ECF-200PO1-18-0031
Revision 0

Identification of Site-Specific Monitoring Constituents for the Nonradioactive Dangerous Waste Landfill

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

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APPROVED
By Janis D. Aardal at 1:14 pm, Apr 08, 2019

Release Approval | Date

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ENVIRONMENTAL CALCULATION COVER PAGE

SECTION 1 - Completed by the Responsible Manager

Project: RCRA Interim to Final Closure Plans	**RELEASE / ISSUE**
Date:	
Calculation Title and Description: Identification of Site-Specific Monitoring Constituents for the Nonradioactive Dangerous Waste Landfill	

Qualifications Summary

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Degree, Major, Institution, Year: BS, Geology, Central Washington University, 2007

Professional Licenses: Licensed Geologist (Washington)

Brief Narrative of Experience: Tessa Clark's professional experience has primarily focused on soil and groundwater remediation project support at the U.S. Department of Energy's Hanford Site, with an emphasis in data quality and interpretation relating to multiple regulatory projects. This includes development of drilling project contract statements of work, CERCLA sampling and analysis plans, and RCRA engineering evaluation reports and groundwater monitoring plans. Additionally, she has experience in the development and oversight of environmental site assessments, including multi-media sampling in Washington and Oregon.

Checker(s):

Name: Gretchen Gee

Degree, Major, Institution, Year: BS, Geology, Western Washington University, 2005
MS, Environmental Science and Engineering, Colorado School of Mines, 2008

Professional Licenses: Registered Geologist(Oregon)

Brief Narrative of Experience: Gretchen has over 10 years of experience in site characterization and remediation. Her experience includes a variety of projects relating to groundwater, sediment, and soil with an emphasis on groundwater modeling, water quality, soil and sediment remediation, and soil-gas investigations. She has played a key role in supporting projects with spatial analysis, technical writing, and project delivery.

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

Senior Reviewer(s):

Name: Heather Sulloway

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Brief Narrative of Experience: Over 20 years of experience in environmental science including preparation of RCRA groundwater sampling and analysis plans and RCRA engineering evaluations reports for groundwater monitoring; RCRA and radiological waste management; CERCLA remedial site characterization, work plans, and cleanup/closeout reports; and environmental data calculations.

SECTION 2 - Completed by Preparer

Calculation Number: ECF-200PO1-18-0031 | Revision Number: 0

Revision History

Revision No.	Description	Date	Affected Pages
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SECTION 3 - Completed by the Responsible Manager

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SECTION 4 - Document Review and Approval

	Position	Signature	Date
Preparer(s): Tessa Clark (Print First and Last Name)	Scientist, CHPRC		01/23/19
Checker(s): Gretchen Gee (Print First and Last Name)	Engineer, Jacobs		01/23/19
Senior Reviewer(s): Heather Sulloway (Print First and Last Name)	Scientist, CHPRC		01/28/19
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ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

SECTION 5 - Applicable if Calculation is a Risk Assessment or Uses an Environmental Model

Prior to Initiating Modeling:

Required training for modelers completed:
Integration Lead:

Print First and Last Name	*Signature*	*Date*

Safety Software Approved:
Integration Lead:

Print First and Last Name	*Signature*	*Date*

Calculation Approved:
Risk/Modeling Integration Manager:

Print First and Last Name	*Signature*	*Date*

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Terms

CAS	Chemical Abstracts Service
K_d	distribution coefficient
K_{OC}	organic carbon-water partition coefficient
NRDWL	Nonradioactive Dangerous Waste Landfill
RCRA	*Resource Conservation and Recovery Act of 1976*

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1 Purpose

This environmental calculation file evaluates the waste constituents associated with the Nonradioactive Dangerous Waste Landfill (NRDWL) to identify proposed groundwater monitoring constituents.

2 Background

NRDWL is an inactive landfill that will be modified into the future Revision 9 of WA7890008967, *Hanford Facility Dangerous Waste Permit (Site-Wide Permit)* as a final status dangerous waste management unit. Site-specific monitoring constituents are required to support final status groundwater monitoring under WAC 173-303-645, "Dangerous Waste Regulations," "Releases from Regulated Units."

3 Methodology

The dangerous wastes identified in WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (Revision 8c) (hereafter referred to as the Hanford Facility RCRA Permit) Part A Permit Application for NRDWL (Closure Unit 20) were evaluated to identify potential monitoring constituents.

3.1 Hanford Facility RCRA Permit Part A Application Dangerous Wastes

The Hanford Facility RCRA Permit Part A Application for NRDWL identifies the dangerous wastes associated with the unit. The Part A Application waste codes are presented in Section 2.3 of SGW-60589, *Engineering Evaluation Report for the Nonradioactive Dangerous Waste Landfill Groundwater Monitoring*. A complete list of specified dangerous wastes and corresponding Chemical Abstracts Service (CAS) numbers was compiled using the waste codes and represents the Part A Permit Application dangerous waste data set (Table 1). A total of 87 distinct waste constituents were identified (Table 1).

3.2 Mobility Screening

The dangerous wastes were screened to identify mobile constituents by comparing literature reference values for constituent distribution coefficient (K_d) to a K_d value of 0.8 mL/g. Constituents with a $K_d \leq 0.8$ mL/g were identified as mobile constituents and further evaluated as potential monitoring constituents (Table 1). If a reference K_d value was not available for a constituent, the constituent was conservatively retained for further evaluation. If a reference soil organic carbon-water partition coefficient (K_{OC}) value was available for a constituent, a K_d value was derived using the following relationship:

$$K_{OC} = (100 \times K_d) \div (\% \ OM)$$

where:

% OM = assumed soil organic carbon content of 0.1 weight percent

Solving this equation for K_d:

$$K_d = (K_{OC} \times \% \ OM) \div 100$$

Based on this evaluation, 63 distinct waste constituents were identified as potential monitoring constituents based either on the mobility evaluation outcome or because further evaluation was required.

Table 1. Dangerous Wastes Identified on the NRDWL Part A Permit Application and Mobility Evaluation

Dangerous Waste Code	Waste Constituent	CAS Number	K_d (mL/g)[a]	K_d Reference	Is $K_d \leq$ 0.8 mL/g? (Yes/No/N/A)	Retain as Potential Monitoring Constituent? (Yes/No/Evaluate)
D004	Arsenic	7440-38-2	29	Ecology, 2015	No	No
D005	Barium	7440-39-3	41	Ecology, 2015	No	No
D006	Cadmium	7440-43-9	6.7	Ecology, 2015	No	No
D007	Chromium	7440-47-3	1000	Ecology, 2015	No	No
D008	Lead	7439-92-1	10000	Ecology, 2015	No	No
D009	Mercury	7439-97-6	52	Ecology, 2015	No	No
D010	Selenium	7782-49-2	5	Ecology, 2015	No	No
D011	Silver	7440-22-4	8.3	Ecology, 2015	No	No
D018	Benzene	71-43-2	0.062	Ecology, 2015	Yes	Yes
D019	Carbon tetrachloride	56-23-5	0.152	Ecology, 2015	Yes	Yes
D022	Chloroform	67-66-3	0.053	Ecology, 2015	Yes	Yes
D039	Tetrachloroethylene	127-18-4	0.265	Ecology, 2015	Yes	Yes
D040	Trichloroethylene	79-01-6	0.094	Ecology, 2015	Yes	Yes
F001	1,1,1-Trichloroethane	71-55-6	0.135	Ecology, 2015	Yes	Yes
F001	Methylene chloride	75-09-2	0.01	Ecology, 2015	Yes	Yes
F001	Carbon tetrachloride	56-23-5	0.152	Ecology, 2015	Yes	Yes
F001	Tetrachloroethylene	127-18-4	0.265	Ecology, 2015	Yes	Yes
F001	Trichloroethylene	79-01-6	0.094	Ecology, 2015	Yes	Yes
F002	1,1,1-Trichloroethane	71-55-6	0.135	Ecology, 2015	Yes	Yes
F002	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	Not Available	N/A	N/A	Evaluate

Table 1. Dangerous Wastes Identified on the NRDWL Part A Permit Application and Mobility Evaluation

Dangerous Waste Code	Waste Constituent	CAS Number	K_d (mL/g)[a]	K_d Reference	Is $K_d \leq$ 0.8 mL/g? (Yes/No/N/A)	Retain as Potential Monitoring Constituent? (Yes/No/Evaluate)
F002	1,1,2-Trichloroethane	79-00-5	0.075	Ecology, 2015	Yes	Yes
F002	Chlorobenzene	108-90-7	0.224	Ecology, 2015	Yes	Yes
F002	Methylene chloride	75-09-2	0.01	Ecology, 2015	Yes	Yes
F002	Ortho-dichlorobenzene	95-50-1	0.379	Ecology, 2015	Yes	Yes
F002	Trichlorofluoromethane	75-69-4	0.044	ECF- HANFORD-12-0023, Rev. 3	Yes	Yes
F002	Tetrachloroethylene	127-18-4	0.265	Ecology, 2015	Yes	Yes
F002	Trichloroethylene	79-01-6	0.094	Ecology, 2015	Yes	Yes
F003	Acetone	67-64-1	0.0006	Ecology, 2015	Yes	Yes
F003	Cyclohexanone	108-94-1	Not Available	N/A	N/A	Evaluate
F003	Ethyl acetate	141-78-6	0.0056	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
F003	Ethyl benzene	100-41-4	0.204	Ecology, 2015	Yes	Yes
F003	Ethyl ether	60-29-7	0.0097	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
F003	Methyl isobutyl ketone	108-10-1	0.013	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
F003	Methanol	67-56-1	0.0010	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
F003	n-Butyl alcohol	71-36-3	0.00692	Ecology, 2015	Yes	Yes
F003	Xylene	1330-20-7	0.233	Ecology, 2015	Yes	Yes
F004	Cresols	1319-77-3	N/A	N/A	N/A	Evaluate
F004	Cresylic acid	93-51-6	N/A	N/A	N/A	Evaluate

Table 1. Dangerous Wastes Identified on the NRDWL Part A Permit Application and Mobility Evaluation

Dangerous Waste Code	Waste Constituent	CAS Number	K_d (mL/g)[a]	K_d Reference	Is $K_d \leq$ 0.8 mL/g? (Yes/No/N/A)	Retain as Potential Monitoring Constituent? (Yes/No/Evaluate)
F004	Nitrobenzene	98-95-3	0.119	Ecology, 2015	Yes	Yes
F005	2-Ethoxyethanol	110-80-5	Not Available	N/A	N/A	Evaluate
F005	2-Nitropropane	79-46-9	Not Available	N/A	N/A	Evaluate
F005	Benzene	71-43-2	0.062	Ecology, 2015	Yes	Yes
F005	Carbon disulfide	75-15-0	0.0457	Ecology, 2015	Yes	Yes
F005	Isobutanol	78-83-1	Not Available	N/A	N/A	Evaluate
F005	Methyl ethyl ketone	78-93-3	0.0045	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
F005	Pyridine	110-86-1	Not Available	N/A	N/A	Evaluate
F005	Toluene	108-88-3	0.14	Ecology, 2015	Yes	Yes
P010	Arsenic acid H3 AsO4	7778-39-4	Not Available	N/A	N/A	Evaluate
P012	Arsenic oxide As2 O3; Arsenic trioxide	1327-53-3	Not Available	N/A	N/A	Evaluate
P022	Carbon disulfide	75-15-0	0.0457	Ecology, 2015	Yes	Yes
P048	2,4-Dinitrophenol; Phenol, 2,4-dinitro-	51-28-5	0.00001	Ecology, 2015	Yes	Yes
P096	Hydrogen phosphide; Phosphine	7803-51-2	Not Available	N/A	N/A	Evaluate
P098	Potassium cyanide; Potassium cyanide K(CN)	151-50-8	Not Available	N/A	N/A	Evaluate
P106	Sodium cyanide; Sodium cyanide Na(CN)	143-33-9	Not Available	N/A	N/A	Evaluate
U001	Acetaldehyde; Ethanal	75-07-0	Not Available	N/A	N/A	Evaluate
U002	Acetone; 2-Propanone	67-64-1	0.000575	Ecology, 2015	Yes	Yes

Table 1. Dangerous Wastes Identified on the NRDWL Part A Permit Application and Mobility Evaluation

Dangerous Waste Code	Waste Constituent	CAS Number	K_d (mL/g)[a]	K_d Reference	Is $K_d \leq$ 0.8 mL/g? (Yes/No/N/A)	Retain as Potential Monitoring Constituent? (Yes/No/Evaluate)
U003	Acetonitrile	75-05-8	Not Available	N/A	N/A	Evaluate
U007	Acrylamide; 2-Propenamide	79-06-1	0.0057	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
U009	Acrylonitrile; 2-Propenenitrile	107-13-1	0.0085	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
U012	Aniline; Benzenamine	62-53-3	Not Available	N/A	N/A	Evaluate
U019	Benzenesulfonic acid chloride	71-43-2	0.062	Ecology, 2015	Yes	Yes
U022	Benzo[a]pyrene	50-32-8	968.774	Ecology, 2015	No	No
U031	1-Butanol; n-Butyl alcohol	71-36-3	0.00692	Ecology, 2015	Yes	Yes
U044	Chloroform; Methane, trichloro-	67-66-3	0.053	Ecology, 2015	Yes	Yes
U053	2-Butenal; Crotonaldehyde	4170-30-3	Not Available	N/A	N/A	Evaluate
U056	Benzene, hexahydro-; Cyclohexane	110-82-7	Not Available	N/A	N/A	Evaluate
U069	1,2-Benzenedicarboxylic acid, dibutyl ester; Dibutyl phthalate	84-74-2	1.567	Ecology, 2015	No	No
U070	Benzene, 1,2-dichloro-; o-Dichlorobenzene	95-50-1	0.379	Ecology, 2015	Yes	Yes
U077	Ethane, 1,2-dichloro-; Ethylene dichloride	107-06-2	0.038	Ecology, 2015	Yes	Yes
U080	Methane, dichloro-; Methylene chloride	75-09-2	0.01	Ecology, 2015	Yes	Yes
U092	Dimethylamine; Methanamine, -methyl	124-40-3	Not Available	N/A	N/A	Evaluate

Table 1. Dangerous Wastes Identified on the NRDWL Part A Permit Application and Mobility Evaluation

Dangerous Waste Code	Waste Constituent	CAS Number	K_d (mL/g)[a]	K_d Reference	Is $K_d \leq$ 0.8 mL/g? (Yes/No/N/A)	Retain as Potential Monitoring Constituent? (Yes/No/Evaluate)
U093	Benzenamine, N,N-dimethyl-4-(phenylazo)-; p-Dimethylaminoazobenzene	60-11-7	Not Available	N/A	N/A	Evaluate
U108	1,4-Diethyleneoxide; 1,4-Dioxane	123-91-1	Not Available	N/A	N/A	Evaluate
U117	Ethane, 1,1'-oxybis-; Ethyl ether	60-29-7	0.0097	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
U122	Formaldehyde	50-00-0	Not Available	N/A	N/A	Evaluate
U123	Formic acid	64-18-6	Not Available	N/A	N/A	Evaluate
U133	Hydrazine	302-01-2	Not Available	N/A	N/A	Evaluate
U134	Hydrofluoric acid; Hydrogen fluoride	7664-39-3	Not Available	N/A	N/A	Evaluate
U142	Kepone; 1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-	143-50-0	Not Available	N/A	N/A	Evaluate
U144	Acetic acid, lead(2+) salt; Lead acetate	301-04-2	Not Available	N/A	N/A	Evaluate
U151	Mercury	7439-97-6	52	Ecology, 2015	No	No
U154	Methanol; Methyl alcohol	67-56-1	0.001	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
U159	2-Butanone; Methyl ethyl ketone (MEK)	78-93-3	0.0045	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
U161	Methyl isobutyl ketone; 4-Methyl-2-pentanone; Pentanol, 4-methyl-	108-10-1	0.013	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes

Table 1. Dangerous Wastes Identified on the NRDWL Part A Permit Application and Mobility Evaluation

Dangerous Waste Code	Waste Constituent	CAS Number	K_d (mL/g)[a]	K_d Reference	Is $K_d \leq$ 0.8 mL/g? (Yes/No/N/A)	Retain as Potential Monitoring Constituent? (Yes/No/Evaluate)
U169	Benzene, nitro-; Nitrobenzene	98-95-3	0.119	Ecology, 2015	Yes	Yes
U188	Phenol	108-95-2	0.029	ECF-HANFORD-12-0023, Rev. 3	Yes	Yes
U196	Pyridine	110-86-1	Not Available	N/A	N/A	Evaluate
U201	1,3-Benzenediol; Resorcinol	108-46-3	Not Available	N/A	N/A	Evaluate
U210	Ethene, tetrachloro-; Tetrachloroethylene	127-18-4	0.265	Ecology, 2015	Yes	Yes
U211	Carbon tetrachloride; Methane, tetrachloro-	56-23-5	0.152	Ecology, 2015	Yes	Yes
U213	Furan, tetrahydro-; Tetrahydrofuran	109-99-9	Not Available	N/A	N/A	Evaluate
U219	Thiourea	62-56-6	Not Available	N/A	N/A	Evaluate
U220	Benzene, methyl-; Toluene	108-88-3	0.14	Ecology, 2015	Yes	Yes
U226	Ethane, 1,1,1-trichloro-; Methyl chloroform; 1,1,1-Trichloroethane	71-55-6	0.135	Ecology, 2015	Yes	Yes
U228	Ethene, trichloro-; Trichloroethylene	79-01-6	0.094	Ecology, 2015	Yes	Yes
U239	Benzene, dimethyl-; Xylene	1330-20-7	0.233	Ecology, 2015	Yes	Yes
WP03[b]	Anthracene	120-12-7	23.493	Ecology, 2015	No	No
WP03[b]	Dibenzo[(a,i)]pyrene	189-55-9	Not Available	N/A	N/A	Evaluate
WP03[b]	Dibenzo[(a,h)]pyrene	189-64-0	Not Available	N/A	N/A	Evaluate
WP03[b]	Benzo(g,h,i)perylene	191-24-2	1950	ECF-HANFORD-12-0023, Rev. 3	No	No

Table 1. Dangerous Wastes Identified on the NRDWL Part A Permit Application and Mobility Evaluation

Dangerous Waste Code	Waste Constituent	CAS Number	K_d (mL/g)[a]	K_d Reference	Is $K_d \leq$ 0.8 mL/g? (Yes/No/N/A)	Retain as Potential Monitoring Constituent? (Yes/No/Evaluate)
WP03[b]	Dibenzo[(a,1)]pyrene	191-30-0	Not Available	N/A	N/A	Evaluate
WP03[b]	Dibenzo(a,e)pyrene	192-65-4	Not Available	N/A	N/A	Evaluate
WP03[b]	Indeno[1,2,3-cd]pyrene	193-39-5	3470	Ecology, 2015	No	No
WP03[b]	Benzo(b)fluoranthene	205-99-2	1230	Ecology, 2015	No	No
WP03[b]	Fluoranthene	206-44-0	49.096	Ecology, 2015	No	No
WP03[b]	Benzo(k)fluoranthene	207-08-9	1230	Ecology, 2015	No	No
WP03[b]	Acenaphthylene	208-96-8	5	ECF-HANFORD-12-0023, Rev. 3	No	No
WP03[b]	Chrysene	218-01-9	398	Ecology, 2015	No	No
WP03[b]	Dibenzo(a,j)acridine	224-42-0	Not Available	N/A	N/A	Evaluate
WP03[b]	Pyrene	129-00-0	67.992	Ecology, 2015	No	No
WP03[b]	Benzo(a)pyrene	50-32-8	968.774	Ecology, 2015	No	No
WP03[b]	Benzo(a)anthracene	56-55-3	357.537	Ecology, 2015	No	No
WP03[b]	Dibenz[a,h]anthracene	53-70-3	1789.101	Ecology, 2015	No	No
WP03[b]	Acenaphthene	83-32-9	4.898	Ecology, 2015	No	No
WP03[b]	Phenanthrene	85-01-8	17	ECF-HANFORD-12-0023, Rev. 3	No	No

Table 1. Dangerous Wastes Identified on the NRDWL Part A Permit Application and Mobility Evaluation

Dangerous Waste Code	Waste Constituent	CAS Number	K_d (mL/g)[a]	K_d Reference	Is $K_d \leq$ 0.8 mL/g? (Yes/No/N/A)	Retain as Potential Monitoring Constituent? (Yes/No/Evaluate)
WP03[b]	Fluorene	86-73-7	7.707	Ecology, 2015	No	No

Source: WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste, Revision 8c*.

References:

ECF-HANFORD-12-0023, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area.*

Ecology, 2015, Cleanup Levels and Risk Calculations (CLARC) database.

Note: This table identifies specific dangerous wastes identified from the waste codes included in the NRDWL Part A Application. Nonspecified cyanides (P030) and creosote (U051), as well as characteristic wastes (D001, D002, and D003) and state-only wastes (WP01, WP02, WT01, and WT02) (waste codes assigned based on waste designation), are included in the NRDWL Part A Application but are not identified in this table.

a. Dangerous waste code contaminant descriptions are from WAC 173-303-090, “Dangerous Waste Regulations,” “Dangerous Waste Characteristics”; WAC 173-303-104, “State-Specific Dangerous Waste Numbers”; WAC 173-303-9903, “Discarded Chemical Products List”; and WAC 173-303-9904, “Dangerous Waste Sources List.”

b. WAC 173-303-040, “Dangerous Waste Regulations,” "Definitions," "Polycyclic aromatic hydrocarbons," was used to identify the polycyclic aromatic hydrocarbons associated with WP03.

CAS = Chemical Abstracts Service

K_d = distribution coefficient

N/A = not applicable

NRDWL = Nonradioactive Dangerous Waste Landfill

3.3 Identification of Potential Monitoring Constituents Already Prescribed for Monitoring at NRDWL

The Washington State Department of Ecology Letter 16-NWP-143, "Groundwater Engineering Report and Final Status Groundwater Monitoring Plan Requirements for the Integrated Disposal Facility, Nonradioactive Dangerous Waste Landfill, Low Level Burial Grounds Trench 94, and Low Level Burial Grounds "Green Islands" Dangerous Waste Management Units," provided direction for preparation of documents to support the final status permit revision. The letter directed that monitoring for WAC 173-303-110(3)(c) and (7) "Sampling, Testing Methods and Analytes," constituents would be performed for 1 year. WAC 173-303-110(3)(c), references Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*, and WAC 173-303-110(7) references Appendix 5 of Ecology Publication No. 97-407.

The 63 distinct waste constituents that were identified as either potential monitoring constituents or requiring further evaluation based on the mobility evaluation of the Part A Application dangerous wastes (Section 3.2) were compiled. Table 2 presents the constituents that were not eliminated in the mobility evaluation (Section 3.2) and identifies whether or not each constituent is included in Appendix 5 of Ecology Publication No. 97-407. Because the waste constituents identified in Appendix 5 of Ecology Publication No. 97-407 will be included for background monitoring at NRDWL, the potential monitoring constituents that are also listed in Appendix 5 of Ecology Publication No. 97-407 (N = 31) were identified as proposed monitoring constituents (Table 2). A total of 32 potential monitoring remained for further evaluation.

Table 2. Evaluation of Potential Monitoring Constituents with Dangerous Wastes Prescribed for Monitoring

CAS Number	Waste Constituent	Retained as Potential Monitoring Constituent due to Mobility? (Yes/Evaluate)	Is Constituent Identified in Appendix 5? (Yes/No)	Proposed Monitoring Constituent? (Yes/Evaluate)
100-41-4	Ethylbenzene	Yes	Yes	Yes
107-06-2	1,2-Dichloroethane	Yes	Yes	Yes
107-13-1	Acrylonitrile	Yes	Yes	Yes
108-10-1	4-Methyl-2-pentanone (Methyl isobutyl ketone)	Yes	Yes	Yes
108-46-3	Resorcinol	Evaluate	No	Evaluate
108-88-3	Toluene	Yes	Yes	Yes
108-90-7	Chlorobenzene	Yes	Yes	Yes
108-94-1	Cyclohexanone	Evaluate	No	Evaluate
108-95-2	Phenol	Yes	Yes	Yes
109-99-9	Tetrahydrofuran	Evaluate	No	Evaluate
110-80-5	2-Ethoxyethanol	Evaluate	No	Evaluate
110-82-7	Cyclohexane	Evaluate	No	Evaluate
110-86-1	Pyridine	Evaluate	Yes	Yes

Table 2. Evaluation of Potential Monitoring Constituents with Dangerous Wastes Prescribed for Monitoring

CAS Number	Waste Constituent	Retained as Potential Monitoring Constituent due to Mobility? (Yes/Evaluate)	Is Constituent Identified in Appendix 5? (Yes/No)	Proposed Monitoring Constituent? (Yes/Evaluate)
123-91-1	1,4-Dioxane	Evaluate	Yes	Yes
124-40-3	Dimethylamine	Evaluate	No	Evaluate
127-18-4	Tetrachloroethene	Yes	Yes	Yes
1319-77-3	Cresols	Evaluate	Yes*	Yes
1327-53-3	Arsenic trioxide	Evaluate	No	Evaluate
1330-20-7	Xylenes (total)	Yes	Yes	Yes
141-78-6	Ethyl acetate	Yes	No	Evaluate
143-33-9	Sodium cyanide	Evaluate	No	Evaluate
143-50-0	Kepone	Evaluate	Yes	Yes
151-50-8	Potassium cyanide	Evaluate	No	Evaluate
189-55-9	Dibenzo[a,i]pyrene	Evaluate	No	Evaluate
189-64-0	Dibenzo[(a,h)]pyrene	Evaluate	No	Evaluate
191-30-0	Dibenzo[(a,l)]pyrene	Evaluate	No	Evaluate
192-65-4	Dibenzo(a,e)pyrene	Evaluate	No	Evaluate
224-42-0	Dibenzo(a,j)acridine	Evaluate	No	Evaluate
301-04-2	Lead(II) acetate	Evaluate	No	Evaluate
302-01-2	Hydrazine	Evaluate	No	Evaluate
4170-30-3	2-Butenal; Crotonaldehyde	Evaluate	No	Evaluate
50-00-0	Formaldehyde	Evaluate	No	Evaluate
51-28-5	2,4-Dinitrophenol	Yes	Yes	Yes
56-23-5	Carbon tetrachloride	Yes	Yes	Yes
60-11-7	p-(Dimethylamino) azobenzene	Evaluate	Yes	Yes
60-29-7	Ethyl ether	Yes	No	Evaluate
62-53-3	Aniline	Evaluate	Yes	Yes
62-56-6	Thiourea	Evaluate	No	Evaluate
64-18-6	Formic acid	Evaluate	No	Evaluate
67-56-1	Methanol	Yes	No	Evaluate
67-64-1	2-Propanone (Acetone)	Yes	Yes	Yes
67-66-3	Chloroform	Yes	Yes	Yes

Table 2. Evaluation of Potential Monitoring Constituents with Dangerous Wastes Prescribed for Monitoring

CAS Number	Waste Constituent	Retained as Potential Monitoring Constituent due to Mobility? (Yes/Evaluate)	Is Constituent Identified in Appendix 5? (Yes/No)	Proposed Monitoring Constituent? (Yes/Evaluate)
71-36-3	1-Butanol (n-Butyl alcohol)	Yes	No	Evaluate
71-43-2	Benzene	Yes	Yes	Yes
71-55-6	1,1,1-Trichloroethane	Yes	Yes	Yes
75-05-8	Acetonitrile (Methyl cyanide)	Evaluate	Yes	Yes
75-07-0	Acetaldehyde	Evaluate	No	Evaluate
75-09-2	Methylene chloride	Yes	Yes	Yes
75-15-0	Carbon disulfide	Yes	Yes	Yes
75-69-4	Trichlorofluoromethane	Yes	Yes	Yes
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	Evaluate	No	Evaluate
7664-39-3	Hydrofluoric acid	Evaluate	No	Evaluate
7778-39-4	Arsenic acid	Evaluate	No	Evaluate
7803-51-2	Phosphine	Evaluate	No	Evaluate
78-83-1	Isobutanol (Isobutyl alcohol)	Evaluate	Yes	Yes
78-93-3	2-Butanone (Methyl ethyl ketone)	Yes	Yes	Yes
79-00-5	1,1,2-Trichloroethane	Yes	Yes	Yes
79-01-6	Trichloroethene (TCE)	Yes	Yes	Yes
79-06-1	Acrylamide	Yes	No	Evaluate
79-46-9	2-Nitropropane	Evaluate	No	Evaluate
93-51-6	Cresylic acid	Evaluate	No	Evaluate
95-50-1	1,2-Dichlorobenzene (o-Dichlorobenzene)	Yes	Yes	Yes
98-95-3	Nitrobenzene	Yes	Yes	Yes

*The isomers of cresol (m-, p-, and o- cresol) are identified in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100.*

CAS = Chemical Abstracts Service

3.4 Availability of Analysis at Commercial Laboratories

The remaining potential monitoring constituents that were not identified as proposed monitoring constituents in the preceding evaluations (N=32) were evaluated for availability of analysis (Table 3).

Any constituent that is not routinely analyzed by commercial laboratories (N=20) was removed from consideration. The potential monitoring constituents that were not excluded due to unavailability of analysis (N=12) were identified as proposed monitoring constituents.

Table 3. Availability of Commercial Laboratory Analysis for Potential Monitoring Constituents

CAS Number	Waste Constituent	Is Analysis Available at Commercial Laboratories? (Yes/No)	Retain as Proposed Monitoring Constituent? (Yes/No)
108-46-3	1,3-Benzenediol (Resorcinol)	No	No
108-94-1	Cyclohexanone	Yes	Yes
109-99-9	Tetrahydrofuran	Yes	Yes
110-80-5	2-Ethoxyethanol	No	No
110-82-7	Cyclohexane	Yes	Yes
124-40-3	Dimethylamine	No	No
1327-53-3	Arsenic oxide	No	No
141-78-6	Ethyl acetate	Yes	Yes
143-33-9	Sodium cyanide	No	No
151-50-8	Potassium cyanide	No	No
189-55-9	Dibenzo[a,i]pyrene	No	No
189-64-0	Dibenzo[(a,h)]pyrene	No	No
191-30-0	Dibenzo[(a,l)]pyrene	No	No
192-65-4	Dibenzo(a,e)pyrene	No	No
224-42-0	Dibenzo(a,j)acridine	No	No
301-04-2	Acetic acid (Lead acetate)	No	No
302-01-2	Hydrazine	Yes	Yes
4170-30-3	2-Butenal; Crotonaldehyde	No	No
50-00-0	Formaldehyde	No	No
60-29-7	Ethyl ether	Yes	Yes
62-56-6	Thiourea	No	No
64-18-6	Formic acid	Yes	Yes
67-56-1	Methanol	Yes	Yes
71-36-3	1-Butanol (n-Butyl alcohol)	Yes	Yes
75-07-0	Acetaldehyde	No	No
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	Yes	Yes
7664-39-3	Hydrofluoric acid	No	No
7778-39-4	Arsenic acid	No	No

Table 3. Availability of Commercial Laboratory Analysis for Potential Monitoring Constituents

CAS Number	Waste Constituent	Is Analysis Available at Commercial Laboratories? (Yes/No)	Retain as Proposed Monitoring Constituent? (Yes/No)
7803-51-2	Hydrogen phosphide (Phosphine)	No	No
79-06-1	2-Propenamide (Acrylamide)	Yes	Yes
79-46-9	2-Nitropropane	Yes	Yes
93-51-6	Cresylic acid	No*	No

* Cresylic acid is a mixture of compounds and is characterized by the analysis of m-, o-, and p-cresol (cresols) and 2,6-di-t-butyl-4-methylphenol (CAS number 128-37-0). Cresols is included as a proposed monitoring constituent. 2,6-Di-t-butyl-4-methylphenol is not routinely analyzed by commercial laboratories.

CAS = Chemical Abstracts Service

4 Assumptions and Inputs

The primary input to this calculation is the NRDWL Part A Permit Application. The NRDWL Part A Permit Application is assumed to be descriptive and representative of the known and potential contents of NRDWL.

5 Software Applications

Microsoft® Excel® software is an approved and appropriate application for this calculation and was used to perform sorting of data.

6 Calculation

The evaluations detailed in this calculation are summarized in the identified tables.

7 Results and Conclusions

Based on the evaluations of waste constituents associated with NRDWL from the Part A Permit Application, proposed groundwater monitoring constituents for NRDWL were identified.

7.1 Results from Evaluation of Dangerous Wastes from the NRDWL Part A Application

Eighty-seven distinct dangerous wastes were identified from the Hanford Facility RCRA Permit Part A Application for NRDWL (Table 1). Further screening for constituent mobility identified 28 mobile constituents with a $K_d < 0.8$ that were retained for further evaluation as potential monitoring constituents (Table 2). Twenty-four distinct constituents had a $K_d > 0.8$ and were not retained as potential monitoring constituents. Thirty-five constituents did not have associated Kd values and, therefore, were not evaluated for mobility (Table 2). However, these 35 constituents were conservatively retained for further evaluation as potential monitoring constituents. In total, 63 constituents were retained for further evaluation as potential monitoring constituents (Table 4).

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Table 4. Mobility Evaluation Results of Dangerous Waste Identified in the NRDWL Part A Permit Application

CAS Number	Waste Constituent	Retained as Potential Monitoring Constituent by K_d? (Yes/Evaluate)
100-41-4	Ethylbenzene	Yes
107-06-2	1,2-Dichloroethane	Yes
107-13-1	Acrylonitrile	Yes
108-10-1	4-Methyl-2-pentanone (Methyl isobutyl ketone)	Yes
108-46-3	Resorcinol	Evaluate
108-88-3	Toluene	Yes
108-90-7	Chlorobenzene	Yes
108-94-1	Cyclohexanone	Evaluate
108-95-2	Phenol	Yes
109-99-9	Tetrahydrofuran	Evaluate
110-80-5	2-Ethoxyethanol	Evaluate
110-82-7	Cyclohexane	Evaluate
110-86-1	Pyridine	Evaluate
123-91-1	1,4-Dioxane	Evaluate
124-40-3	Dimethylamine	Evaluate
127-18-4	Tetrachloroethene	Yes
1319-77-3	Cresols	Evaluate
1327-53-3	Arsenic trioxide	Evaluate
1330-20-7	Xylenes (total)	Yes
141-78-6	Ethyl acetate	Yes
143-33-9	Sodium cyanide	Evaluate
143-50-0	Kepone	Evaluate
151-50-8	Potassium cyanide	Evaluate
189-55-9	Dibenzo[a,i]pyrene	Evaluate
189-64-0	Dibenzo[(a,h)]pyrene	Evaluate
191-30-0	Dibenzo[(a,l)]pyrene	Evaluate
192-65-4	Dibenzo(a,e)pyrene	Evaluate

Table 4. Mobility Evaluation Results of Dangerous Waste Identified in the NRDWL Part A Permit Application

CAS Number	Waste Constituent	Retained as Potential Monitoring Constituent by K_d? (Yes/Evaluate)
224-42-0	Dibenzo(a,j)acridine	Evaluate
301-04-2	Lead(II) acetate	Evaluate
302-01-2	Hydrazine	Evaluate
4170-30-3	Crotonaldehyde	Evaluate
50-00-0	Formaldehyde	Evaluate
51-28-5	2,4-Dinitrophenol	Yes
56-23-5	Carbon tetrachloride	Yes
60-11-7	p-(Dimethylamino)azobenzene	Evaluate
60-29-7	Ethyl ether	Yes
62-53-3	Aniline	Evaluate
62-56-6	Thiourea	Evaluate
64-18-6	Formic acid	Evaluate
67-56-1	Methanol	Yes
67-64-1	2-Propanone (Acetone)	Yes
67-66-3	Chloroform	Yes
71-36-3	1-Butanol (n-Butyl alcohol)	Yes
71-43-2	Benzene	Yes
71-55-6	1,1,1-Trichloroethane	Yes
75-05-8	Acetonitrile (Methyl cyanide)	Evaluate
75-07-0	Acetaldehyde	Evaluate
75-09-2	Methylene chloride	Yes
75-15-0	Carbon disulfide	Yes
75-69-4	Trichlorofluoromethane	Yes
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	Evaluate
7664-39-3	Hydrofluoric acid	Evaluate
7778-39-4	Arsenic acid	Evaluate
7803-51-2	Phosphine	Evaluate
78-83-1	Isobutanol (Isobutyl alcohol)	Evaluate

Table 4. Mobility Evaluation Results of Dangerous Waste Identified in the NRDWL Part A Permit Application

CAS Number	Waste Constituent	Retained as Potential Monitoring Constituent by K_d? (Yes/Evaluate)
78-93-3	2-Butanone (Methyl ethyl ketone; MEK)	Yes
79-00-5	1,1,2-Trichloroethane	Yes
79-01-6	Trichloroethene (TCE)	Yes
79-06-1	Acrylamide	Yes
79-46-9	2-Nitropropane	Evaluate
93-51-6	Cresylic acid	Evaluate
95-50-1	1,2-Dichlorobenzene (o-Dichlorobenzene)	Yes
98-95-3	Nitrobenzene	Yes

*For constituents identified as "Evaluate," no established distribution coefficient is available for mobility evaluation.

CAS = Chemical Abstracts Service

K_d = distribution coefficient

7.2 Results from Identification of Potential Monitoring Constituents Already Prescribed for Monitoring at NRDWL

The 63 distinct waste constituents that were identified as either potential monitoring constituents or requiring further evaluation based on the mobility evaluation of the Part A Application dangerous wastes (Section 7.1) were compiled. Because the constituents identified in Appendix 5 of Ecology Publication No. 97-407 will be included for background monitoring at NRDWL, the potential monitoring constituents that are also listed in Appendix 5 of Ecology Publication No. 97-407 (N = 31) were identified as proposed monitoring constituents (Table 5).

Table 5. Potential Monitoring Constituents Included in Appendix 5 and Identified as Proposed Monitoring Constituent

CAS Number	Waste Constituent
100-41-4	Ethylbenzene
107-06-2	1,2-Dichloroethane
107-13-1	Acrylonitrile
108-10-1	4-Methyl-2-pentanone (Methyl isobutyl ketone)
108-88-3	Toluene
108-90-7	Chlorobenzene
108-95-2	Phenol
110-86-1	Pyridine

Table 5. Potential Monitoring Constituents Included in Appendix 5 and Identified as Proposed Monitoring Constituent

CAS Number	Waste Constituent
123-91-1	1,4-Dioxane
127-18-4	Tetrachloroethene
1319-77-3	Cresols (as isomers)*
1330-20-7	Xylenes (total)
143-50-0	Kepone
51-28-5	2,4-Dinitrophenol
56-23-5	Carbon tetrachloride
60-11-7	p-(Dimethylamino)azobenzene
62-53-3	Aniline
67-64-1	2-Propanone (Acetone)
67-66-3	Chloroform
71-43-2	Benzene
71-55-6	1,1,1-Trichloroethane
75-05-8	Acetonitrile (Methyl cyanide)
75-09-2	Methylene chloride
75-15-0	Carbon disulfide
75-69-4	Trichlorofluoromethane
78-83-1	Isobutanol (Isobutyl alcohol)
78-93-3	2-Butanone (Methyl ethyl ketone)
79-00-5	1,1,2-Trichloroethane
79-01-6	Trichloroethene (TCE)
95-50-1	1,2-Dichlorobenzene (o-Dichlorobenzene)
98-95-3	Nitrobenzene

* The isomers of cresol (m-, p-, and o- cresol) are identified in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100.*

CAS = Chemical Abstracts Service

7.3 Results from Analytical Availability Evaluation

Of the 63 potential monitoring constituents identified in Section 7.1 (Table 4), 31 are included in Appendix 5 of Ecology Publication 97-407 and were identified as proposed monitoring constituents (Table 5). The remaining 32 potential monitoring constituents were evaluated for availability of analysis at commercial laboratories (Section 3.3). Twenty of the potential monitoring constituents are not routinely analyzed by commercial laboratories and were removed as potential monitoring constituents (Table 3).

Each of the remaining 12 potential monitoring constituents were identified as proposed monitoring constituents (Table 6).

Table 6. Potential Monitoring Constituents with Analysis Available at Commercial Laboratories and Identified as Proposed Monitoring Constituents

CAS Number	Waste Constituent
108-94-1	Cyclohexanone
109-99-9	Tetrahydrofuran
110-82-7	Cyclohexane
141-78-6	Ethyl acetate
302-01-2	Hydrazine
60-29-7	Ethyl ether
64-18-6	Formic acid
67-56-1	Methanol
71-36-3	1-Butanol (n-Butyl alcohol)
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane
79-06-1	2-Propenamide (Acrylamide)
79-46-9	2-Nitropropane

CAS = Chemical Abstracts Service

7.4 Conclusions

Based on the evaluation of the dangerous wastes identified from the NRDWL Part A Permit Application, 43 waste constituents are identified as proposed monitoring constituents to detect and monitor any groundwater impacts from dangerous waste releases at NRDWL (Table 7).

Table 7. Proposed Groundwater Monitoring Constituents for NRDWL

Waste Constituent	CAS Number
1-Butanol (n-Butyl alcohol)	71-36-3
1,1,1-Trichloroethane	71-55-6
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1
1,1,2-Trichloroethane	79-00-5
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1
1,2-Dichloroethane	107-06-2
1,4-Dioxane	123-91-1
2-Butanone (Methyl ethyl ketone)	78-93-3

Table 7. Proposed Groundwater Monitoring Constituents for NRDWL

Waste Constituent	CAS Number
2-Nitropropane	79-46-9
2-Propanone (Acetone)	67-64-1
2-Propenamide (Acrylamide)	79-06-1
2,4-Dinitrophenol	51-28-5
4-Methyl-2-pentanone (Methyl isobutyl ketone)	108-10-1
Acetonitrile (Methyl cyanide)	75-05-8
Acrylonitrile	107-13-1
Aniline	62-53-3
Benzene	71-43-2
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroform	67-66-3
Cresols	1319-77-3
Cyclohexane	110-82-7
Cyclohexanone	108-94-1
Ethyl acetate	141-78-6
Ethyl ether	60-29-7
Ethylbenzene	100-41-4
Formic acid	64-18-6
Hydrazine	302-01-2
Isobutanol (Isobutyl alcohol)	78-83-1
Kepone	143-50-0
Methanol	67-56-1
Methylene chloride	75-09-2
Nitrobenzene	98-95-3
p-(Dimethylamino)azobenzene	60-11-7
Phenol	108-95-2
Pyridine	110-86-1
Tetrachloroethene	127-18-4
Tetrahydrofuran	109-99-9
Toluene	108-88-3

Table 7. Proposed Groundwater Monitoring Constituents for NRDWL

Waste Constituent	CAS Number
Trichloroethene (TCE)	79-01-6
Trichlorofluoromethane	75-69-4
Xylenes (total)	1330-20-7

CAS = Chemical Abstracts Service

8 References

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