1998				0	0
1999				0	0
2000				0	0
2001				0	0
2002				0	0
2003				0	0
2004				0	0
2005				0	0
2006				0	0
2007				0	0
2008				0	0
2009				0	0
2010				0	0
2011				0	0
2012				0	0
2013				0	0
2014				0	0
2015				0	0
TOTALS				$53,000	$48,400

Table 6-32
COST ESTIMATE FOR EXAMPLE ALTERNATIVE 5
(in thousands of dollars)

CAPITAL COSTS:

Elements	Costs
Dewatering system	$204
Groundwater treatment facility	1,832
Excavation with offsite disposal	83,164
Fill	2,272
Decontamination facility	302
Buffer zone	89
Monitoring wells	66
Subtotal	$87,929
Contractor Mobilization(5%)	4,396
Contractor Bond and Insurance(3%)	2,770
Health, Safety, and Decontamination(15%)	13,189
Subtotal	$108,285
Contingency(30%)	32,485
Subtotal	$140,770
Engineering and Legal(20%)	28,154
Sales Tax(8.1%)	11,402
TOTAL CAPITAL COST	$180,300

ANNUAL OPERATION AND MAINTENANCE COSTS:

Elements	Costs
Monitoring	$540
Labor	350
Power	31
Chemicals	663
Sludge disposal	142
Maintenance	24
Sewer service charge	150
TOTAL O&M COST(First Year)	$1,900

Note that O & M costs decrease during the years of operation.

Example Alternative 5

Table 6-32
(continued)

PRESENT WORTH ANALYSIS:

Year	Plant Cost	Annual O&M	Replacements	Total	Present Worth
1985	$46,975			$46,975	$46,975
1986	46,975			46,975	42,705
1987	46,975			46,975	38,822
1988	46,975			46,975	35,293
1989		100		100	68
1990		100		100	62
1991		100		100	56
1992		100		100	51
1993				0	0
1994				0	0
1995				0	0
1996				0	0
1997				0	0
1998				0	0
1999				0	0
2000				0	0
2001				0	0
2002				0	0
2003				0	0
2004				0	0
2005				0	0
2006				0	0
2007				0	0
2008				0	0
2009				0	0
2010				0	0
2011				0	0
2012				0	0
2013				0	0
2014				0	0
2015				0	0
TOTALS				$188,300	$164,000

Table 6-33
COST ESTIMATE FOR EXAMPLE ALTERNATIVE 7
(in thousands of dollars)

CAPITAL COSTS:

Elements	Costs
Temporary Diversion	$108
Excavate and Dispose of Sediments	480
Bank and Bed Restoration	50
Subtotal	$638
Contractor Mobilization(5%)	32
Contractor Bond and Insurance(3%)	19
Health, Safety, and Decontamination(15%)	96
Subtotal	$785
Contingency(30%)	235
Subtotal	$1,020
Engineering and Legal(20%)	204
Sales Tax(8.1%)	83
TOTAL CAPITAL COST	$1,300

ANNUAL OPERATION AND MAINTENANCE COSTS:

This example alternative does not require operation and maintenance.

PRESENT WORTH ANALYSIS:

This example alternative has costs for only one month thus present worth analysis is not applicable.

volume, and abnormal technical difficulties are not accounted for in the contingency.

6.4.4.2 General Assumptions

General assumptions made in estimating costs were as follows:

1. Costs are for the Seattle area, first quarter 1985.

2. A minimum of Level C personnel protection would be required for all onsite activities associated with contaminated soil handling or processing, with the exception of vehicle operators working entirely in enclosed vehicle cabs. These workers would be required to use a minimum of Level D protection gear. The use of Levels C and D personnel protective gear can reduce worker efficiency, shorten summer work periods, and have other health and safety requirements. For Level C, these effects have been reported to increase labor costs by at least three times over standard conditions. Decontamination trailers, truck wash stations, and site safety officers would also have to be present for all onsite activities.

3. Stringent dust control would be required for any alternative that involves significant soil disruption.

4. A program for monitoring airborne particulates and organics would be operated through all phases of excavation. The program is anticipated to include the use of perimeter air samplers, onsite air samplers, and one onsite meterological station.

5. Onsite security would be provided during all construction, excavation, stabilization, and treatment activities.

6. Yearly maintenance of a RCRA cap would consist primarily of inspections and mowing and other maintenance of the seeded cover. In addition, portions of the RCRA cover would be regraded at 3- to 5-year intervals to account for subsidence of the cover. Significant regrading may be required the year after capping is completed. Imported soils would be used for regrading.

7. Present worth calculations were performed using a 10 percent interest rate.

8. Operating costs were calculated based on the provisions of each example alternative.

9. Where imported fill materials are needed, they are assumed to be available locally in sufficient quantities.

10. Process, mechanical, and electrical equipment has been assigned a 15-year life. Salvage values were calculated using straight-line depreciation.

11. No land costs were included in the calculations.

6.4.4.3 Specific Assumptions for Example Alternatives

EXAMPLE ALTERNATIVE 1

No cost estimate was prepared for the no action alternative.

EXAMPLE ALTERNATIVE 2

1. Construction duration would be 8 months to one year.

2. The operating period would be 30 years.

3. For costing purposes, the groundwater monitoring system was assumed to consist of 10 wells with a total of 500 feet of drilling, sampled quarterly for 30 years.

EXAMPLE ALTERNATIVE 3

1. Construction duration would be 4 years.

2. Treatment plant operations and maintenance costs during the construction period are considered to be construction costs.

3. The operating period would be 30 years.

4. Contaminated material excavated from the site would be eligible for inclusion in the landfill under Washington State regulations.

5. For costing purposes, the groundwater monitoring system was assumed to consist of 10 wells with a total of 500 feet of drilling, sampled quarterly for 30 years.

EXAMPLE ALTERNATIVE 4

1. Construction duration would be 2 years.

2. The operating period would be 5 years. Dismantling and capping activities would occur in the sixth year following construction.

3. For costing purposes, the groundwater monitoring system was assumed to consist of 10 wells with a total of 500 feet of drilling, sampled quarterly for 5 years.

EXAMPLE ALTERNATIVE 5

1. Construction duration is assumed to be 4 years.

2. The dewatering system and plant operations and maintenance costs during the construction period are considered to be construction costs.

3. A 5-month-per-year, 5-day work week construction season is assumed for excavation activities.

4. For costing purposes, the groundwater monitoring system was assumed to consist of 10 wells with a total of 500 feet of drilling, sampled quarterly for 5 years.

EXAMPLE ALTERNATIVE 6

No cost estimate was prepared for the Mill Creek no action alternative.

EXAMPLE ALTERNATIVE 7

1. Construction duration would be one month.

2. No costs have been included for a temporary easement for the diversion line.

3. Sediments would be shippable and disposed in a hazardous waste landfill as removed from the creek.

4. No monitoring costs were included.

6.5 SUMMARY

A summary of the conclusions of the technical, environmental/public health, and cost evaluations of the seven example alternatives is provided in Table 6-34. Included in this table, as appropriate, are summary statements related to other considerations such as the institutional evaluation. The summary focuses primarily on evaluation results related to the following factors:

- Prevention of direct human and animal contact with contaminated materials

- Prevention of contaminated stormwater runoff from the Western Processing site

- Prevention or minimization of infiltration and leaching of contaminants from unsaturated zone soils

- Improvement of groundwater quality in the shallow aquifer beneath the site

- Reduction in contaminant discharge from the site to Mill Creek via groundwater to a level that would allow contaminant levels in the creek to meet ambient quality criteria or background levels, whichever are higher.

Table 6-34
SUMMARY OF PUBLIC HEALTH, ENVIRONMENTAL, AND TECHNICAL EVALUATIONS

Example Alternative	Cost (Millions) Capital	Cost (Millions) Present Worth	Public Health Aspects	Environmental Aspects	Technical Aspects	Other
1. No Action	-0-	-0-	On-property contamination (soils up to 12 feet deep) would continue to have potential maximum lifetime excess cancer risk (worker scenario) of 5 x 10^{-4}. Groundwater contamination from Western Processing would pose no threat to City of Kent or any other public water supply wellfields. The concentrations of organic and inorganic (metal) contaminants in the groundwater immediately below Western Processing exceed drinking water standards and Acceptable Daily Intake (ADI) levels. Ingestion of this groundwater over a 40-year period could lead to a maximum lifetime excess cancer risk (worker scenario) of 2 x 10^{-1}. However, the shallow aquifer is not used for water supply. Recreational use of Mill Creek would not pose a threat to human health.	Priority pollutant metal concentrations in Mill Creek downstream of Western Processing exceed chronic and acute ambient water quality criteria for aquatic organisms. These metal concentrations probably are and would continue to be toxic to a wide variety of aquatic organisms for hundreds of years. Priority pollutant organic concentrations in Mill Creek downstream of Western Processing do not exceed ambient water quality criteria for aquatic organisms. Sediments in Mill Creek contain high levels of priority pollutant metals.	Stormwater runoff would be in contact with contaminated soils and could carry contamination from the site onto adjacent areas and into Mill Creek. Infiltration would continue to leach contaminants from the unsaturated zone and carry them into the groundwater beneath the site. Contaminated groundwater from Western Processing would continue to discharge into Mill Creek at 50 to 70 gpm. Groundwater quality beneath the site would improve only very slowly (i.e., would require well beyond hundreds of years to achieve levels that would not adversely impact Mill Creek water quality).	Since 1983, three major response/remedial actions at Western Processing have stopped the discharge of contaminated runoff from the property to Mill Creek and removed waste materials and all structures from the surface of the property. These actions have eliminated potential hazards such as fires, explosions, and spills or leaks of waste materials. Future use of the site may be restricted by local authorities.
2. Multimedia cap over Areas I and II, and a portion of Area V (provides two layers to prevent infiltration). Controlled stormwater discharge from capped areas into Mill Creek Groundwater pumping from Areas I, II, V and IX,	$12.2 Average annual operation & maintenance cost/ $1.87	$30.2	Would eliminate direct human and animal contact with contaminated surface soils in capped areas; however, all soils would remain in place. Drinking water standards and ADI's for organics in the groundwater under the site would be met in less than 15 years of pumping; SNARL's* for longer term use would not	Once pumping begins, Mill Creek waters would approach ambient water quality criteria or background (whichever is higher) for dissolved metal contaminants. Contaminants adhering to Mill Creek sediments and gradually leaching back into Mill Creek waters may delay achieving ambient water quality criteria or background.	The pumping system would eliminate discharge of contaminated groundwater to Mill Creek from Areas I, II, V, and IX during the pumping period. An extremely long pumping, treatment, and systems maintenance period would be required before water quality criteria, standards, or	Would comply with RCRA technical requirements for closure as an existing land disposal facility. The groundwater extraction rate would be limited primarily by sewer system capacity and secondarily by the permeability of the soils.

*Suggested No Adverse Response Level(s).

Table 6-34
(continued)

Example Alternative	Cost (Millions)		Public Health Aspects	Environmental Aspects	Technical Aspects	Other
	Capital	Present Worth				
2. Continued						
onsite treatment and discharge into Metro system (100 gpm) Monitoring Health and safety plans and training prior to construction			be met until after approximately 40 years of pumping. Achieving federal drinking water standards in the groundwater for metal contaminants would be much more difficult. For example, it would require well beyond 100 years of pumping to achieve the cadmium standard, while the standard for lead may never be achieved.	Would eliminate contaminated stormwater discharges from capped area. Approximately 60 to 120 years of groundwater pumping would be required to reduce the concentrations of metals in the groundwater to levels that would not cause continued degradation of Mill Creek after the pumping system is turned off. Water quality problems in Mill Creek upstream of Western Processing, such as low dissolved oxygen levels, could continue to limit the habitat quality in Mill Creek.	background levels could be met in Mill Creek after the pumping system is turned off. Cap would prevent infiltration and leaching of contaminants from the unsaturated zone in Areas I, II, and V into the groundwater. Effective cap lifetime in this application is not known. Would require permanent access to some adjacent properties. Would require a 12-month construction period. Cap would require relatively complex construction techniques. Construction impacts could be mitigated by good construction practices, dust and runoff controls, and scheduling.	Future use of the capped areas would be prohibited.
3. Excavate all unsaturated soils (108,000 cubic yards) in Areas I and II and one foot in a portion of Area VIII, with disposal in new 11-acre, double-lined, RCRA onsite landfill. Multimedia cap over landfill (Area I), Area II, and a portion of Area V (see Example Alternative 2).	$18.3 Average annual O&M cost: $1.69	$31.9	Would eliminate direct human and animal contact with contaminated soils in capped areas and in Area VIII. Ability to achieve drinking water standards, ADI's, and SNARL's for organic and inorganic (metal) contaminants in groundwater beneath the site would be essentially identical to Example Alternative 2.	Would be identical to Example Alternative 2.	Would eliminate discharge of contaminated groundwater from Western Processing to Mill Creek while the pumping system is operating. Like Example Alternative 2, an extremely long post-construction pumping, treatment, and site maintenance period would be required before water quality standards, criteria, or background levels could be met in Mill Creek after the pumping system is turned off.	Would comply with RCRA technical standards for construction and closure of a new hazardous waste landfill. Materials to be excavated have not yet been classified under the WDOE Dangerous Waste Regulations. No "Extremely Hazardous Waste" may be landfilled within Washington State. Certain excavated materials such as PCB's, buried drums, and concentrated wastes would

Table 6-34
(continued)

Example Alternative	Cost (Millions) Capital	Present Worth	Public Health Aspects	Environmental Aspects	Technical Aspects	Other
3. Continued						
Controlled stormwater discharged from capped areas into Mill Creek					Would require the same type of access as in Example Alternative 2.	require special handing and possibly disposal procedures. Future use of the landfill and capped areas would be prohibited.
Groundwater pumping around landfill and in portions of Areas II and V, onsite treatment, and discharge into Metro system (85 gpm)					Landfill liners and leachate collection system, when combined with the cap, would provide more protection from contaminant leaching from unsaturated zone into the groundwater than Example Alternative 2. Effective landfill and cap lifetime in this application is not known.	
Monitoring						
Health and safety plans and training prior to construction.					The landfill would be constructed in phases, with the excavated material stored onsite. This would be very difficult, but not impossible, to accomplish on the limited (11-acre) space on Area I.	
					Would require 48-month construction period. Cap and landfill would require relatively complex construction techniques.	
					The landfill and cap combination would isolate approximately 60 percent of both the zinc and total contamination in the soil.	
					Construction impacts could be mitigated by good construction practices, dust and run-off controls, and scheduling.	

Table 6-34
(continued)

Example Alternative	Cost (Millions)		Public Health Aspects	Environmental Aspects	Technical Aspects	Other
	Capital	Present Worth				
4. The PRP Proposal* Excavate to variable depths (1' to 8') in Area I Offsite disposal of all excavated material (75,000 cubic yards) in a double-lined RCRA landfill Replace excavated material with imported fill Diversion wall, 40 feet deep, inside the perimeter of Area I Groundwater pumping and stormwater infiltration in Area I for up to 5 years, onsite or offsite treatment, discharge to Metro or the Green River (100 gpm) Asphalt pavement over Area I upon completion of pumping Monitoring Health and safety plans and training prior to construction	$45.4 Average annual O&M cost: $1.9	$48.9	Would eliminate direct human and animal contact with all surface soils in Area I. ADI's, drinking water standards, and SNARL's for all except one indicator organic would be met within up to 5 years of pumping. Drinking water standards for metals could not be met even if the pumping program were extended indefinitely.	Both during and after up to 5 years of pumping, Mill Creek water quality should be able to meet ambient water quality or background levels for all Western Processing-related contaminants. Water quality problems in the creek not related to Western Processing would continue.	Once the diversion barrier is installed, the discharge of contaminated groundwater to Mill Creek from Area I would be reduced by approximately 50 percent. Once pumping starts, the discharge of all contaminated groundwater from Area I would be prevented. The potential for discharge of contaminated stormwater runoff from Area I would be eliminated. The infiltration system that would operate during the pumping program would provide additional contaminant removal from the Area I unsaturated zone. Would require 24-month construction period. Installation of diversion barrier would require relatively complex construction techniques. Construction impacts could be mitigated by good construction practices, dust and runoff controls, and scheduling. Would remove 70 percent of contaminants from the unsaturated zone including 88 percent of the zinc contamination in Area I.	Does not address off-property contamination other than off-property contaminated groundwater (which could potentially be removed during the pumping program). Off-property remedial actions such as those described in the other example alternatives would be one of the subjects of negotiations. The groundwater extraction rate for this alternative is primarily limited by considerations related to reducing total groundwater treatment *requirements and secondarily* by soil conditions. Double-lined landfill capacity is not currently available in the Northwest but will be available by mid-1985. The disposal costs were estimated to be $100 per ton, but could vary substantially. Property would be suitable for future use.

*Summary prepared by PRPs.

Table 6-34
(continued)

Example Alternative	Cost (Millions) Capital	Cost (Millions) Present Worth	Public Health Aspects	Environmental Aspects	Technical Aspects	Other
5. Excavate 15 feet in Areas I and II, 3 feet in a portion of Area V (including the old discharge line), 3 feet in Area IX, and 1 foot in a portion of Area VIII. Offsite disposal of all excavated material (300,000 cubic yards) in a double-lined RCRA landfill Replace excavated material with imported soil Groundwater pumping for excavation, dewatering, onsite treatment, and discharge to the Metro system. Monitoring Health and safety plans and training prior to construction.	$180.3 Average annual O&M Cost: $0.1	$164.0	Would eliminate direct human and animal contact with all surface soils contaminated by Western Processing. Would reduce concentrations of organic contaminants in the groundwater beneath Areas I and II to or near drinking water standards, ADI's, and SNARL's for longer term use. Lead levels will be reduced sufficiently to meet the drinking water standard; however, cadmium will not.	Excavation would be sufficient to allow the levels of metals in Mill Creek, including zinc, to permanently meet ambient water quality criteria or background, whichever is higher. Would eliminate contaminated stormwater discharge to groundwater and Mill Creek. Water quality problems in Mill Creek not related to Western Processing would continue to limit habitat quality.	Most reliable and proven source control alternative. Approximately 95 percent of all contamination in soil would be removed by excavation. Would permanently eliminate contaminated groundwater discharges to Mill Creek from Areas I and II. The off-property excavations would reduce most average metal concentrations in soils to background. 20 months of excavation over a 4-year construction period. Dewatering and groundwater treatment would continue during months when excavation is not occurring. 40,000 truck trips would be required to haul contaminated material away from and imported material to the site. Would require no operation or maintenance activities other than monitoring. No permanent access would be required. Construction impacts could be mitigated by good construction practices, dust and run-off controls, transportation plans, and scheduling.	Complies with RCRA technical requirements for closure as a storage facility. Future property use would not be restricted. Double-lined RCRA landfill capacity is not currently available in the Northwest but will be available by mid-1985. The disposal costs were estimated to be $100 per ton but could vary substantially.
6. Mill Creek No Action (After implementation of Example Alternative 2, 3, 4, or 5)	-0-	-0-	None. Mill Creek sediments do not pose a threat to human health.	The Mill Creek sediments, which are contaminated particularly with metals as a result of surface and groundwater discharges from Western Processing, would continue to be moved downstream (and eventually dispersed and diluted) by natural processes. Contaminants on sediments could adversely affect aquatic organisms by leaching into the water or by toxic effects on bottom dwelling organisms.	With an effective source control action (such as Example Alternative 2, 3, 4, or 5), it would take from 5 to 10 years for the contaminated sediments to be transported out of the local stream reach. The source control would have to remain effective for the sediments to remain uncontaminated.	Modification of Mill Creek above Western Processing as part of Kent's drainage master plan could change the effectiveness of this example alternative, as could the introduction of upstream sources of contaminants.

Table 6-34
(continued)

Example Alternative	Cost (Millions) Capital	Present Worth	Public Health Aspects	Environmental Aspects	Technical Aspects	Other
6. Continued				Avoids the adverse impacts of diversion and excavation.		
7. Mill Creek Sediment Removal (after implementation of Example Alternative 2, 3, 4, or 5) Excavate and dispose of sediment from the bed and banks of Mill Creek adjacent to and 1,300 feet downstream of Western Processing. (1,700 cubic yards) Divert 2,300 feet of Mill Creek into a pump-and-pipe system during excavation (approximately one month during low flow season) Rehabilitate stream bed with gravel riffles and natural vegetation Monitoring	$1.3		None. Mill Creek sediments do not pose a threat to human health.	All contaminated sediment in a 2,300-foot reach of Mill Creek would be removed. Resuspension and downstream transport of contaminated sediments during construction would be prevented by diverting the creek around the reach to be excavated. Excavation and diversion would temporarily destroy 2,300 feet of aquatic habitat. Fish would not be able to pass through this part of Mill Creek during the one-month diversion. After streambed excavation and rehabilitation, water quality problems upstream of Western Processing, such as low dissolved oxygen levels, could continue to limit habitat quality in Mill Creek.	Monitoring of groundwater quality and flow near the creek would be necessary to determine the optimal time to remove the contaminated sediments. The source control would have to remain effective for the sediments to remain uncontaminated. One-month construction period. No operation and maintenance would be required.	Modification of Mill Creek above Western Processing as part of Kent's drainage master plan could change the effectiveness of this example alternative, as could the introduction of upstream sources of contaminants.

Chapter 7
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