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Baseline Risk Assessment for the Groundwater Operable Units at the Chemical Plant Area and the Ordnance Works Area, Weldon Spring, Missouri

July 1997

U.S. Department of Energy
Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

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July 1997

prepared by

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prepared for

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NOTATION

The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this document. Some acronyms used in tables or equations only are defined in the respective tables or equations.

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

General

ADD	applied daily dose
AWQC	ambient water quality criteria
BCF	bioconcentration factor
BRA	baseline risk assessment (this document)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended
COEC	contaminant of ecological concern
COPC	contaminant of potential concern
DA	U.S. Department of the Army
DOE	U.S. Department of Energy
EEQ	ecological effects quotient
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FS	feasibility study
GWOU	groundwater operable unit
IAEA	International Atomic Energy Agency
IRIS	*Integrated Risk Information System* (EPA)
IT	International Technology (Corporation)
LOAEL	lowest-observed-adverse-effect level
MCL	maximum contaminant level
NCRP	National Commission on Radiation Protection and Measurements
NOAEL	no-observed-adverse-effect level
NPL	National Priorities List
RDA	recommended daily allowance
RfD	reference dose
RI	remedial investigation
UCL	95% upper confidence limit of the arithmetic average
USGS	U.S. Geological Survey

Compounds

1,2-DCE	1,2-dichloroethylene
1,3-DNB	1,3-dinitrobenzene
DNT	dinitrotoluene
2-amino-4,6-DNT	2-amino-4,6-dinitrotoluene
4-amino-2,6-DNT	4-amino-2,6-dinitrotoluene
2,4-DNT	2,4-dinitrotoluene
2,6-DNT	2,6-dinitrotoluene
TCE	trichloroethylene
1,3,5-TNB	1,3,5-trinitrobenzene
TNT	trinitrotoluene
2,4,6-TNT	2,4,6-trinitrotoluene

UNITS OF MEASURE

Ci	curie(s)	L	liter(s)
cm	centimeter(s)	µg	microgram(s)
cm^2	square centimeter(s)	m	meter(s)
cm^3	cubic centimeter(s)	m^3	cubic meter(s)
d	day(s)	mg	milligram(s)
ft	foot (feet)	mi	mile(s)
g	gram(s)	mL	milliliter(s)
h	hour(s)	pCi	picocurie(s)
ha	hectare(s)	qt	quart(s)
kg	kilogram(s)	rad	radiation absorbed dose
km	kilometer(s)	yr	year(s)

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS

Multiply	By	To Obtain
English/Metric Equivalents		
acres	0.4047	hectares (ha)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
cubic yards (yd^3)	0.7646	cubic meters (m^3)
degrees Fahrenheit (°F) -32	0.5555	degrees Celsius (°C)
feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (L)
gallons (gal)	0.003785	cubic meters (m^3)
inches (in.)	2.540	centimeters (cm)
miles (mi)	1.609	kilometers (km)
pounds (lb)	0.4536	kilograms (kg)
short tons (tons)	907.2	kilograms (kg)
short tons (tons)	0.9072	metric tons (t)
square feet (ft^2)	0.09290	square meters (m^2)
square yards (yd^2)	0.8361	square meters (m^2)
square miles (mi^2)	2.590	square kilometers (km^2)
yards (yd)	0.9144	meters (m)
Metric/English Equivalents		
centimeters (cm)	0.3937	inches (in.)
cubic meters (m^3)	35.31	cubic feet (ft^3)
cubic meters (m^3)	1.308	cubic yards (yd^3)
cubic meters (m^3)	264.2	gallons (gal)
degrees Celsius (°C) +17.78	1.8	degrees Fahrenheit (°F)
hectares (ha)	2.471	acres
kilograms (kg)	2.205	pounds (lb)
kilograms (kg)	0.001102	short tons (tons)
kilometers (km)	0.6214	miles (mi)
liters (L)	0.2642	gallons (gal)
meters (m)	3.281	feet (ft)
meters (m)	1.094	yards (yd)
metric tons (t)	1.102	short tons (tons)
square kilometers (km^2)	0.3861	square miles (mi^2)
square meters (m^2)	10.76	square feet (ft^2)
square meters (m^2)	1.196	square yards (yd^2)

1 INTRODUCTION

The U.S. Department of Energy (DOE) and the U.S. Department of the Army (DA) are evaluating conditions in groundwater and springs at the DOE chemical plant area and the DA ordnance works area near Weldon Spring, Missouri. The two areas are located in St. Charles County, about 48 km (30 mi) west of St. Louis (Figure 1.1). The 88-ha (217-acre) chemical plant area is chemically and radioactively contaminated as a result of uranium-processing activities conducted by the U.S. Atomic Energy Commission in the 1950s and 1960s and explosives-production activities conducted by the U.S. Army (Army) in the 1940s. The 6,974-ha (17,232-acre) ordnance works area is primarily chemically contaminated as a result of trinitrotoluene (TNT) and dinitrotoluene (DNT) manufacturing activities during World War II.

This baseline risk assessment (BRA) is being conducted as part of the remedial investigation/feasibility study (RI/FS) required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended. The purpose of the BRA is to evaluate potential human health and ecological impacts from contamination associated with the groundwater operable units (GWOUs) of the chemical plant area and ordnance works area. An RI/FS work plan issued jointly in 1995 by the DOE and DA (DOE 1995) analyzed existing conditions at the GWOUs. The work plan included a conceptual hydrogeological model based on data available when the report was prepared; this model indicated that the aquifer of concern is common to both areas. Hence, to optimize further data collection and interpretation efforts, the DOE and DA have decided to conduct a joint RI/BRA.

Characterization data obtained from the chemical plant area wells indicate that uranium is present at levels slightly higher than background, with a few concentrations exceeding the proposed U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) of 20 µg/L (EPA 1996c). Concentrations of other radionuclides (e.g., radium and thorium) were measured at background levels and were eliminated from further consideration (DOE 1995). Chemical contaminants identified in wells at the chemical plant area and ordnance works area include nitroaromatic compounds, metals, and inorganic anions. Trichloroethylene (TCE) and 1,2-dichloroethylene (1,2-DCE) have been detected recently in a few wells near the raffinate pits at the chemical plant.

1.1 SCOPE OF THE BASELINE RISK ASSESSMENT

The human health component of this BRA provides risk estimates for exposure to groundwater and spring water. The focus of the groundwater assessment is the shallow aquifer system represented by wells completed in the Burlington-Keokuk Limestone and Fern Glen Formation. Previous evaluations have indicated that the potential for contaminated water in the shallow aquifer to enter the deep aquifer is small, and the time required for water to travel this distance is measured in hundreds of years (Kleeschulte 1991). In addition, the potentiometric surface of the deep bedrock

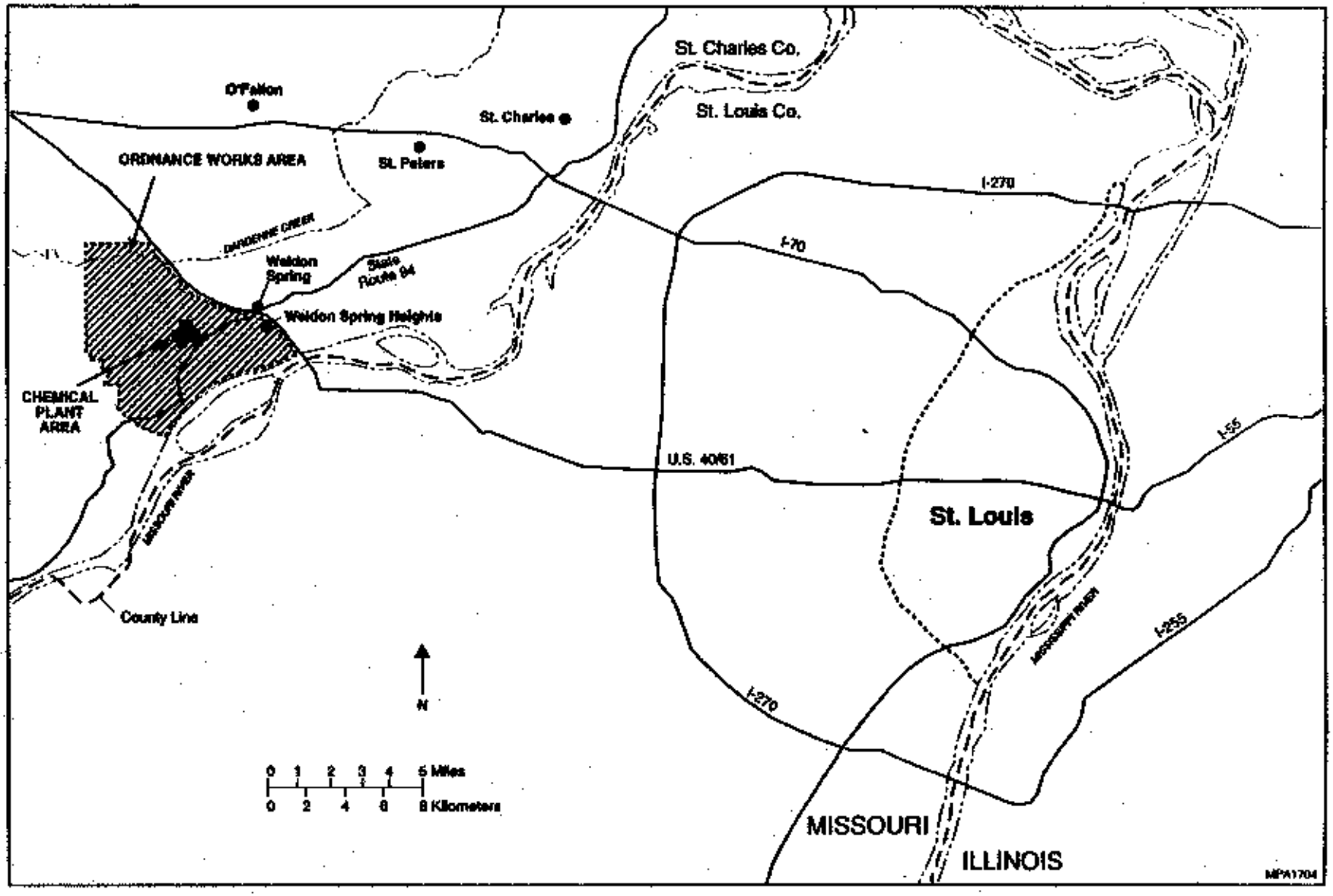

FIGURE 1.1 Locations of the Chemical Plant Area and the Ordnance Works Area

aquifer is significantly lower than those of the shallow and middle aquifers, which indicates a limited hydrogeologic connection between the deep and upper aquifers (DOE and DA 1997).

Both the DOE and DA have previously evaluated conditions at the area springs, including Burgermeister Spring. DOE is currently addressing contamination in springs at the Southeast Drainage; separate documentation has been prepared by DOE to support decision making for this drainage (DOE 1997). The results of earlier evaluations for the area springs indicated that the potential human health risk from spring water is minimal; the estimated risks were lower than the acceptable risk range recommended by the EPA. Also, contaminant concentrations and the potential risk from sediments were lower than those in area spring water, except at the Southeast Drainage. These results are presented in the BRA reports supporting the operable units that addressed soil and structural contamination at the chemical plant area (DOE 1992) and at the ordnance works area (International Technology [IT] Corporation 1993b). However, in May and August of 1995, more recent spring water data were collected from selected springs as part of the joint DOE/DA sampling effort. The 15 springs sampled, including SP-5303 at the Southeast Drainage, were selected because they were considered to be locations that receive groundwater discharge. An assessment of potential human health and ecological impacts from these springs is included in this report to provide an updated evaluation incorporating these recent data.

The ecological risk assessment addresses impacts to aquatic and terrestrial biota from groundwater that discharges to the surface at springs; the assessment was conducted in accordance with EPA guidance (EPA 1992b). Risk estimates to aquatic biota were based on direct exposure to contaminated media, whereas risks to terrestrial biota were based on modeled uptake of contaminants via direct ingestion of surface water. The ecological risk assessment also evaluates the conditions of aquatic biota and habitats associated with Burgermeister Spring and includes measurements of the toxicity to aquatic biota of surface water and sediment from this spring. Burgermeister Spring receives discharge of groundwater originating from the chemical plant and ordnance works areas, and concentrations of some contaminants are as high or higher than concentrations from most other springs in the area. Furthermore, Burgermeister Spring and downstream areas provide more permanent habitat for aquatic biota than most of the other springs in the area and thus likely support a more diverse and abundant aquatic biota than the other springs. Therefore, maximum environmental impacts could be associated with contaminants in the Burgermeister Spring system. Higher concentrations of some contaminants have been reported from springs in the 5300 drainage, which provide more permanent habitat than most other springs in the area. However, springs in the 5300 drainage were not evaluated in this ecological risk assessment because ecological risks associated with this drainage basin have been evaluated previously and are discussed in DOE (1996).

Risk estimates for current and future land use projections were conducted in accordance with EPA guidance (EPA 1989b-c). Current land uses at both the chemical plant area and the ordnance works area do not include use of groundwater for drinking; however, access to springs is possible. Future land uses at both areas would be expected to be similar to current land uses. To address current and likely future potential exposure to springs in these two areas, a recreational

visitor scenario was developed and calculated. Access to groundwater was assumed for a hypothetical resident scenario; the risk from groundwater for a future resident was calculated to provide information representing potential upper-bound risk.

Although the main scope of this report addresses potential risk from groundwater and spring water contaminants, cumulative risks for the future recreational visitor and residential scenarios, incorporating projected exposures to other site media (i.e., soil), are discussed in Chapter 5. Risk for soil was assessed and presented in reports prepared to support cleanup of soil and structural contamination at the chemical plant area (DOE 1992) and the ordnance works area (IT Corporation 1993b).

1.2 PURPOSE OF THIS BASELINE RISK ASSESSMENT

This BRA provides a baseline of potential human health and ecological impacts for the GWOUs at the chemical plant area and ordnance works area. It estimates the magnitude of potential health risks and environmental impacts that would be associated with GWOU contaminants if no remedial action were taken. In addition, the risk estimates presented in this BRA serve as a baseline for comparison with the protectiveness of cleanup alternatives discussed in upcoming RI/FS reports.

1.3 ORGANIZATION OF THE REPORT

The assessment approach followed in this report is consistent with the approach recommended in EPA guidance (EPA 1989b-c). The report is organized as follows:

- Chapter 2 — Description of data sources, data interpretation, and evaluation procedures, and identification of the contaminants of potential concern (COPCs).
- Chapter 3 — Discussion of the development of the human health exposure scenarios to depict current and future land uses, the ecological exposure assessment, and the derivation of exposure point concentrations and intakes.
- Chapter 4 — Brief discussion of the toxicities of the COPCs.
- Chapter 5 — Results of the human health risk assessment and accompanying rationale.
- Chapter 6 — Results of the ecological risk assessment.
- Chapter 7 — Summary of human health and ecological impacts.
- Chapter 8 — List of references cited.

2 IDENTIFICATION OF CONTAMINANTS OF CONCERN

Information relevant to collecting and evaluating data for the human health and ecological risk assessments in this BRA is summarized in this chapter. General background information for the GWOUs, including origin of contamination, is presented in the work plan (DOE 1995). Data summaries and detailed descriptions of data collection efforts are presented in the RI report (DOE and DA 1997).

A considerable amount of data was available at the initial (work plan) phases of the RI/FS, allowing for a more conclusive interpretation of the data. As a result, potential contaminants were identified, which were evaluated further on the basis of data collected from the joint sampling performed by the DOE and DA in May and August of 1995. The COPCs that were carried through the calculations for the human health component of this BRA are identified in the RI on the basis of comparison to background levels of naturally occurring constituents. The process performed for identifying contaminants of ecological concern (COECs) is discussed in Section 2.2.

2.1 DATA CONSIDERATIONS

The data evaluated for use in this risk assessment are presented in the RI report (DOE and DA 1997). The quantity of data was sufficient to develop an adequate statistical base for use in the risk assessment calculations. The quality of the data is discussed in Section 7 of the RI report and was also considered sufficient for use in this risk assessment.

Monitoring results for the contaminants from 155 wells included in the monitoring networks at the chemical plant area and ordnance works area are presented in Chapter 4 of the RI report. The locations of these wells are shown in Figure 2.1. Monitoring results from five other wells in the ordnance works network — wells MWS-23, MWS-111, MWD-105, MWS-108, and MWD-109 — are presented in the RI as background data (DOE and DA 1997). Wells within this network have been categorized as deep, overburden, weathered, or unweathered wells, as discussed in the RI. Because it is likely that any potential future consumptive-use well would draw water from all of these units, data for all wells were considered in the human health risk calculations. The RI also presents results from in-situ groundwater sampling at six locations at or near the Southeast Drainage. To aid in better delineation of the extent of uranium contamination in the area, a monitoring well was installed recently (May 1997); one round of sampling and analysis has been performed to date. Because of the preliminary nature of these data, a qualitative discussion of the risk associated with the detected contaminant levels is included in Chapter 5 (Sections 5.3 and 5.4) of this BRA.

All groundwater and spring water data collected by the DOE and DA were considered for use in this assessment, except those that were qualified as invalid and identified as "rejected" in the databases. Of the approximately 50,000 discrete records available to determine groundwater quality

in the GWOUs, approximately 200 records (less than 0.5%) were rejected because of laboratory quality assurance/quality control concerns.

Data for assessment of spring water are available from the DOE, DA, and U.S. Geological Survey (USGS). The DOE data cover the period from late 1987 through the first quarter of 1995; the DA data include data reported for sampling rounds 2 and 4 to 16 covering the period November 1989 through February 1995 (IT Corporation 1992, 1993a-f, 1994a-d, 1995a-b); and the USGS data are for nitroaromatic compounds from eight springs, including Burgermeister Spring. Data for 15 springs are also available from the joint sampling rounds performed by the DOE and DA in 1995. The locations of these springs are shown in Figure 2.1.

2.2 DATA EVALUATION

A subset of constituents was selected from the potential contaminants identified in the RI report (DOE and DA 1997) to focus the risk assessment on only those contaminants considered to be significant contributors to overall risks. These data evaluation procedures have been recommended by the EPA (1989b, 1993) to select the human health COPCs and the ecological COECs. However, all contaminants identified in the RI were considered to be COPCs for the human health assessment and were carried through the risk calculations presented in the remainder of this report. In the RI, groundwater and surface water data were compared with background levels, and those constituents exceeding background levels were identified as site contaminants, as follows:

- Metals: antimony, cadmium, iron, lithium, manganese, mercury, molybdenum, silver, and uranium;
- Inorganic anions: chloride, nitrate-N, and sulfate;
- Organic compounds: 1,3,5-trinitrobenzene (1,3,5-TNB), 1,3-dinitrobenzene (1,3-DNB), 2,4,6-trinitrotoluene (2,4,6-TNT), 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), 2-amino-4,6-dinitrotoluene (2-amino-4,6-DNT), 4-amino-2,6-dinitrotoluene (4-amino-2,6-DNT), m-nitrotoluene, o-nitrotoluene, p-nitrotoluene, nitrobenzene, trichloroethylene (TCE), and 1,2-dichloroethylene (1,2-DCE).

Each contaminant has been identified as either a spring water contaminant, groundwater contaminant, or both (see Table 2.1).

Uranium was evaluated as both a radioactive and a chemical contaminant. The concentrations of uranium in groundwater and spring water are generally reported in units of picocuries of total uranium (i.e, the sum of the activities of uranium-238, uranium-235, and uranium-234) per liter of water (pCi/L). Because the slope factors for these three radionuclides are essentially identical (see Section 4.3.1), it was not necessary to know the exact mix of uranium isotopes to calculate the

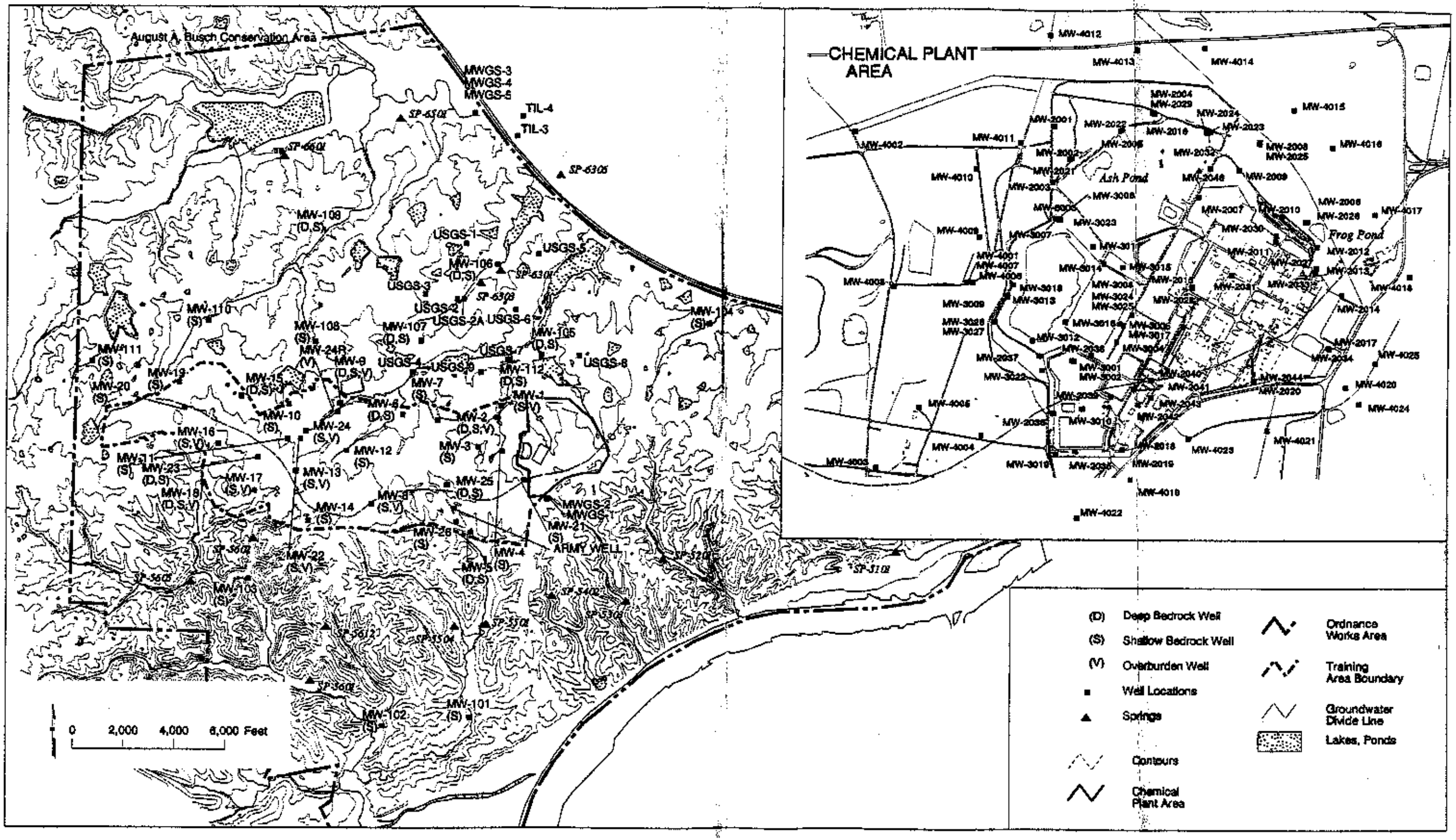

FIGURE 2.1 Location of Monitoring Wells and Springs at the Chemical Plant and Ordnance Works Area

TABLE 2.1 Groundwater and Spring Water Contaminants[a]

Metals	Inorganic Anions	Organic Compounds
Antimony[b]	Chloride[b,c]	1,3,5-Trinitrobenzene[b,c]
Cadmium[b]	Nitrate-N[b,c]	1,3-Dinitrobenzene[b,c]
Iron[b]	Sulfate[b,c]	2,4,6-Trinitrotoluene[b,c]
Lithium[b,c]		2,4-Dinitrotoluene[b,c]
Manganese[b]		2,6-Dinitrotoluene[b,c]
Mercury[b]		2-Amino-4,6-dinitrotoluene[b,c]
Molybdenum[b,c]		4-Amino-2,6-dinitrotoluene[b,c]
Silver[b]		m-Nitrotoluene[b,c]
Uranium[c,d]		o-Nitrotoluene[b,c]
		p-Nitrotoluene[b,c]
		Nitrobenzene[b,c]
		Trichloroethylene[e]
		1,2-dichloroethylene[e]

[a] The inorganic parameters listed represent all of the constituents identified in the RI report (DOE and DA 1997) as potential contaminants that were also determined to be at levels greater than background.

[b] Identified as spring water contaminant.

[c] Identified as groundwater contaminant.

[d] Radiological and chemical effects of uranium were considered in this assessment.

[e] Recently (1996) detected in a few chemical plant wells.

radiological risk. However, the distribution of isotopes was needed to calculate the mass concentration of uranium (in mg/L) because the three uranium isotopes have different specific activities (Ci/g). The mass concentration was needed both from the standpoint of regulatory compliance (because the proposed MCL is expressed in these units) and for calculating the chemical risk associated with uranium intake.

Uranium isotopes are present in natural ores in the activity ratio of uranium-238/uranium-234/uranium-235 of 1.0:1.0:0.046 (Brodsky 1996). Because most of the material processed at the chemical plant area was natural uranium (a very limited amount of slightly enriched uranium was also processed), the uranium contamination would be expected to be present in the same ratio as in natural ores, which has been confirmed by isotopic analyses for a number of soil samples at the chemical plant area. However, such analyses for groundwater samples have indicated a slightly higher ratio of uranium-234 to uranium-238, ranging from 1:1 to 1:3. Such analyses were performed for only a limited number of samples and not for all sampling locations.

To simplify the analyses and add some conservatism to the risk results, it was assumed that the uranium isotopes are present in groundwater and spring water in the same concentrations as they are in chemical plant area soil. Measured activities at each sampling location were used to calculate the radiological risk, and these activities were converted to mass concentrations using a conversion factor of 0.0015 mg/pCi of total uranium. This conversion factor was obtained from the specific activities of the three uranium isotopes[1] (assumed to be present in the ratios identified above). Because uranium-234 and uranium-235 both have higher specific activities than uranium-238 (due to their shorter half-lives), this approach tends to overestimate the mass concentration of uranium in those instances where uranium-234 (and possibly uranium-235) has a higher activity ratio (relative to uranium-238) than in chemical plant area soil. In cases where the uranium-234 and uranium-238 concentrations are essentially the same, this approach provides an accurate estimate of the mass concentration. In no case was the activity of uranium-234 less than that of uranium-238. This approach for estimating the mass concentration of uranium at all sampling locations for groundwater and spring water provides, in a consistent manner using all available data, a realistic yet somewhat conservative estimate of the chemical risk associated with uranium intake.

The COECs in surface water from all spring locations and in sediments from Burgermeister Spring were identified by comparing the reported concentrations (see Table 2.1) with several criteria, including background concentrations and screening benchmark values considered to be protective of aquatic biota, as outlined in EPA guidance (EPA 1989c, 1992b). All contaminants detected in surface water were evaluated in the risk assessment for terrestrial biota. The screening process also considered the contaminant's ability to bioaccumulate and the contaminant's importance as a micro- or macronutrient.

The screening for COECs proceeded in three steps. First, the screening considered only those contaminants detected in samples from all springs and proximate downstream locations for which data were available. Second, the 95% upper confidence limit (UCL) concentration for each metal and inorganic ion was compared with the corresponding 95% UCL concentration detected in the background monitoring wells completed in the weathered zone of the Burlington-Keokuk. Because spring water is groundwater that is discharging to the surface, use of the groundwater data from the background monitoring wells as background spring data is justified. A contaminant was retained for further screening when the reported 95% UCL spring water concentration exceeded the 95% UCL background level. Because nitroaromatic compounds do not occur naturally, background concentrations of these were assumed to be zero. Third, for those contaminants that did exceed background levels, the 95% UCL concentrations were then compared with screening values, and constituents present at concentrations exceeding screening concentrations were retained as final COECs for further evaluation in the ecological risk assessment. Surface water concentrations were compared with either the chronic effects value of the EPA ambient water quality criteria (AWQC) for protection of aquatic biota (EPA 1986) or the AWQC acute effects value if a chronic value was

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[1] The specific activities for uranium-234, uranium-235, and uranium-238 are 6.320×10^{-3} Ci/g, 2.186×10^{-6} Ci/g, and 3.400×10^{-7} Ci/g, respectively; the specific activity for natural uranium is 6.77×10^{-7} Ci/g (Brodsky 1996).

unavailable. Other sources of screening values for surface waters included EPA Region III screening guidance (EPA 1995a), Suter and Tsao (1996), Eisler (1985), and the open scientific literature. Sediment screening values were obtained from EPA ecotox threshold values (EPA 1996a), Long and Morgan (1990), Hull and Suter (1994), EPA Region III screening guidance (EPA 1995a), and the scientific literature. Results of the screening process and the COECs are given in Tables 2.2 and 2.3.

TABLE 2.2 Screening of Sediment from the Burgermeister Spring System to Identify COECs

Contaminant	Detection Frequency	Concentration Range (mg/kg)	Background Concentration[a] (mg/kg)	Screening Concentration (mg/kg)	Retain as COEC?
Metals					
Arsenic	8/8	3.1 – 43	5.7 – 16	8.2[b]	Yes
Chromium	8/8	12 – 48	16 – 32	81[b]	No
Lead	8/8	12 – 110	4.9 – 28	47[b]	Yes
Mercury	0/8	–[c]	–	0.15[b]	No
Selenium	1/8	0.96	0.54	NA[c]	Yes
Silver	3/8	1.6 – 1.7	1.1	1.0[d]	Yes
Uranium, total	8/8	1.4 – 100	1.6 – 2.6	NA	Yes
Inorganic anion					
Nitrate-N	4/8	1.0 – 5.0	0.99	NA	Yes
Nitroaromatic compounds					
1,3,5-TNB	0/8	–	–	0.30[e]	No
1,3-DNB	0/8	–	–	1.2[e]	No
2,4,6-TNT	0/8	–	–	13[e]	No
2,4-DNT	0/8	–	–	NA	No
Nitrobenzene	0/4	–	–	NA	No

[a] Background concentrations are those reported for the Busch Conservation Area in the chemical plant area baseline assessment (DOE 1992).

[b] Screening value is EPA ecotox threshold value (EPA 1996a).

[c] A hyphen (–) indicates the contaminant was not detected; NA = screening value not available.

[d] Benchmark value from Hull and Suter (1994).

[e] Screening value from Talmage and Opresko (1996).

TABLE 2.3 Screening of Surface Water from Springs in the Chemical Plant Area and the Ordnance Works Area to Identify COECs

Contaminant	Detection Frequency	95% UCL Concentration	95% UCL Background Concentration[a]	Screening Concentration[b]	Retain as COEC?
Metals (µg/L)					
Aluminum	121/190	250	3,100	87 chronic	No
Antimony	42/155	14	6.3	30 chronic[c]	No
Arsenic	39/186	6.2	3.4	20 chronic[d]	No
Barium	21/234	160	310	50,000 chronic[e]	No
Cadmium	6/170	1.4	0.7	2.4	No
Chromium	73/206	5.8	6.2	11 chronic	No
Copper	53/166	5.3	14	21 chronic	No
Iron	170/192	6,200	4,500	1,000 chronic	Yes
Lead	21/190	5.9	5.2	8.4 chronic	No
Lithium	18/112	14	6.6	14[c]	No
Manganese	114/150	1,600	290	120 chronic[c]	Yes
Mercury	35/208	86	0.25	1.3 chronic	Yes
Molybdenum	22/108	11	0.50	370 chronic[c]	No
Nickel	62/165	7.0	84	352 chronic	No
Selenium	27/209	1.2	1.1	5.0 chronic	No
Silver	11/208	5.3	2.9	20.8 chronic	No
Strontium	2/2	190[f]	NA[g]	1,500 chronic[c]	No
Thallium	13/171	1.6	1.8	40 chronic[h]	No
Uranium, total	213/249	84	1.4	570[i]	Yes
Inorganic anions (mg/L)					
Chloride	89/89	12	1.6	230[c]	No
Nitrate-N	150/166	180	0.29	90,000[e]	No
Sulfate	109/113	37	12	NA	No

TABLE 2.3 (Cont.)

Contaminant	Detection Frequency	95% UCL Concentration	95% UCL Background Concentration[a]	Screening Concentration[b]	Retain as COEC?
Nitroaromatic compounds (μg/L)					
1,3,5-TNB	61/278	0.56	–[g]	14 chronic[j]	No
1,3-DNB	17/276	0.033	–	30 chronic[j]	No
2,4,6-TNT	136/279	8.1	–	130 chronic[j]	No
2,4-DNT	81/279	0.20	–	230 chronic[k]	No
2,6-DNT	111/277	0.49	–	NA	Yes
Nitrotoluene[l]	3/380	0.0023	–	NA	Yes
2-Amino-4,6-DNT	68/85	2.0	–	0.02[c]	Yes
4-Amino-2,6-DNT	67/85	2.8	–	NA	Yes
Nitrobenzene	11/278	0.027	–	NA	Yes

[a] Background concentrations are the concentrations measured in samples collected from background monitoring wells.

[b] Screening values are EPA (1986) AWQC unless otherwise noted. All hardness-dependent values were calculated using hardness = 258.9 mg equivalent calcium carbonate per liter.

[c] Screening value from Suter and Tsao (1996).

[d] State of Missouri water quality criteria for the protection of aquatic life (Missouri Department of Natural Resources 1992).

[e] EPA (1986) identifies the concentration as a potentially "safe" maximum concentration; no AWQC is identified.

[f] Because of the small sample size, it was not possible to calculate a 95% UCL value; the reported value is the maximum reported concentration.

[g] NA = not available; a hyphen (–) indicates the contaminant was not detected;

[h] EPA (1986) states that insufficient data are available to develop AWQC; screening value is lowest-observed-effects level identified in EPA (1986).

[i] No AWQC available; screening concentration is lowest reported concentration to be chemotoxic to aquatic biota (Poston et al. 1984).

[j] Secondary chronic value (Talmage and Opresko 1996).

[k] EPA Region III screening value (EPA 1995a).

[l] Includes o-nitrotoluene, m-nitrotoluene, and p-nitrotoluene.

3 EXPOSURE AND EFFECTS ASSESSMENT

The former ordnance works area has been divided into several contiguous areas with different land uses (Figure 3.1). The 670-ha (1,655-acre) Weldon Spring Training Area is adjacent to the 88-ha (217-acre) chemical plant area. Both areas are fenced, and access by the general public is restricted. Portions of the training area are currently used for field training and outdoor drilling by the U.S. Army Reserve, the Missouri Army National Guard, and other military and police units. An estimated 3,300 local Army reservists and 3,400 other reserve troops use the training area each year. The Army intends to continue using the training area for similar training activities in the future. Most of the remaining portions of the ordnance works area have been converted into two conservation areas: the 2,977-ha (7,356-acre) Weldon Spring Conservation Area and the 2,828-ha (6,987-acre) August A. Busch Memorial Conservation Area. These areas are managed by the Missouri Department of Conservation and are open to the public throughout the year for recreational use. Future land uses for the ordnance works area and chemical plant area are expected to remain similar to current land uses, except that a disposal cell currently under construction will occupy up to one-third of the chemical plant area.

3.1 IDENTIFICATION OF EXPOSURE PATHWAYS

Potential human and biotic exposure pathways were identified for this study on the basis of the following factors:

- Locations of contaminated source areas, types of contaminants found at the source areas, and potential mechanisms of contaminant release from those areas;
- Likely fate and transport of the contaminants within or between environmental media;
- Estimated concentrations of contaminants at points of potential human and biota contact (i.e., exposure points) and the associated probable routes of human and biota exposure (e.g., ingestion); and
- Completeness of each exposure pathway — that is, the presence of a source and a mechanism of contaminant release, an environmental transport medium, a point of human and biota contact with the contaminated source or medium, and a route of human and biota exposure at that point.

All of these factors were considered in developing the conceptual site exposure model presented in Figure 3.2. Detailed discussion regarding sources, nature and extent of contamination, and fate and transport of contaminants is presented in the RI (DOE and DA 1997).

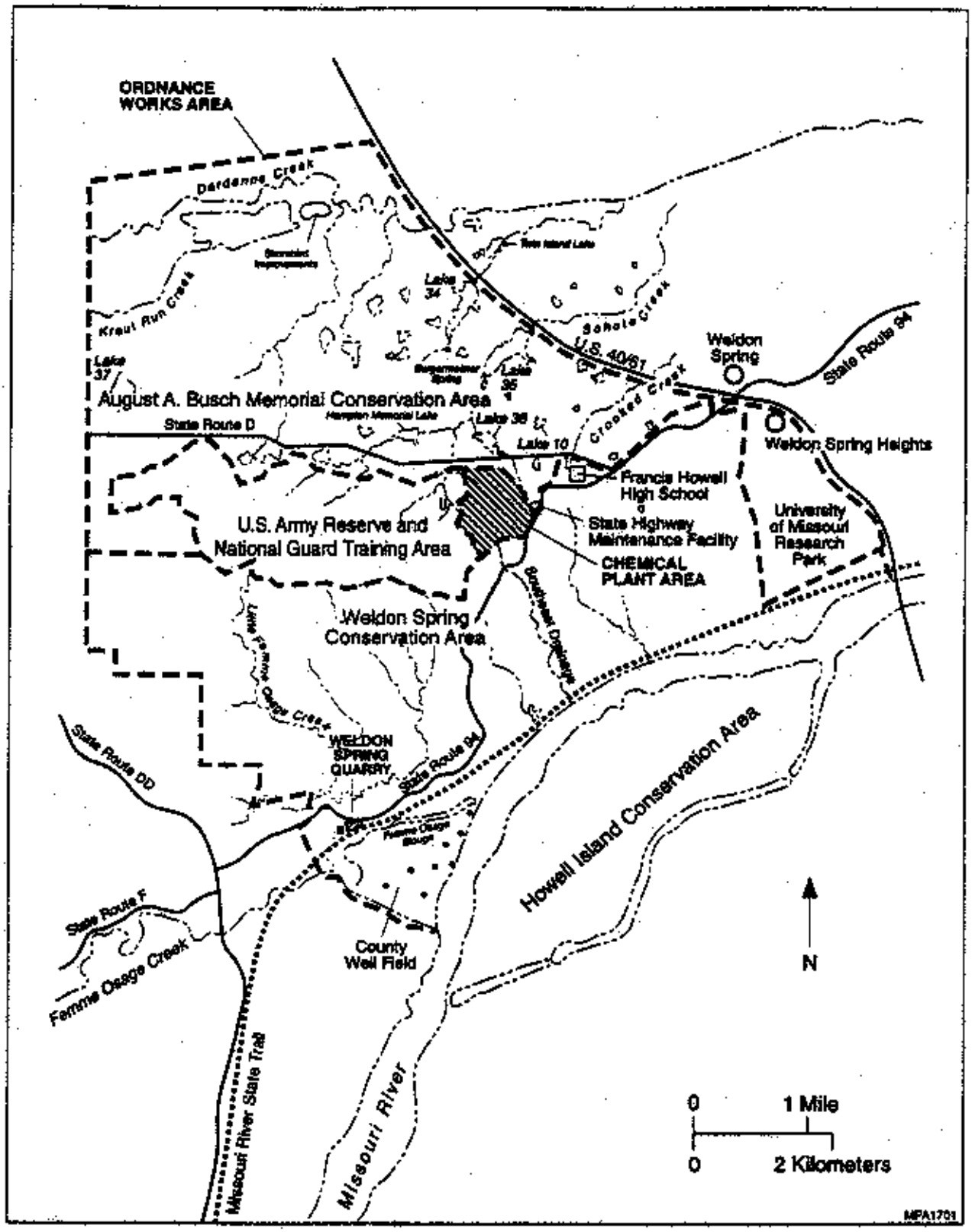


FIGURE 3.1 Map of the Chemical Plant Area and Ordnance Works Area and Immediate Vicinity

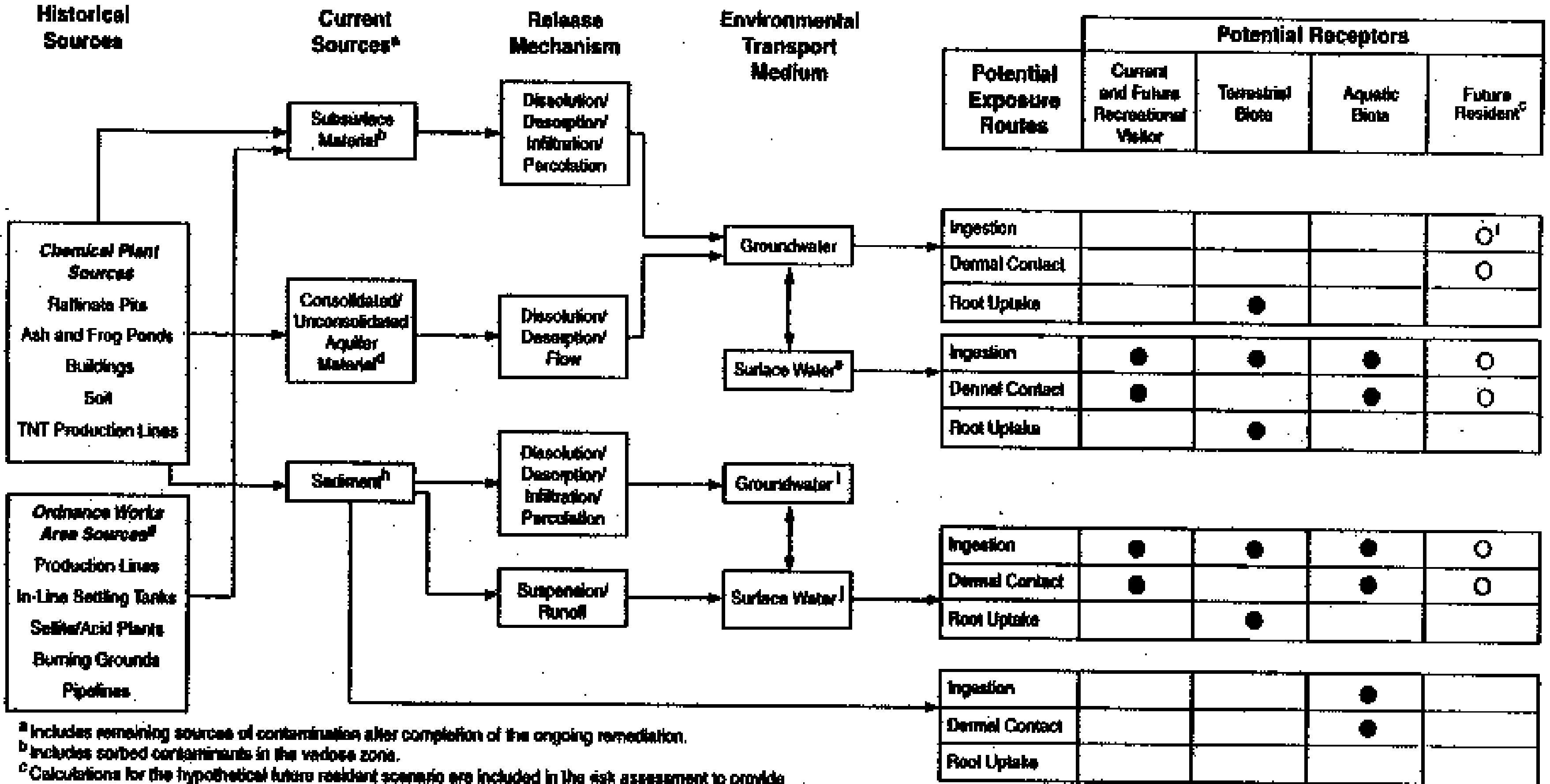
3.1.1 Human Health Pathways

The principal route of exposure for a human receptor is considered to be ingestion of spring water. Dermal exposure to spring water was also calculated, although this exposure pathway would be less significant based on the limited area and depth of most springs. Because of the small size of the springs and the very low levels of contamination measured in the spring sediments, the potential for dermal contact with, or ingestion of, sediment is considered to be low. Inhalation was not identified as a pathway of concern because of the absence of volatile organic compounds, radon, and airborne particulates. External gamma radiation was also eliminated as a pathway of concern because of the small size of the springs and the very low levels of uranium in the sediment. The water cover over the sediment also acts to attenuate the low-level gamma radiation.

Under current land uses, the most likely receptor would be a recreational visitor who might be exposed to contaminated discharge water at one of the springs. Army reservists and a full-time site caretaker of the ordnance works area were also considered as potential receptors; however, these scenarios were not evaluated. There are no potential pathways of exposure for the reservist because no active springs are located in the Army training area and municipal water is available at the tap. Similarly, the potential for the site caretaker to come in contact with contaminated groundwater and spring water is unlikely because of the availability of municipal water. The potential risk to a reservist who might venture outside the fenced training area and drink spring water is covered by the calculations performed for the recreational visitor (however, one may assume that if a reservist visited parts of the ordnance works area other than the training area, he would take a drinking water supply with him). It was considered reasonable for reservists to train at the training area two to three weekends (about 6 days) per year. If these same reservists also spent their yearly retreat training of 2 weeks there, the frequency of exposure would extend to about 20 days, which is the same as the exposure frequency assumed for a recreational visitor.

Because future land-use conditions are expected to be similar to current conditions, the most likely receptor was also assumed to be a recreational visitor. The Army intends to continue using the training area for training activities in the future. The 89th Regional Support Command, U.S. Army Reserve, has developed plans to construct a training center at the Weldon Spring Training Area. This facility would contain headquarters for several reserve units with about 30 full-time personnel. The units headquartered at the facility would conduct drills on assigned weekends and evenings at the facility and the training area. The chemical plant area is currently being remediated, and all site waste will be disposed of in an engineered disposal cell constructed on-site. The cell is estimated to occupy approximately one-third of the chemical plant area.

The August A. Busch Memorial Conservation Area and the Weldon Spring Conservation Area, which occupy a large portion of the former ordnance works area, are managed by the Missouri Department of Conservation and are open throughout the year for recreational use. These areas are extensively used, as indicated by the estimated 1,200,000 visitors each year (Crigler 1992).



[a] Includes remaining sources of contamination after completion of the ongoing remediation.
[b] Includes sorbed contaminants in the vadose zone.
[c] Calculations for the hypothetical future resident scenario are included in the risk assessment to provide information representing upper-bound risk. Potential pathways for a residential receptor are ingestion of, dermal contact with, and inhalation of groundwater.
[d] Includes the sorbed contaminants within the shallow unconfined aquifer.
[e] Includes surface water at area springs.
[f] The symbol O denotes incomplete pathway.
[g] Other minor sources are wastewater treatment plants, laboratory building, "Mechanical City," storage bunkers, regraining areas, lagoons, and dumps.
[h] Includes sediment within the Burgermeister Spring conduit system.
[i] No potential receptor; serves as transport medium to the surface water.
[j] Includes surface water at Burgermeister Spring.

FIGURE 3.2 Conceptual Site Exposure Model for the Chemical Plant Area and Ordnance Works Area

Current land uses in the vicinity also include a state highway maintenance facility east of the chemical plant area and a private housing development known as Weldon Spring Heights. Both the maintenance facility and the housing development receive their water from the St. Charles County municipal water supply. Francis Howell High School, located about 1 km (0.6 mi) east of the chemical plant area, also obtains its water from St. Charles County.

Forty-five old wells were identified on the ordnance works area as a result of a review of archival records from state files and interviews with persons familiar with the site. Many of these private wells were open to the deeper bedrock aquifers (i.e., Kimmswick and St. Peter) to obtain sufficient well yields. Although some of these private wells were open to the shallow aquifer, to obtain sufficient yield they were open throughout the entire shallow aquifer (including all or part of the Fern Glen), rather than only the upper weathered part of the Burlington-Keokuk.

Due to the low transmissivity and low yield of the shallow aquifer, a future resident would likely screen a private well in the deeper, more productive aquifers or, because of the 24-m (80-ft) casing requirement, the well would be open to a larger portion of the shallow aquifer (rather than only the upper weathered unit of the Burlington-Keokuk). The 80-ft casing requirement would, of itself, not preclude using water from the shallow groundwater system. Use of a longer screen would improve the quality of the pumped water because of mixing with less contaminated water (the contamination decreases with depth). In 1989, pumping tests for the shallow aquifer at the chemical plant area indicated a maximum sustainable pump rate of 0.3 gallons per minute. Even with an extended casing, well yields would barely support the daily use of a family. However, the low yields could be increased by installing a cistern and replenishing the cistern from the groundwater; this approach would supply a sufficient amount of water to support a typical household. Multiple single-family housing units in a future subdivision development in the area would most likely receive water from a municipal water supplier. This water would be obtained from deeper formations such as the Kimmswick or St. Peter formations.

Risk calculations were also performed for a hypothetical future resident scenario because this scenario would provide potential upper-bound risk information to aid in risk management decision making for groundwater. Pathways evaluated included ingestion and dermal contact through showering. The inhalation pathway was evaluated only for TCE. Similar calculations for recreational use of the groundwater would result in hazard indices or risks of approximately one-hundredth of those estimated for the hypothetical future resident. Exposure parameters for the human health receptors are summarized in Table 3.1.[1]

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[1] All tables in this chapter have been placed at the of the text (Section 3.4.5).

3.1.2 Ecological Effects

Ecological health effects were also evaluated as part of the exposure assessment. Because of the nature of the contamination, risks to ecological resources would be related primarily to direct contact and ingestion of surface water and sediment originating at a spring; therefore, the ecological risk assessment focused primarily on (1) aquatic biota inhabiting a spring and immediate downstream habitats and (2) terrestrial biota drinking from a spring and downstream locations.

For aquatic biota, the exposure scenario consists of direct exposure to contaminated spring water and sediment. Risk calculations were performed using the 95% UCL concentrations for the spring water and the maximum contaminant concentrations for the sediment. Burgermeister Spring and its immediate downstream habitats was chosen as the exposure area for all risk determinations in this study. Although some risks to aquatic biota might be associated with other springs, the likelihood of actual exposure of aquatic biota is low because aquatic habitats associated with most springs are ephemeral in nature and provide limited year-round use. In contrast, Burgermeister Spring and its drainage support the largest amount of permanent aquatic habitat, including the uppermost portion of Lake 34, and thus have the greatest potential for exposure of aquatic biota. The use of contaminant concentrations reported from all springs together with the Burgermeister Spring exposure area should, therefore, fully cover the risks to aquatic biota associated with the springs of the chemical plant and ordnance works areas. An exception might be the springs within the lower segment of the Southeast Drainage (5300 drainage). Although the aquatic habitats immediately above and below the springs in the 5300 drainage are ephemeral, the lowermost portion of the drainage contains permanent year-round aquatic habitat with direct connection to the Missouri River. Higher concentrations of metals and nitroaromatic compounds have been detected in surface water and sediment from the Southeast Drainage than from Burgermeister Spring or other area springs, and a separate ecological risk assessment has been conducted as part of an engineering evaluation/cost analysis for a proposed removal action at the drainage (DOE 1996).

Ingestion of contaminated drinking water is considered the principal exposure pathway for terrestrial biota in this study, and each spring in the ordnance works area represents a potential drinking water source. Risks were evaluated for selected terrestrial wildlife receptors (American robin and white-tailed deer). The exposure scenarios considered in this study consist only of contaminant uptake through ingestion of surface water; however, most of the springs are small and/or ephemeral in nature and, thus, individually are not likely to represent a significant portion of the drinking water supply for any wildlife receptor. Potential risks were calculated using the same surface water concentrations and exposure areas as were used for evaluating risks to aquatic biota. Burgermeister Spring and its immediate downstream waters likely exceed the total exposure area of all spring discharge points combined; therefore, the use of Burgermeister Spring as the exposure area in this exposure scenario should maximize the potential for contaminant uptake via ingestion of drinking water.

3.2 ESTIMATION OF EXPOSURE POINT CONCENTRATIONS

A media-specific concentration of a contaminant at the location of exposure (i.e., exposure point concentration [EPC]) must be estimated to calculate the potential human and biota exposure that might be associated with a contaminated source or medium. For the human health component of this risk assessment, an EPC was determined for each COPC using the lower of the 95% UCL of the arithmetic mean or the maximum value detected during the 1995 DOE/DA joint sampling rounds (see Section 2.2). The nature and extent of contamination defined by the data from the 1995 joint sampling rounds were comparable to the nature and extent of contamination defined by previously collected data (i.e., pre-1995). The EPCs are listed in Tables 3.2, 3.3, and 3.4 for the current and future recreational visitor and in Tables 3.5 through 3.9 for the hypothetical future resident. These concentrations were used to calculate hazard indices and risks for a recreational visitor who ingested or came into dermal contact with spring water from any of the springs. The results provide a range of potential human health impacts from these springs.

Groundwater calculations were performed for each well because the results from the monitoring networks covering the two areas indicated that contaminant concentrations are heterogeneous. A more detailed discussion of the nature and extent of contamination is presented in Chapter 4 of the RI report (DOE and DA 1997).

Future EPCs were assumed to be the same as current concentrations. This is a conservative assumption because attenuation of contaminant concentrations is anticipated over time as a result of removal of contaminant sources such as soil and raffinate pit sludge.

3.3 ESTIMATION OF INTAKES

Estimates of chemical and radioactive contaminant intakes were based on contaminant concentrations at the exposure points (Section 3.2) and on scenario-specific exposure assumptions and intake parameters. In accordance with EPA (1989b) guidance, the scenario-specific assumptions and intake parameters were based on the "reasonable maximum exposure" expected to occur for a given receptor under current and future land-use conditions. The recreational visitor was assumed to visit the area and drink water from a spring 20 times per year for 30 years. A water ingestion rate of 400 mL (about 2 cups) was assumed for each visit. For the hypothetical future resident calculations, it was assumed that the resident would drink 2 L (2.1 quarts) of water per day from a single well, 350 days per year, for 30 years. These and other assumptions are summarized in Table 3.1. For the current and future recreational visitor, calculations were performed for springs identified as representative of all springs in the area. The methodology used to calculate intakes and the results are presented in Section 3.3.1 for uranium and in Section 3.3.2 for the chemical contaminants. Cadmium, 1,3-DNB, nitrotoluenes, and nitrobenzene were identified in the RI as contaminants in the springs at levels greater than the statistically derived background values. However, because these contaminants were not detected in any samples collected during the 1995 joint DOE/DA sampling

rounds, intakes were not calculated (these compounds were detected at very low frequencies and low concentrations in the pre-1995 data set [DOE and DA 1997]).

3.3.1 Radiological Intakes

Intakes for radioactive contaminants were calculated similarly to those for chemical carcinogens (see Section 3.3.2). Radiological intake is the amount of contaminant taken into the body per unit time, expressed in pCi. The intake of radioactive contaminant i (I_i) from ingestion of groundwater or spring water was calculated as follows:

$$I_i = R_{wi} \times IR \times EF \times ED$$

where:

R_{wi} = concentration of radionuclide in groundwater or spring water;

IR = ingestion rate;

EF = exposure frequency; and

ED = exposure duration.

The intake of radioactive contaminant i (I_i) from dermal contact with spring water and groundwater was calculated as follows:

$$I_i = R_{wi} \times SA \times PC_i \times CF \times ET \times EF \times ED$$

where:

SA = surface area exposed (cm^2);

PC = permeability coefficient (cm/h);

CF = conversion factor (1×10^{-3} L/cm^3); and

ET = exposure time (h).

Estimated radiological intakes are provided in Tables 3.4 and 3.9 for the recreational visitor and residential scenarios, respectively.

3.3.2 Chemical Intakes

Exposure to chemical contaminants is expressed in terms of intake. Intake is the amount of contaminant taken into the body per unit body weight per unit time (expressed as mg/kg-d). The intakes of chemical contaminant i (I_i) from ingestion of groundwater and spring water was calculated as follows:

$$I_i = \frac{C_{wi} \times IR \times EF \times ED}{BW \times AT}$$

where:

C_{wi} = concentration of contaminant in groundwater or spring water;

IR = ingestion rate;

EF = exposure frequency;

ED = exposure duration;

BW = average body weight over the exposure period (kg); and

AT = averaging time (d).

The intake of chemical contaminant i (I_i) from dermal contact with spring water and groundwater was calculated as follows:

$$I_i = \frac{C_{wi} \times SA \times PC_i \times CF \times ET \times EF \times ED}{BW \times AT}$$

where:

C_{wi} = concentration of contaminant in groundwater or spring water;

SA = skin surface area (cm^2/event);

PCi = dermal permeability coefficient for contaminant i (cm/h); and

CF = conversion factor (1×10^{-3} L/cm^3).

Tables 3.2, 3.3, and 3.5 through 3.8 present the chemical exposure point concentrations and estimated intakes for the recreational and residential scenarios.

The following equation was used to calculate intake of TCE from groundwater through inhalation while showering:

$$I_i = \frac{C_i \times IR \times ET \times EF \times ED}{BW \times AF \times AD}$$

where:

C_i = concentration of chemical i (TCE) in shower air (mg/m^3) — calculated by multiplying the water exposure point concentration in mg/L (Table 3.8) times the water volume per shower (200 L) divided by a shower volume of 2.5 m^3 and then dividing the total quantity by 2 (see DOE [1993] for methodology);

IR = inhalation rate (m^3/h);

ET = exposure time (h/d);

EF = exposure frequency (d/yr);

ED = exposure duration (yr);

BW = body weight (kg);

AF = averaging frequency (365 d/yr); and

AD = averaging duration (yr) (70 years for carcinogens).

3.4 ECOLOGICAL RESOURCES EXPOSURE AND EFFECTS ASSESSMENT

3.4.1 Methodology

For aquatic biota, the risk assessment included consideration of both exposure and effects. Biotic surveys of the fish and invertebrate communities were conducted using the EPA *Rapid Bioassessment Protocols* (EPA 1989a). This method provided direct information on (1) the status of the aquatic community inhabiting Burgermeister Spring and exposed to the COECs and (2) the habitat quality of the spring and receiving drainage. Samples of surface water and sediment collected from Burgermeister Spring were tested for toxicity to evaluate potential effects of current levels of contamination in the spring to aquatic biota. Acute and chronic toxicity tests were conducted for two invertebrates (*Daphnia* and *Hyalella*), a fish (*Pimephales*), and an amphibian (*Xenopus*). These test organisms represent the major taxonomic categories of aquatic biota that occur in the spring and its

downstream drainage. Fish and invertebrate samples were also collected from Burgermeister Spring for tissue analysis.

The risk assessment for terrestrial wildlife modeled uptake of each contaminant through the drinking water pathway for two receptor species, the white-tailed deer (*Odocoileus virginianus*) and the American robin (*Turdus migratorius*). The uptake modeling permitted prediction of an applied daily dose (ADD) for each receptor and each contaminant. Contaminant uptake from the ingestion of contaminated drinking water was estimated with the following equation:

$$ADD_{dw} = C_{dw} \times FR \times (IR_{dw}/BW)$$

where:

ADD_{dw} = applied daily dose from drinking water (mg/kg-d);

C_{dw} = exposure point concentration (mg/L) at the drinking water supply, using the maximum reported contaminant concentrations from all springs;

FR = fraction of total water ingested from contaminated source, using Burgermeister Spring as the drinking water supply;

IR_{dw} = ingestion rate of drinking water (g/d); and

BW = body weight (g) of the receptor.

Values of drinking water ingestion rates and body weights were obtained from the *Wildlife Exposure Factors Handbook* (EPA 1993) and the open scientific literature. The exposure factors used for this risk assessment are presented in Tables 3.10 and 3.11. Every effort was made to select exposure factors from populations nearest the August A. Busch Memorial Conservation Area. The fraction of total water ingestion by each receptor from Burgermeister Spring was estimated by centering the receptor home range on the spring, identifying all surface waters within the home range, and determining the percent contribution (by area) of the spring and its downstream waters (to Lake 34) to the total available surface water area within the receptor's home range.

Modeling contaminant uptake and determining the ADD were based on the following assumptions:

- Consistent with EPA (1993) guidance, the home range used in this assessment includes both daily activity and foraging ranges.

- All foraging activities of each receptor are constant and uniformly distributed over the receptor's entire home range.

- Contaminant uptake by biota does not significantly affect the environmental concentration of contaminants.

- Contaminant assimilation is complete (100%).

3.4.2 Toxicity Results

The results of the acute and chronic toxicity testing indicate some toxicity of surface water and sediment from Burgermeister Spring. Surface water toxicity, as indicated by reduced survival, was measured for two locations, SP-6301-1 and SP-6301-2 (Table 3.12). These locations correspond to the spring proper and a location approximately 30 m (100 ft) downstream from the spring, respectively. Toxicity at these locations was limited to the fish test biota; on the basis of either acute or chronic testing, no toxicity was evident for the other three test biota. Some surface water toxicity was also suggested for location SP-6301-3, which is downstream of the confluence of a large stream with the stream that originates at Burgermeister Spring. At SP-6301-3, no acute toxicity was indicated for any of the test biota, and chronic toxicity was observed only for *Xenopus* (30% reduction in survival of exposed *Xenopus*; Table 3.12).

Sediment toxicity, as evidenced by reduced survival, was indicated for several locations (Table 3.13). Acute toxicity to *Pimephales* and chronic toxicity to *Xenopus* was indicated for sediment from location SP-6301-2. No acute toxicity was evident for any other test locations or biota. Toxicity to *Hyalella* was indicated for sediment collected directly from the spring (location SP-6301-1) and to *Pimephales* from the farthest downstream sampling location from the spring proper (SP-6301-4). Although survival was reduced in all of these tests, the survival rates were greater than 70% at all but the most downstream sampling location (Table 3.13).

3.4.3 Tissue Analysis Results

Macroinvertebrate and fish tissue samples were collected from Burgermeister Spring and analyzed for seven metals (arsenic, chromium, lead, mercury, selenium, silver, and uranium). The results of this analysis are presented in Appendix A of the RI report (DOE and DA 1997). Silver was not detected in either macroinvertebrate samples or fish samples, whereas mercury was detected only in fish samples and selenium only in macroinvertebrate samples. Estimated bioconcentration factors (BCFs) for macroinvertebrates (from sediment) and fish (from spring water) were typically less than 20; a BCF of 300 or more is considered to indicate significant bioconcentration (EPA 1989c). Only the BCF for mercury in fish exceeded a value of 300, suggesting a potential for significant bioconcentration.

Although the BCF for mercury in fish was high (1,100), this value alone does not represent an effects concentration and does not indicate that fish in the Burgermeister Spring drainage are being impacted in any way. By definition, the BCF represents only the ratio between biological and environmental contaminant concentrations and is independent of effects. The measured tissue concentrations for fish from the Burgermeister Spring drainage are in the low end of the range of mercury tissue concentrations reported for freshwater fish in North America and within the whole-body concentration of 5,000 µg/kg suggested to be protective of freshwater fish by the U.S. Fish and Wildlife Service (Eisler 1987). In addition, the measured tissue concentrations in fish samples from Burgermeister Spring are not expected to pose a risk to piscivorous avian and mammalian wildlife. The measured concentrations are within the total mercury levels in prey suggested to be safe for birds (100 µg/kg) and small mammals (1,100 µg/kg) (Eisler 1987).

Thus, on the basis of the analysis of samples from Burgermeister Spring and the levels considered to be protective of fish and wildlife, the reported BCF values indicate that neither macro-invertebrates nor fish in Burgermeister Spring are accumulating contaminants from the environment at levels of concern.

3.4.4 Biotic Survey Results

Biotic surveys of the aquatic invertebrate and vertebrate biota inhabiting Burgermeister Spring indicate the presence of an aquatic community that would be expected to occur in similar spring systems and low-order headwater stream systems in the Midwest. No fish were collected from the spring proper, and the invertebrate community was dominated by amphipods and isopods (DOE and DA 1997). Fish are present in the drainage downstream of the spring proper. Although the fish community includes headwater stream fishes (e.g., orangethroat darter, brook silverside, and red shiner), it is dominated by juvenile fishes of species that typically inhabit slow-water streams and lakes (bluegill, green sunfish, largemouth bass, and black crappie), and it represents the strong influence of the fish community present in Lake 34. These latter species become more abundant as one proceeds downstream from the spring to Lake 34. The absence of fish in the uppermost portion of Burgermeister Spring is due to the presence of a concrete weir across the stream; located about 15 m (50 ft) downstream of the spring, the weir serves as a barrier to the upstream passage of fish to the spring.

Habitat impairment and community quality were evaluated by following the EPA *Rapid Bioassessment Protocols* for fish and invertebrates (EPA 1989a). Burgermeister Spring and its downstream locations were found to support a limited fish community and slightly impaired aquatic invertebrate community (DOE and DA 1997), conditions that are probably a result of the physical characteristics of the spring rather than the contaminant levels. Flow in the uppermost segment of the stream is maintained almost exclusively by discharge at the spring; under low-flow conditions in the summer, the stream becomes intermittent and portions of the habitat become dry. The fish community at the lower end of the drainage is maintained by the permanent waters of Lake 34.

The amphibian survey results show that the amphibian community at Burgermeister Spring consists of species that are common to similar habitats throughout the Midwest and would be expected to inhabit the Burgermeister Spring drainage.

3.4.5 Dose Estimates for Biota

Contaminant uptake through ingestion of drinking water was estimated for the American robin and white-tailed deer using the uptake models presented in Section 3.4.1 and the exposure factors in Tables 3.8 and 3.9. For the American robin, 100% of the ingested drinking water was assumed to be obtained from Burgermeister Spring and downstream waters, whereas only 1.8% of the total water intake for the white-tailed deer was considered to come from this spring. These diet fractions were developed as the ratio of the total surface area of the Burgermeister Spring drainage (spring outflow to Lake 34 inflow) to the total available surface water area within the home range of each receptor (see Tables 3.10 and 3.11 for home range values). Contaminant uptake was modeled using the maximum contaminant concentrations reported from all springs.

Burgermeister Spring and its downstream waters was selected as the drinking water exposure point because the spring represents the largest and most permanent surface water body of all the springs. Although other springs in the area may be used by wildlife, most of these springs are very small and/or intermittent and, thus, probably do not represent a significant source of drinking water for terrestrial biota. Burgermeister Spring and its downstream waters likely exceed the total available surface water of all springs in the area, so use of the former as the drinking water exposure point maximizes the potential for contaminant uptake by the terrestrial receptors. Because maximum contaminant concentrations vary among the springs for any particular contaminant, the EPCs used in the uptake models were the maximum reported concentrations reported from all of the springs. Thus, the approach of using Burgermeister Spring as the drinking water exposure point area together with the maximum contaminant concentrations reported from any spring should result in very conservative estimates of contaminant uptake by terrestrial biota through ingestion of drinking water.

Modeling results are presented in Table 3.14. Uptake of nitroaromatic compounds through ingestion of drinking water was estimated to be very minor, with ingestion of any one compound being less than 0.001 mg/kg-d for the white-tailed deer. Uptake of nitroaromatic compounds by the American robin was estimated to be less than 0.01 mg/kg-d for any one compound, except 2,4,6-TNT, which was estimated at 0.04 mg/kg-d (Table 3.14). Similarly, the estimated daily uptake of metals was also typically very low for both receptor species.

TABLE 3.1 Exposure Scenario Assumptions and Intake Parameters[a]

Parameter	Unit	Current or Future Recreational Visitor	Future Resident
Exposure time	h/event	4	0.16[b]
Exposure frequency	events/yr	20	350
Exposure duration	yr	30	30
Body weight	kg	70	70 (4)[c]
Spring water ingestion rate	mL/event	400	NA[d]
Groundwater ingestion rate	L/event	NA	2 (0.64)[c]
Inhalation rate (showering scenario for TCE only)	m^3/h	NA	0.83
Surface area	cm^2	4,200[e]	20,000[f]
Permeability coefficient	cm/h		
Default		1×10^{-3}	1×10^{-3}
TCE		NA	1.6×10^{-2}

[a] Assumptions and intake parameters are consistent with recommendations by the EPA (1995b, 1992a).

[b] Assumed length of time per day for showering.

[c] Exposure assumptions in parentheses are for an infant ingesting groundwater. These parameters were used to calculate intakes and hazard quotients for nitrates in groundwater because of the greater sensitivity of infants to the toxic effects of this contaminant.

[d] NA = not applicable.

[e] Surface area consists of the arms, hands, and lower legs (EPA 1992a).

[f] Surface area is the whole body (EPA 1992a).

TABLE 3.2 Estimated Noncarcinogenic Intakes of COPCs for the Current and Future Recreational Visitor[a]

	Antimony			Iron			Lithium			Manganese		
		Intake (mg/kg-d)			Intake (mg/kg-d)			Intake (mg/kg-d)			Intake (mg/kg-d)	
Spring ID	EPC[b] (µg/L)	Ingestion	Dermal	EPC[b] (µg/L)	Ingestion	Dermal	EPC[b] (µg/L)	Ingestion	Dermal	EPC[b] (µg/L)	Ingestion	Dermal
5101	2.7[c]	4.2×10^{-7}	8.9×10^{-9}	790[c]	1.2×10^{-4}	2.6×10^{-6}	2.6[c]	4.1×10^{-7}	8.5×10^{-9}	55[c]	8.6×10^{-6}	1.8×10^{-7}
5201	2.1	3.3×10^{-7}	6.9×10^{-9}	170	2.7×10^{-5}	5.7×10^{-7}	–[d]	–	–	5.4	8.4×10^{-7}	1.8×10^{-8}
5303	2.8	4.3×10^{-7}	9.1×10^{-9}	1,200	1.9×10^{-4}	4.0×10^{-6}	8.7	1.4×10^{-6}	2.9×10^{-8}	31	4.8×10^{-6}	1.0×10^{-7}
5402	1.9[c]	3.0×10^{-7}	6.2×10^{-9}	760	1.2×10^{-4}	2.5×10^{-6}	–	–	–	9.8	1.5×10^{-6}	3.2×10^{-8}
5501	2.6[c]	4.1×10^{-7}	8.5×10^{-9}	280[c]	4.4×10^{-5}	9.2×10^{-7}	2.3[c]	3.6×10^{-7}	7.6×10^{-9}	30	4.6×10^{-6}	9.7×10^{-8}
5504	1.4	2.2×10^{-7}	4.7×10^{-9}	140[c]	2.1×10^{-5}	4.4×10^{-7}	–	–	–	5.8	9.1×10^{-7}	1.9×10^{-8}
5601	3.4	5.3×10^{-7}	1.1×10^{-8}	1,000	1.6×10^{-4}	3.4×10^{-6}	–	–	–	220	3.4×10^{-5}	7.2×10^{-7}
5602	8	1.3×10^{-6}	2.6×10^{-8}	500	7.8×10^{-5}	1.6×10^{-6}	–	–	–	210	3.3×10^{-5}	7.0×10^{-7}
5605	2.7[c]	4.2×10^{-7}	8.9×10^{-9}	360[c]	5.6×10^{-5}	1.2×10^{-6}	–	–	–	32[c]	5.0×10^{-6}	1.1×10^{-7}
5612	13[c]	2.0×10^{-6}	4.3×10^{-8}	86[c]	1.4×10^{-5}	2.8×10^{-7}	–	–	–	9.6[c]	1.5×10^{-6}	3.2×10^{-8}
6301	2.1[c]	3.3×10^{-7}	6.9×10^{-9}	390	6.0×10^{-5}	1.3×10^{-6}	18[c]	2.8×10^{-6}	6.0×10^{-8}	18	2.9×10^{-6}	6.0×10^{-8}
6303	5.5	8.6×10^{-7}	1.8×10^{-8}	980	1.5×10^{-4}	3.2×10^{-6}	3.6[c]	5.6×10^{-7}	1.2×10^{-8}	52[c]	8.1×10^{-6}	1.7×10^{-7}
6306	2.3	3.7×10^{-7}	7.7×10^{-9}	7,300[c]	1.1×10^{-3}	2.4×10^{-5}	–	–	–	8,600[c]	1.3×10^{-3}	2.8×10^{-5}
6501	1.4[c]	2.2×10^{-7}	4.6×10^{-9}	650[c]	1.0×10^{-4}	2.1×10^{-6}	–	–	–	29	4.6×10^{-6}	9.6×10^{-8}
6601	4.8	7.6×10^{-7}	1.6×10^{-8}	340	5.3×10^{-5}	1.1×10^{-6}	–	–	–	45[c]	7.1×10^{-6}	1.5×10^{-7}

TABLE 3.2 (Cont.)

Spring ID	Mercury			Molybdenum			Silver			Uranium, Total		
	EPC[b] (µg/L)	Intake (mg/kg-d)		EPC[b] (µg/L)	Intake (mg/kg-d)		EPC[b] (µg/L)	Intake (mg/kg-d)		EPC[b] (µg/L)	Intake (mg/kg-d)	
		Ingestion	Dermal		Ingestion	Dermal		Ingestion	Dermal		Ingestion	Dermal
5101	–	–	–	–	–	–	–	–	–	0.57[c]	9.0×10^{-8}	1.9×10^{-9}
5201	–	–	–	–	–	–	–	–	–	1.3[c]	2.0×10^{-7}	4.2×10^{-9}
5303	0.94	1.5×10^{-7}	3.1×10^{-9}	13	2.1×10^{-6}	4.4×10^{-8}	–	–	–	180[c]	2.9×10^{-5}	6.0×10^{-7}
5402	–	–	–	–	–	–	–	–	–	1.4[c]	2.2×10^{-7}	4.7×10^{-9}
5501	–	–	–	–	–	–	–	–	–	1.1[c]	1.7×10^{-7}	3.6×10^{-9}
5504	–	–	–	–	–	–	1.5	2.4×10^{-7}	5.0×10^{-9}	0.75[c]	1.2×10^{-7}	2.5×10^{-9}
5601	–	–	–	–	–	–	–	–	–	0.67[c]	1.0×10^{-7}	2.2×10^{-9}
5602	–	–	–	–	–	–	–	–	–	0.5[c]	7.8×10^{-8}	1.6×10^{-9}
5605	–	–	–	–	–	–	–	–	–	0.93[c]	1.4×10^{-7}	3.0×10^{-9}
5612	–	–	–	–	–	–	–	–	–	0.77[c]	1.2×10^{-7}	2.5×10^{-9}
6301	–	–	–	–	–	–	2	3.1×10^{-7}	6.6×10^{-9}	95	1.5×10^{-5}	3.1×10^{-7}
6303	–	–	–	–	–	–	–	–	–	1.9[c]	3.0×10^{-7}	6.2×10^{-9}
6306	–	–	–	4.7[c]	7.4×10^{-7}	1.5×10^{-8}	–	–	–	1[c]	1.6×10^{-7}	3.4×10^{-9}
6501	–	–	–	–	–	–	31	4.8×10^{-6}	1.0×10^{-7}	3.6	5.6×10^{-7}	1.2×10^{-8}
6601	–	–	–	–	–	–	–	–	–	0.56[c]	8.8×10^{-8}	1.9×10^{-9}

TABLE 3.2 (Cont.)

Spring ID	Chloride EPC[b] (µg/L)	Chloride Intake (mg/kg-d) Ingestion	Chloride Intake (mg/kg-d) Dermal	Nitrate-N EPC[b] (µg/L)	Nitrate-N Intake (mg/kg-d) Ingestion	Nitrate-N Intake (mg/kg-d) Dermal	Sulfate EPC[b] (µg/L)	Sulfate Intake (mg/kg-d) Ingestion	Sulfate Intake (mg/kg-d) Dermal
5101	35,000	5.5×10^{-3}	1.2×10^{-4}	2,500[c]	3.9×10^{-4}	8.2×10^{-6}	48,000	7.5×10^{-3}	1.6×10^{-4}
5201	13,000	2.0×10^{-3}	4.3×10^{-5}	170[c]	2.7×10^{-5}	5.6×10^{-7}	36,000	5.6×10^{-3}	1.2×10^{-4}
5303	21,000	3.3×10^{-3}	6.9×10^{-5}	2,100[c]	3.3×10^{-4}	6.9×10^{-6}	51,000	8.0×10^{-3}	1.7×10^{-4}
5402	22,000	3.4×10^{-3}	7.2×10^{-5}	420[c]	6.5×10^{-5}	1.4×10^{-6}	23,000	3.6×10^{-3}	7.6×10^{-5}
5501	5,400	8.5×10^{-4}	1.8×10^{-5}	410[c]	6.4×10^{-5}	1.3×10^{-6}	39,000	6.1×10^{-3}	1.3×10^{-4}
5504	2,700	4.2×10^{-4}	8.9×10^{-6}	–	–	–	30,000	4.7×10^{-3}	9.9×10^{-5}
5601	2,100	3.3×10^{-4}	6.9×10^{-6}	–	–	–	18,000	2.8×10^{-3}	5.9×10^{-5}
5602	1,100	1.7×10^{-4}	3.6×10^{-6}	460[c]	7.2×10^{-5}	1.5×10^{-6}	14,000	2.2×10^{-3}	4.6×10^{-5}
5605	2,600	4.1×10^{-4}	8.5×10^{-6}	140[c]	2.2×10^{-5}	4.6×10^{-7}	21,000	3.3×10^{-3}	6.9×10^{-5}
5612	2,200	3.4×10^{-4}	7.2×10^{-6}	–	–	–	23,000	3.6×10^{-3}	7.6×10^{-5}
6301	14,000	2.2×10^{-3}	4.6×10^{-5}	18,000	2.7×10^{-3}	5.8×10^{-5}	43,000	6.7×10^{-3}	1.4×10^{-4}
6303	3,300	5.2×10^{-4}	1.1×10^{-5}	12,000[c]	1.9×10^{-3}	3.9×10^{-5}	25,000	3.9×10^{-3}	8.2×10^{-5}
6306	7,500	1.2×10^{-3}	2.5×10^{-5}	–	–	–	–	–	–
6501	2,400	3.8×10^{-4}	7.9×10^{-6}	450	7.1×10^{-5}	1.5×10^{-6}	15,000	2.3×10^{-3}	4.9×10^{-5}
6601	2,100	3.3×10^{-4}	6.9×10^{-6}	760[c]	1.2×10^{-4}	2.5×10^{-6}	14,000	2.2×10^{-3}	4.6×10^{-5}

TABLE 3.2 (Cont.)

Spring ID	1,3,5-TNB EPC[b] (µg/L)	1,3,5-TNB Intake (mg/kg-d) Ingestion	1,3,5-TNB Intake (mg/kg-d) Dermal	2,4,6-TNT EPC[b] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[b] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal
5101	–	–	–	–	–	–	–	–	
5201	6[c]	9.4×10^{-7}	2.0×10^{-8}	110[c]	1.7×10^{-5}	3.6×10^{-7}	0.076[c]	1.2×10^{-8}	2.5×10^{-10}
5303	0.41[c]	6.4×10^{-8}	1.3×10^{-9}	120[c]	1.9×10^{-5}	3.9×10^{-7}	0.21[c]	3.3×10^{-8}	6.9×10^{-10}
5402	–	–	–	–	–	–	–	–	–
5501	–	–	–	–	–	–	0.046[c]	7.2×10^{-9}	1.5×10^{-10}
5504	–	–	–	–	–	–	–	–	–
5601	–	–	–	–	–	–	0.04[c]	6.3×10^{-9}	1.3×10^{-10}
5602	0.25[c]	3.9×10^{-8}	8.2×10^{-10}	1[c]	1.6×10^{-7}	3.3×10^{-9}	0.13[c]	2.0×10^{-8}	4.3×10^{-10}
5605	0.096[c]	1.5×10^{-8}	3.2×10^{-10}	4.8[c]	7.5×10^{-7}	1.6×10^{-8}	0.15[c]	2.3×10^{-8}	4.9×10^{-10}
5612	–	–	–	0.073[c]	1.1×10^{-8}	2.4×10^{-10}	–	–	–
6301	0.024	3.7×10^{-9}	7.7×10^{-11}	0.25	3.9×10^{-8}	8.2×10^{-10}	0.065	1.0×10^{-8}	2.1×10^{-10}
6303	0.09[c]	1.4×10^{-8}	3.0×10^{-10}	1.5[c]	2.3×10^{-7}	4.9×10^{-9}	0.15[c]	2.3×10^{-8}	4.9×10^{-10}
6306	–	–	–	–	–	–	–	–	–
6501	–	–	–	–	–	–	–	–	–
6601	–	–	–	0.02[c]	3.1×10^{-9}	6.6×10^{-11}	–	–	–

TABLE 3.2 (Cont.)

Spring ID	2,6-DNT EPC[b] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	2-Amino-4,6-DNT EPC[b] (µg/L)	2-Amino-4,6-DNT Intake (mg/kg-d) Ingestion	2-Amino-4,6-DNT Intake (mg/kg-d) Dermal	4-Amino-2,6-DNT EPC[b] (µg/L)	4-Amino-2,6-DNT Intake (mg/kg-d) Ingestion	4-Amino-2,6-DNT Intake (mg/kg-d) Dermal
5101	–	–	–	–	–	–	–	–	–
5201	1.8[c]	2.8×10^{-7}	5.9×10^{-9}	19[c]	3.0×10^{-6}	6.2×10^{-8}	20[c]	3.1×10^{-6}	6.6×10^{-8}
5303	0.41[c]	6.4×10^{-8}	1.3×10^{-9}	9.2[c]	1.4×10^{-6}	3.0×10^{-8}	15[c]	2.3×10^{-6}	4.9×10^{-8}
5402	–	–	–	–	–	–	–	–	–
5501	0.075[c]	1.2×10^{-8}	2.5×10^{-10}	0.22[c]	3.4×10^{-8}	7.2×10^{-10}	0.37[c]	5.8×10^{-8}	1.2×10^{-9}
5504	–	–	–	–	–	–	–	–	–
5601	0.051[c]	8.0×10^{-9}	1.7×10^{-10}	0.22[c]	3.4×10^{-8}	7.2×10^{-10}	0.37[c]	5.8×10^{-8}	1.2×10^{-9}
5602	2[c]	3.1×10^{-7}	6.6×10^{-9}	0.83[c]	1.3×10^{-7}	2.7×10^{-9}	1.3[c]	2.0×10^{-7}	4.3×10^{-9}
5605	0.27[c]	4.2×10^{-8}	8.9×10^{-10}	1.6[c]	2.5×10^{-7}	5.3×10^{-9}	2.8[c]	4.4×10^{-7}	9.2×10^{-9}
5612	–	–	–	0.46[c]	7.2×10^{-8}	1.5×10^{-9}	0.58[c]	9.1×10^{-8}	1.9×10^{-9}
6301	0.22	3.5×10^{-8}	7.4×10^{-10}	0.71	1.1×10^{-7}	2.3×10^{-9}	1.3	2.1×10^{-7}	4.4×10^{-9}
6303	0.4[c]	6.3×10^{-8}	1.3×10^{-9}	1.2[c]	1.9×10^{-7}	3.9×10^{-9}	2.1[c]	3.3×10^{-7}	6.9×10^{-9}
6306	–	–	–	–	–	–	–	–	–
6501	–	–	–	0.018[c]	2.8×10^{-9}	5.9×10^{-11}	0.036[c]	5.6×10^{-9}	1.2×10^{-10}
6601	0.048[c]	7.5×10^{-9}	1.6×10^{-10}	0.39[c]	6.1×10^{-8}	1.3×10^{-9}	0.59[c]	9.2×10^{-8}	1.9×10^{-9}

[a] Cadmium, 1,3-DNB, nitrobenzene, and nitrotoluenes were not detected in the 1995 joint DOE/DA sampling rounds.

[b] EPC = exposure point concentrations represented by the 95% UCL or the maximum concentration (indicated by footnote c).

[c] Value is the maximum concentration.

[d] A hyphen (–) indicates that the parameter was not detected.

TABLE 3.3 Estimated Carcinogenic Intakes of COPCs for the Current and Future Recreational Visitor

Spring ID	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4,-DNT EPC[a] (µg/L)	2,4,-DNT Intake (mg/kg-d) Ingestion	2,4,-DNT Intake (mg/kg-d) Dermal	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal
5101	–[b]	–	–	–	–	–	–	–	–
5102	–	–	–	–	–	–	–	–	–
5201	110[c]	7.4×10^{-6}	1.5×10^{-7}	0.076	5.1×10^{-9}	1.1×10^{-10}	1.8	1.2×10^{-7}	2.5×10^{-9}
5303	120	8.1×10^{-6}	1.7×10^{-7}	0.21	1.4×10^{-8}	3.0×10^{-10}	0.41	2.8×10^{-8}	5.8×10^{-10}
5402	–	–	–	–	–	–	–	–	–
5501	–	–	–	0.046	3.1×10^{-9}	6.5×10^{-11}	0.075	5.0×10^{-9}	1.1×10^{-10}
5504	–	–	–	–	–	–	–	–	–
5601	–	–	–	0.04	2.7×10^{-9}	5.6×10^{-11}	0.051	3.4×10^{-9}	7.2×10^{-11}
5602	1	6.7×10^{-8}	1.4×10^{-9}	0.13	8.7×10^{-9}	1.8×10^{-10}	2	1.3×10^{-7}	2.8×10^{-9}
5605	4.8	3.2×10^{-7}	6.8×10^{-9}	0.15	1.0×10^{-8}	2.1×10^{-10}	0.27	1.8×10^{-8}	3.8×10^{-10}
5612	0.073	4.9×10^{-9}	1.0×10^{-10}	–	–	–	–	–	–
6301	0.25	1.7×10^{-8}	3.5×10^{-10}	0.065	4.3×10^{-9}	9.1×10^{-11}	0.22	1.5×10^{-8}	3.2×10^{-10}
6303	1.5	1.0×10^{-7}	2.1×10^{-9}	0.15	1.0×10^{-8}	2.1×10^{-10}	0.4	2.7×10^{-8}	5.6×10^{-10}
6306	–	–	–	–	–	–	–	–	–
6501	–	–	–	–	–	–	–	–	–
6601	0.02	1.3×10^{-9}	2.8×10^{-11}	–	–	–	0.048	3.2×10^{-9}	6.8×10^{-11}

[a] EPC = exposure point concentrations represented by the 95% UCL or the maximum concentration (indicated by footnote c).

[b] A hyphen (–) indicates that the parameter was not detected.

[c] Value is the maximum concentration.

TABLE 3.4 Estimated Intakes of Uranium for the Current and Future Recreational Visitor

	Uranium		
		Intake (pCi)	
Spring ID	EPC [a] (pCi/L)	Ingestion	Dermal
5101	0.38	9.1×10^{1}	9.6×10^{-1}
5201	0.87	2.1×10^{2}	2.2
5303	120	2.9×10^{4}	3.0×10^{2}
5402	0.95	2.3×10^{2}	2.4
5501	0.74	1.8×10^{2}	1.9
5504	0.50	1.2×10^{2}	1.3
5601	0.45	1.1×10^{2}	1.1
5602	0.33	7.9×10^{1}	8.3×10^{-1}
5605	0.62	1.5×10^{2}	1.6
5612	0.52	1.2×10^{2}	1.3
6301	91	2.2×10^{4}	2.3×10^{2}
6303	1.3	3.1×10^{2}	3.3
6306	0.69	1.7×10^{2}	1.7
6501	2.8	6.7×10^{2}	7.1
6601	0.38	9.1×10^{1}	9.6×10^{-1}

[a] EPC = exposure point concentration, which is the maximum uranium value for each spring from the 1995 joint DOE/DA sampling rounds.

TABLE 3.5 Estimated Noncarcinogenic Intakes of Metal COPCs for the Hypothetical Future Resident

Well ID	Lithium EPC[a] (µg/L)	Lithium Intake (mg/kg-d) Ingestion	Lithium Intake (mg/kg-d) Dermal	Molybdenum EPC[a] (µg/L)	Molybdenum Intake (mg/kg-d) Ingestion	Molybdenum Intake (mg/kg-d) Dermal	Uranium, Total EPC[a] (µg/L)	Uranium, Total Intake (mg/kg-d) Ingestion	Uranium, Total Intake (mg/kg-d) Dermal
Deep Wells									
MWD-05	20	5.4×10^{-4}	8.7×10^{-7}	1.3	3.6×10^{-5}	5.7×10^{-8}	0.86	2.4×10^{-5}	3.8×10^{-8}
MWD-18	6.7	1.8×10^{-4}	2.9×10^{-7}	–[b]	–	–	1.2	3.2×10^{-5}	5.1×10^{-8}
MWGS-01	–	–	–	–	–	–	–	–	–
MWGS-02	–	–	–	–	–	–	–	–	–
MWS-18	9.4	2.6×10^{-4}	4.1×10^{-7}	7.6	2.1×10^{-4}	3.3×10^{-7}	2.3	6.3×10^{-5}	1.0×10^{-7}
MWS-101	1.1	3.0×10^{-5}	4.8×10^{-8}	–	–	–	0.80	2.2×10^{-5}	3.5×10^{-8}
MWS-102	7.4	2.0×10^{-4}	3.2×10^{-7}	6.7	1.8×10^{-4}	2.9×10^{-7}	3.9	1.1×10^{-4}	1.7×10^{-7}
MWS-103	4.2	1.2×10^{-4}	1.8×10^{-7}	–	–	–	1.1	3.1×10^{-5}	5.0×10^{-8}
TIL-3	3.7	1.0×10^{-4}	1.6×10^{-7}	2.5	6.8×10^{-5}	1.1×10^{-7}	0.16	4.4×10^{-6}	7.0×10^{-9}
Overburden									
MW-2031	–	–	–	–	–	–	–	–	–
MW-2032	14	3.8×10^{-4}	6.1×10^{-7}	1.8	4.9×10^{-5}	7.9×10^{-8}	6.3	1.7×10^{-4}	2.7×10^{-7}
MW-2033	3.7	1.0×10^{-4}	1.6×10^{-7}	–	–	–	3.5	9.6×10^{-5}	1.5×10^{-7}
MW-3001	–	–	–	–	–	–	–	–	–
MW-3013	–	–	–	–	–	–	–	–	–
MW-3018	–	–	–	–	–	–	–	–	–
MW-3022	–	–	–	–	–	–	–	–	–
USGS-2A	–	–	–	–	–	–	–	–	–
MWV-01	2.3	6.3×10^{-5}	1.0×10^{-7}	–	–	–	6.2	1.7×10^{-4}	2.7×10^{-7}
MWV-02	3.0	8.2×10^{-5}	1.3×10^{-7}	1.6	4.4×10^{-5}	7.0×10^{-8}	4.5	1.2×10^{-4}	2.0×10^{-7}
MWV-09	7.0	1.9×10^{-4}	3.1×10^{-7}	–	–	–	1.1	3.0×10^{-5}	4.7×10^{-8}
MWV-13	3.2	8.8×10^{-5}	1.4×10^{-7}	–	–	–	2.2	5.9×10^{-5}	9.5×10^{-8}
MWV-16	1.2	3.3×10^{-5}	5.3×10^{-8}	1.1	3.0×10^{-5}	4.8×10^{-8}	1.7	4.7×10^{-5}	7.6×10^{-8}
MWV-17	0.26	7.2×10^{-6}	1.2×10^{-8}	–	–	–	0.091	2.5×10^{-6}	4.0×10^{-9}
MWV-18	–	–	–	–	–	–	–	–	–
MWV-22	2.3	6.3×10^{-5}	1.0×10^{-7}	0.49	1.3×10^{-5}	2.1×10^{-8}	1.3	3.6×10^{-5}	5.8×10^{-8}
MWV-24R	8.2	2.2×10^{-4}	3.6×10^{-7}	1.1	3.0×10^{-5}	4.8×10^{-8}	2.3	6.2×10^{-5}	9.9×10^{-8}

TABLE 3.5 (Cont.)

Well ID	Lithium EPC[a] (µg/L)	Lithium Intake (mg/kg-d) Ingestion	Lithium Intake (mg/kg-d) Dermal	Molybdenum EPC[a] (µg/L)	Molybdenum Intake (mg/kg-d) Ingestion	Molybdenum Intake (mg/kg-d) Dermal	Uranium, Total EPC[a] (µg/L)	Uranium, Total Intake (mg/kg-d) Ingestion	Uranium, Total Intake (mg/kg-d) Dermal
Unweathered									
MW-2019	21	5.8×10^{-4}	9.2×10^{-7}	27	7.4×10^{-4}	1.2×10^{-6}	4.5	1.2×10^{-4}	2.0×10^{-7}
MW-2021	3.8	1.0×10^{-4}	1.7×10^{-7}	7.6	2.1×10^{-4}	3.3×10^{-7}	1.3	3.6×10^{-5}	5.7×10^{-8}
MW-2022	3.7	1.0×10^{-4}	1.6×10^{-7}	2.3	6.3×10^{-5}	1.0×10^{-7}	1.9	5.1×10^{-5}	8.2×10^{-8}
MW-2023	3.6	9.9×10^{-5}	1.6×10^{-7}	6.6	1.8×10^{-4}	2.9×10^{-7}	3.8	1.0×10^{-4}	1.7×10^{-7}
MW-2024	5.3	1.5×10^{-4}	2.3×10^{-7}	2.0	5.5×10^{-5}	8.8×10^{-8}	0.17	4.6×10^{-6}	7.3×10^{-9}
MW-2025	–	–	–	–	–	–	–	–	–
MW-2026	29	7.9×10^{-5}	1.3×10^{-7}	8.2	2.2×10^{-4}	3.6×10^{-7}	1.2	3.3×10^{-5}	5.3×10^{-8}
MW-2027	4.1	1.1×10^{-4}	1.8×10^{-7}	3.2	8.8×10^{-5}	1.4×10^{-7}	1.2	3.3×10^{-5}	5.3×10^{-8}
MW-2028	1.9	5.3×10^{-4}	8.5×10^{-7}	4.7	1.3×10^{-4}	2.1×10^{-7}	1.9	5.2×10^{-5}	8.3×10^{-8}
MW-2029	–	–	–	–	–	–	–	–	–
MW-3002	–	–	–	–	–	–	–	–	–
MW-3006	13	3.4×10^{-4}	5.5×10^{-7}	15	4.0×10^{-4}	6.4×10^{-7}	1.0	2.9×10^{-5}	4.6×10^{-8}
MW-3024	200	5.5×10^{-3}	8.9×10^{-6}	–	–	–	4.6	1.2×10^{-4}	2.0×10^{-7}
MW-3026	35	9.6×10^{-4}	1.5×10^{-6}	2.1	5.8×10^{-5}	9.2×10^{-8}	6.3	1.7×10^{-4}	2.8×10^{-7}
MW-4004	4.0	1.1×10^{-4}	1.8×10^{-7}	4.7	1.3×10^{-4}	2.1×10^{-7}	3.2	8.8×10^{-5}	1.4×10^{-7}
MW-4007	6.0	1.6×10^{-4}	2.6×10^{-7}	5.8	1.6×10^{-4}	2.5×10^{-7}	2.6	7.2×10^{-5}	1.2×10^{-7}
MW-4008	2.6	7.1×10^{-5}	1.1×10^{-7}	–	–	–	1.2	3.4×10^{-5}	5.4×10^{-8}
MW-4009	90	2.5×10^{-3}	3.9×10^{-6}	8.3	2.3×10^{-4}	3.6×10^{-7}	2.6	7.0×10^{-5}	1.1×10^{-7}
MW-4011	65	1.8×10^{-3}	2.8×10^{-6}	3.2	8.8×10^{-5}	1.4×10^{-7}	4.7	1.3×10^{-4}	2.0×10^{-7}
MW-4012	84	2.3×10^{-3}	3.7×10^{-6}	37	1.0×10^{-3}	1.6×10^{-6}	7.5	2.0×10^{-4}	3.3×10^{-7}
MW-4022	34	9.3×10^{-4}	1.5×10^{-6}	6.6	1.8×10^{-4}	2.9×10^{-7}	7.7	2.1×10^{-4}	3.4×10^{-7}
MWD-02	30	8.3×10^{-4}	1.3×10^{-6}	8.0	2.2×10^{-4}	3.5×10^{-7}	3.8	1.0×10^{-4}	1.7×10^{-7}
MWD-06	4.1	1.1×10^{-4}	1.8×10^{-7}	–	–	–	0.86	2.4×10^{-5}	3.8×10^{-8}
MWD-09	5.4	1.5×10^{-4}	2.4×10^{-7}	–	–	–	1.4	3.8×10^{-5}	6.1×10^{-8}
MWD-23	4.3	1.2×10^{-4}	1.9×10^{-7}	24	6.6×10^{-4}	1.1×10^{-6}	7.4	2.0×10^{-4}	3.2×10^{-7}
MWD-106	3.6	9.9×10^{-5}	1.6×10^{-7}	–	–	–	–	–	–
MWS-05	3.0	8.2×10^{-5}	1.3×10^{-7}	–	–	–	1.5	4.1×10^{-5}	6.5×10^{-8}
MWS-06	4.3	1.2×10^{-4}	1.9×10^{-7}	–	–	–	4.3	1.2×10^{-4}	1.9×10^{-7}
MWS-105	2.0	5.5×10^{-5}	8.8×10^{-8}	4.4	1.2×10^{-4}	1.9×10^{-7}	0.25	6.7×10^{-6}	1.1×10^{-8}

TABLE 3.5 (Cont.)

Well ID	Lithium EPC[a] (µg/L)	Lithium Intake (mg/kg-d) Ingestion	Lithium Intake (mg/kg-d) Dermal	Molybdenum EPC[a] (µg/L)	Molybdenum Intake (mg/kg-d) Ingestion	Molybdenum Intake (mg/kg-d) Dermal	Uranium, Total EPC[a] (µg/L)	Uranium, Total Intake (mg/kg-d) Ingestion	Uranium, Total Intake (mg/kg-d) Dermal
Unweathered (cont.)									
MWS-106	2.3	6.3×10^{-5}	1.0×10^{-7}	2.3	6.3×10^{-5}	1.0×10^{-7}	1.7	4.7×10^{-5}	7.6×10^{-8}
MWS-109	2.2	6.0×10^{-5}	9.6×10^{-8}	1.9	5.2×10^{-5}	8.3×10^{-8}	1.5	4.1×10^{-5}	6.6×10^{-8}
TH-4	–	–	–	–	–	–	–	–	–
USGS-1	3.8	1.0×10^{-4}	1.7×10^{-7}	–	–	–	1.6	4.3×10^{-5}	6.9×10^{-8}
USGS-6	1.8	4.9×10^{-5}	7.9×10^{-8}	3.2	8.8×10^{-5}	1.4×10^{-7}	5.9	1.6×10^{-4}	2.6×10^{-7}
Weathered									
MW-2001	2.6	7.1×10^{-5}	1.1×10^{-7}	–	–	–	0.97	2.6×10^{-5}	4.2×10^{-8}
MW-2002	270	7.4×10^{-3}	1.2×10^{-5}	11	3.0×10^{-4}	4.8×10^{-7}	0.71	1.9×10^{-5}	3.1×10^{-8}
MW-2003	430	1.2×10^{-2}	1.9×10^{-5}	2.2	6.0×10^{-5}	9.6×10^{-8}	1.6	4.3×10^{-5}	6.9×10^{-8}
MW-2004	–	–	–	–	–	–	–	–	–
MW-2005	98	2.7×10^{-3}	4.3×10^{-6}	1.4	3.8×10^{-5}	6.1×10^{-8}	0.67	1.8×10^{-5}	3.0×10^{-8}
MW-2006	16	4.3×10^{-4}	6.9×10^{-7}	2.4	6.6×10^{-5}	1.1×10^{-7}	0.72	2.0×10^{-5}	3.2×10^{-8}
MW-2007	4.0	1.1×10^{-4}	1.8×10^{-7}	4.2	1.2×10^{-4}	1.8×10^{-7}	1.5	4.1×10^{-5}	6.6×10^{-8}
MW-2008	–	–	–	–	–	–	–	–	–
MW-2009	–	–	–	–	–	–	–	–	–
MW-2010	17	4.7×10^{-4}	7.5×10^{-7}	11	2.9×10^{-4}	4.6×10^{-7}	1.8	4.9×10^{-5}	7.9×10^{-8}
MW-2011	6.4	1.8×10^{-4}	2.8×10^{-7}	–	–	–	0.44	1.2×10^{-5}	1.9×10^{-8}
MW-2012	1.8	4.9×10^{-5}	7.9×10^{-8}	–	–	–	0.50	1.4×10^{-5}	2.2×10^{-8}
MW-2013	6.1	1.7×10^{-4}	2.7×10^{-7}	–	–	–	0.98	2.7×10^{-5}	4.3×10^{-8}
MW-2014	20	5.5×10^{-4}	8.9×10^{-7}	–	–	–	0.72	2.0×10^{-5}	3.2×10^{-8}
MW-2015	15	4.2×10^{-4}	6.7×10^{-7}	–	–	–	2.9	7.9×10^{-5}	1.3×10^{-7}
MW-2016	–	–	–	–	–	–	–	–	–
MW-2017	110	3.0×10^{-3}	4.7×10^{-6}	16	4.3×10^{-4}	6.8×10^{-7}	18	4.9×10^{-4}	7.9×10^{-7}
MW-2018	20	5.5×10^{-4}	8.8×10^{-7}	4.5	1.2×10^{-4}	2.0×10^{-7}	2.3	6.3×10^{-5}	1.0×10^{-7}
MW-2020	–	–	–	–	–	–	–	–	–
MW-2030	6.4	1.8×10^{-4}	2.8×10^{-7}	–	–	–	19	5.2×10^{-4}	8.2×10^{-7}
MW-2034	32	8.9×10^{-4}	1.4×10^{-6}	–	–	–	4.5	1.2×10^{-4}	2.0×10^{-7}
MW-2035	2.7	7.4×10^{-5}	1.2×10^{-7}	3.4	9.3×10^{-5}	1.5×10^{-7}	0.60	1.6×10^{-5}	2.6×10^{-8}
MW-2036	6.8	1.9×10^{-4}	3.0×10^{-7}	–	–	–	1.1	3.1×10^{-5}	5.0×10^{-8}

TABLE 3.5 (Cont.)

Well ID	Lithium EPC[a] (µg/L)	Lithium Intake (mg/kg-d) Ingestion	Lithium Intake (mg/kg-d) Dermal	Molybdenum EPC[a] (µg/L)	Molybdenum Intake (mg/kg-d) Ingestion	Molybdenum Intake (mg/kg-d) Dermal	Uranium, Total EPC[a] (µg/L)	Uranium, Total Intake (mg/kg-d) Ingestion	Uranium, Total Intake (mg/kg-d) Dermal
Weathered (cont.)									
MW-2037	410	1.1×10^{-2}	1.8×10^{-5}	–	–	–	1.9	5.1×10^{-5}	8.1×10^{-8}
MW-2038	520	1.4×10^{-2}	2.3×10^{-5}	1.4	3.8×10^{-5}	6.1×10^{-8}	2.2	5.9×10^{-5}	9.5×10^{-8}
MW-2039	22	6.1×10^{-4}	9.7×10^{-7}	4.4	1.2×10^{-4}	1.9×10^{-7}	4.6	1.3×10^{-4}	2.0×10^{-7}
MW-2040	33	9.0×10^{-4}	1.4×10^{-6}	6.6	1.8×10^{-4}	2.9×10^{-7}	4.5	1.2×10^{-4}	2.0×10^{-7}
MW-2041	26	7.0×10^{-4}	1.1×10^{-6}	2.2	6.0×10^{-5}	9.6×10^{-8}	5.0	1.4×10^{-4}	2.2×10^{-7}
MW-2042	20	5.6×10^{-4}	8.9×10^{-7}	–	–	–	3.9	1.1×10^{-4}	1.7×10^{-7}
MW-2043	17	4.7×10^{-4}	7.5×10^{-7}	1.5	4.1×10^{-5}	6.6×10^{-8}	2.7	7.3×10^{-5}	1.2×10^{-7}
MW-2044	29	7.9×10^{-4}	1.3×10^{-6}	1.8	4.9×10^{-5}	7.9×10^{-8}	3.4	9.2×10^{-5}	1.5×10^{-7}
MW-3003	650	1.8×10^{-2}	2.8×10^{-5}	5.7	1.6×10^{-4}	2.5×10^{-7}	28	7.6×10^{-4}	1.2×10^{-6}
MW-3007	–	–	–	–	–	–	–	–	–
MW-3008	–	–	–	–	–	–	–	–	–
MW-3009	–	–	–	–	–	–	–	–	–
MW-3010	–	–	–	–	–	–	–	–	–
MW-3019	15	4.0×10^{-4}	6.4×10^{-7}	1.0	2.7×10^{-5}	4.4×10^{-8}	3.2	8.7×10^{-5}	1.4×10^{-7}
MW-3023	640	1.8×10^{-2}	2.8×10^{-5}	250	6.9×10^{-3}	1.1×10^{-5}	19	5.2×10^{-4}	8.4×10^{-7}
MW-3025	160	4.4×10^{-3}	7.0×10^{-6}	–	–	–	4.1	1.1×10^{-4}	1.8×10^{-7}
MW-3027	18	4.9×10^{-4}	7.9×10^{-7}	–	–	–	1.9	5.2×10^{-5}	8.2×10^{-8}
MW-4001	7.7	2.1×10^{-4}	3.4×10^{-7}	1.8	4.9×10^{-5}	7.9×10^{-8}	0.61	1.7×10^{-5}	2.7×10^{-8}
MW-4002	3.9	1.1×10^{-4}	1.7×10^{-7}	1.1	3.0×10^{-5}	4.8×10^{-8}	0.89	2.4×10^{-5}	3.9×10^{-8}
MW-4003	3.0	8.2×10^{-5}	1.3×10^{-7}	–	–	–	1.7	4.7×10^{-5}	7.5×10^{-8}
MW-4005	6.7	1.8×10^{-4}	2.9×10^{-7}	5.0	1.4×10^{-4}	2.2×10^{-7}	2.4	6.5×10^{-5}	1.0×10^{-7}
MW-4006	3.0	8.2×10^{-5}	1.3×10^{-7}	1.1	3.0×10^{-5}	4.8×10^{-8}	0.39	1.1×10^{-5}	1.7×10^{-8}
MW-4010	5.8	1.6×10^{-4}	2.5×10^{-7}	3.7	1.0×10^{-4}	1.6×10^{-7}	4.6	1.3×10^{-4}	2.0×10^{-7}
MW-4013	68	1.9×10^{-3}	3.0×10^{-6}	–	–	–	1.8	4.8×10^{-5}	7.7×10^{-8}
MW-4014	3.5	9.6×10^{-5}	1.5×10^{-7}	–	–	–	0.33	9.1×10^{-6}	1.5×10^{-8}
MW-4015	1.9	5.2×10^{-5}	8.3×10^{-8}	0.25	6.8×10^{-6}	1.1×10^{-8}	0.48	1.3×10^{-5}	2.1×10^{-8}
MW-4016	3.7	1.0×10^{-4}	1.6×10^{-7}	9.6	2.6×10^{-4}	4.2×10^{-7}	4.7	1.3×10^{-4}	2.1×10^{-7}
MW-4017	–	–	–	–	–	–	–	–	–
MW-4018	4.1	1.1×10^{-4}	1.8×10^{-7}	–	–	–	0.95	2.6×10^{-5}	4.2×10^{-8}
MW-4019	10	2.7×10^{-4}	4.4×10^{-7}	–	–	–	2.6	7.0×10^{-5}	1.1×10^{-7}

TABLE 3.5 (Cont.)

Well ID	Lithium EPC[a] (µg/L)	Lithium Intake (mg/kg-d) Ingestion	Lithium Intake (mg/kg-d) Dermal	Molybdenum EPC[a] (µg/L)	Molybdenum Intake (mg/kg-d) Ingestion	Molybdenum Intake (mg/kg-d) Dermal	Uranium, Total EPC[a] (µg/L)	Uranium, Total Intake (mg/kg-d) Ingestion	Uranium, Total Intake (mg/kg-d) Dermal
Weathered (cont.)									
MW-4020	22	6.1×10^{-4}	9.8×10^{-7}	1.3	3.6×10^{-5}	5.7×10^{-8}	15	4.0×10^{-4}	6.4×10^{-7}
MW-4021	23	6.2×10^{-4}	9.9×10^{-7}	–	–	–	4.6	1.3×10^{-4}	2.0×10^{-7}
MW-4023	14	3.9×10^{-4}	6.3×10^{-7}	–	–	–	2.3	6.4×10^{-5}	1.0×10^{-7}
MW-4024	82	2.2×10^{-3}	3.6×10^{-6}	11	3.0×10^{-4}	4.9×10^{-7}	90	2.5×10^{-3}	3.9×10^{-6}
MW-4025	12	3.2×10^{-4}	5.1×10^{-7}	4.2	1.2×10^{-4}	1.8×10^{-7}	1.5	4.2×10^{-5}	6.7×10^{-8}
MWD-15	1.2	3.3×10^{-5}	5.3×10^{-8}	–	–	–	0.74	2.0×10^{-5}	3.2×10^{-8}
MWD-25	2.4	6.6×10^{-5}	1.1×10^{-7}	1.9	5.2×10^{-5}	8.3×10^{-8}	2.6	7.2×10^{-5}	1.2×10^{-7}
MWD-107	5.4	1.5×10^{-4}	2.4×10^{-7}	4.6	1.3×10^{-4}	2.0×10^{-7}	3.0	8.3×10^{-5}	1.3×10^{-7}
MWD-112	2.7	7.4×10^{-5}	1.2×10^{-7}	2.2	6.0×10^{-5}	9.6×10^{-8}	1.2	3.2×10^{-5}	5.1×10^{-8}
MWS-01	1.9	5.2×10^{-5}	8.3×10^{-8}	–	–	–	1.9	5.3×10^{-5}	8.5×10^{-8}
MWS-02	3.6	9.9×10^{-5}	1.6×10^{-7}	4.2	1.2×10^{-4}	1.8×10^{-7}	3.0	8.3×10^{-5}	1.3×10^{-7}
MWS-03	5.1	1.4×10^{-4}	2.2×10^{-7}	3.4	9.3×10^{-5}	1.5×10^{-7}	4.9	1.3×10^{-4}	2.1×10^{-7}
MWS-04	4.0	1.1×10^{-4}	1.8×10^{-7}	–	–	–	15	4.2×10^{-4}	6.7×10^{-7}
MWS-07	–	–	–	–	–	–	1.1	3.0×10^{-5}	4.7×10^{-8}
MWS-08	23	6.2×10^{-4}	9.9×10^{-7}	–	–	–	1.7	4.6×10^{-5}	7.3×10^{-8}
MWS-09	6.6	1.8×10^{-4}	2.9×10^{-7}	–	–	–	1.8	4.9×10^{-5}	7.8×10^{-8}
MWS-10	4.5	1.2×10^{-4}	2.0×10^{-7}	1.7	4.7×10^{-5}	7.5×10^{-8}	0.20	5.4×10^{-6}	8.7×10^{-9}
MWS-11	2.4	6.6×10^{-5}	1.1×10^{-7}	–	–	–	2.6	7.0×10^{-5}	1.1×10^{-7}
MWS-12	3.1	8.5×10^{-5}	1.4×10^{-7}	–	–	–	1.5	4.1×10^{-5}	6.5×10^{-8}
MWS-13	6.8	1.9×10^{-4}	3.0×10^{-7}	0.54	1.5×10^{-5}	2.3×10^{-8}	0.80	2.2×10^{-5}	3.5×10^{-8}
MWS-14	25	6.7×10^{-4}	1.1×10^{-6}	1.6	4.4×10^{-5}	7.0×10^{-8}	4.0	1.1×10^{-4}	1.8×10^{-7}
MWS-15	1.3	3.6×10^{-5}	5.7×10^{-8}	–	–	–	0.84	2.3×10^{-5}	3.7×10^{-8}
MWS-16	–	–	–	–	–	–	0.98	2.7×10^{-5}	4.3×10^{-8}
MWS-17	2.6	7.1×10^{-5}	1.1×10^{-7}	–	–	–	1.7	4.8×10^{-5}	7.7×10^{-8}
MWS-19	1.2	3.3×10^{-5}	5.3×10^{-8}	1.0	2.7×10^{-5}	4.4×10^{-8}	1.9	5.3×10^{-5}	8.4×10^{-8}
MWS-20	1.5	4.0×10^{-5}	6.4×10^{-8}	–	–	–	1.0	2.8×10^{-5}	4.5×10^{-8}
MWS-21	0.36	9.8×10^{-3}	1.6×10^{-5}	4.9	1.3×10^{-4}	2.1×10^{-7}	4.5	1.2×10^{-4}	2.0×10^{-7}
MWS-22	3.0	8.2×10^{-5}	1.3×10^{-7}	0.13	3.5×10^{-6}	5.6×10^{-9}	1.8	4.9×10^{-5}	7.8×10^{-8}
MWS-24	–	–	–	–	–	–	–	–	–
MWS-25	–	–	–	1.7	4.7×10^{-5}	7.5×10^{-8}	2.4	6.5×10^{-5}	1.0×10^{-7}

TABLE 3.5 (Cont.)

Well ID	Lithium EPC[a] (µg/L)	Lithium Intake (mg/kg-d) Ingestion	Lithium Intake (mg/kg-d) Dermal	Molybdenum EPC[a] (µg/L)	Molybdenum Intake (mg/kg-d) Ingestion	Molybdenum Intake (mg/kg-d) Dermal	Uranium, Total EPC[a] (µg/L)	Uranium, Total Intake (mg/kg-d) Ingestion	Uranium, Total Intake (mg/kg-d) Dermal
Weathered (cont.)									
MWS-26	15	4.1×10^{-4}	6.6×10^{-7}	2.0	5.5×10^{-5}	8.8×10^{-8}	5.9	1.6×10^{-4}	2.6×10^{-7}
MWS-104	1.7	4.7×10^{-5}	7.5×10^{-8}	4.4	1.2×10^{-4}	1.9×10^{-7}	1.9	5.3×10^{-5}	8.5×10^{-8}
MWS-107	5.0	1.4×10^{-4}	2.2×10^{-7}	1.0	2.7×10^{-5}	4.4×10^{-8}	2.7	7.4×10^{-5}	1.2×10^{-7}
MWS-110	3.3	9.0×10^{-5}	1.4×10^{-7}	–	–	–	0.93	2.6×10^{-5}	4.1×10^{-8}
MWS-112	17	4.7×10^{-4}	7.5×10^{-7}	36	9.7×10^{-4}	1.6×10^{-6}	4.1	1.1×10^{-4}	1.8×10^{-7}
USGS-2	–	–	–	1.8	4.9×10^{-5}	7.9×10^{-8}	0.51	1.4×10^{-5}	6.5×10^{-11}
USGS-3	4.8	1.3×10^{-4}	2.1×10^{-7}	1.6	4.4×10^{-5}	7.0×10^{-8}	2.1	5.8×10^{-5}	9.3×10^{-8}
USGS-4	3.9	1.1×10^{-4}	1.7×10^{-7}	1.2	3.3×10^{-5}	5.3×10^{-8}	0.80	2.2×10^{-5}	3.5×10^{-8}
USGS-5	3.5	9.6×10^{-5}	1.5×10^{-7}	5.4	1.5×10^{-4}	2.4×10^{-7}	7.3	2.0×10^{-4}	3.2×10^{-7}
USGS-7	–	–	–	–	–	–	–	–	–
USGS-8	10	2.8×10^{-4}	4.5×10^{-7}	1.6	4.4×10^{-5}	7.0×10^{-8}	0.93	2.6×10^{-5}	4.1×10^{-8}
USGS-9	3.0	8.2×10^{-5}	1.3×10^{-7}	–	–	–	0.51	1.4×10^{-5}	2.3×10^{-8}

[a] EPC = exposure point concentration, which is the maximum uranium value for each spring from the 1995 joint DOE/DA sampling rounds.

[b] A hyphen (–) indicates the parameter was not detected.

TABLE 3.6 Estimated Noncarcinogenic Intakes of Inorganic Anion COPCs for the Hypothetical Future Resident

Well ID	Chloride EPC[a] (mg/L)	Chloride Intake (mg/kg-d) Ingestion	Chloride Intake (mg/kg-d) Dermal	Nitrate-N EPC[a] (mg/L)	Nitrate-N Intake (mg/kg-d) Ingestion[b]	Nitrate-N Intake (mg/kg-d) Dermal	Sulfate EPC[a] (mg/L)	Sulfate Intake (mg/kg-d) Ingestion	Sulfate Intake (mg/kg-d) Dermal
Deep Wells									
MWD-05	1.9	5.2×10^{-2}	8.3×10^{-5}	0.13	3.6×10^{-3}	5.7×10^{-6}	26	7.1×10^{-1}	1.1×10^{-3}
MWD-18	1.8	4.9×10^{-2}	7.9×10^{-5}	–	–	–	15	4.1×10^{-1}	6.6×10^{-4}
MWGS-01	–[c]	–	–	–	–	–	–	–	
MWGS-02	–	–	–	–	–	–	–	–	–
MWS-18	2.9	7.9×10^{-2}	1.3×10^{-4}	0.33	9.0×10^{-3}	1.4×10^{-5}	100	2.7	4.4×10^{-3}
MWS-101	9.1	2.5×10^{-1}	4.0×10^{-4}	–	–	–	8.4	2.3×10^{-1}	3.7×10^{-4}
MWS-102	4.2	1.2×10^{-1}	1.8×10^{-4}	–	–	–	15	4.1×10^{-1}	6.6×10^{-4}
MWS-103	3.2	8.8×10^{-2}	1.4×10^{-4}	–	–	–	49	1.3	2.1×10^{-3}
TIL-3	2.3	6.3×10^{-2}	1.0×10^{-4}	0.1	–	–	11	3.0×10^{-1}	4.8×10^{-4}
Overburden									
MW-2031	–	–	–	–	–	–	–	–	–
MW-2032	17	4.7×10^{-1}	7.5×10^{-4}	56	1.5	2.5×10^{-3}	54	1.5	2.4×10^{-3}
MW-2033	5.4	1.5×10^{-1}	2.4×10^{-4}	1.1	3.0×10^{-2}	4.8×10^{-5}	42	1.2	1.8×10^{-3}
MW-3001	–	–	–	–	–	–	–	–	–
MW-3013	–	–	–	–	–	–	–	–	–
MW-3018	–	–	–	–	–	–	–	–	–
MW-3022	–	–	–	–	–	–	–	–	–
USGS-2A	–	–	–	–	–	–	–	–	–
MWV-01	–	–	–	1.5	4.1×10^{-2}	6.6×10^{-5}	14	3.8×10^{-1}	6.1×10^{-4}
MWV-02	1.8	4.9×10^{-2}	7.9×10^{-5}	2.7	7.4×10^{-2}	1.2×10^{-4}	25	6.8×10^{-1}	1.1×10^{-3}
MWV-09	2.3	6.3×10^{-2}	1.0×10^{-4}	0.79	2.2×10^{-2}	3.5×10^{-5}	56	1.5	2.5×10^{-3}
MWV-13	6.6	1.8×10^{-1}	2.9×10^{-4}	1.5	4.1×10^{-2}	6.6×10^{-5}	360	9.9	1.6×10^{-2}
MWV-16	3	8.2×10^{-2}	1.3×10^{-4}	1.1	3.0×10^{-2}	4.8×10^{-5}	25	6.8×10^{-1}	1.1×10^{-3}
MWV-17	–	–	–	2.1	5.8×10^{-2}	9.2×10^{-5}	15	4.1×10^{-1}	6.6×10^{-4}
MWV-18	–	–	–	–	–	–	–	–	–
MWV-22	4	1.1×10^{-1}	1.8×10^{-4}	3.4	9.3×10^{-2}	1.5×10^{-4}	14	3.8×10^{-1}	6.1×10^{-4}
MWV-24R	1.1	3.0×10^{-2}	4.8×10^{-5}	0.35	9.6×10^{-3}	1.5×10^{-5}	31	8.5×10^{-1}	1.4×10^{-3}

TABLE 3.6 (Cont.)

Well ID	Chloride EPC[a] (mg/L)	Chloride Intake (mg/kg-d) Ingestion	Chloride Intake (mg/kg-d) Dermal	Nitrate-N EPC[a] (mg/L)	Nitrate-N Intake (mg/kg-d) Ingestion[b]	Nitrate-N Intake (mg/kg-d) Dermal	Sulfate EPC[a] (mg/L)	Sulfate Intake (mg/kg-d) Ingestion	Sulfate Intake (mg/kg-d) Dermal
Unweathered									
MW-2019	1	2.7×10^{-2}	4.4×10^{-5}	–	–	–	22	6.0×10^{-1}	9.6×10^{-4}
MW-2021	1.1	3.0×10^{-2}	4.8×10^{-5}	0.005	1.4×10^{-4}	2.2×10^{-7}	13	3.6×10^{-1}	5.7×10^{-4}
MW-2022	1.2	3.3×10^{-2}	5.3×10^{-5}	–	–	–	14	3.8×10^{-1}	6.1×10^{-4}
MW-2023	1.1	3.0×10^{-2}	4.8×10^{-5}	–	–	–	14	3.8×10^{-1}	6.1×10^{-4}
MW-2024	1.7	4.7×10^{-2}	7.5×10^{-5}	–	–	–	29	7.9×10^{-1}	1.3×10^{-3}
MW-2025	–	–	–	–	–	–	–	–	–
MW-2026	1.4	3.8×10^{-2}	6.1×10^{-5}	–	–	–	13	3.6×10^{-1}	5.7×10^{-4}
MW-2027	1.1	3.0×10^{-2}	4.8×10^{-5}	–	–	–	5.3	1.5×10^{-1}	2.3×10^{-4}
MW-2028	1.3	3.6×10^{-2}	5.7×10^{-5}	–	–	–	130	3.4	5.5×10^{-3}
MW-2029	–	–	–	–	–	–	–	–	–
MW-3002	–	–	–	–	–	–	–	–	–
MW-3006	1.2	3.3×10^{-2}	5.3×10^{-5}	–	–	–	22	6.0×10^{-1}	9.6×10^{-4}
MW-3024	12	3.3×10^{-1}	5.3×10^{-4}	370	1.0×10^{1}	1.6×10^{-2}	88	2.4	3.9×10^{-3}
MW-3026	6.3	1.7×10^{-1}	2.8×10^{-4}	220	6.0	9.6×10^{-3}	19	5.2×10^{-1}	8.3×10^{-4}
MW-4004	3.3	9.0×10^{-2}	1.4×10^{-4}	1.1	3.0×10^{-2}	4.8×10^{-5}	19	5.2×10^{-1}	8.3×10^{-4}
MW-4007	2.3	6.3×10^{-2}	1.0×10^{-4}	–	–	–	62	1.7	2.7×10^{-3}
MW-4008	–	–	–	–	–	–	14	3.8×10^{-1}	6.1×10^{-4}
MW-4009	–	–	–	0.14	3.8×10^{-3}	6.1×10^{-6}	13	3.6×10^{-1}	5.7×10^{-4}
MW-4011	11	3.0×10^{-1}	4.8×10^{-4}	170	4.7	7.5×10^{-3}	83	2.3	3.6×10^{-3}
MW-4012	1.8	4.9×10^{-2}	7.9×10^{-5}	–	–	–	36	9.9×10^{-1}	1.6×10^{-3}
MW-4022	2.6	7.1×10^{-2}	1.1×10^{-4}	0.39	1.1×10^{-2}	1.7×10^{-5}	23	6.3×10^{-1}	1.0×10^{-3}
MWD-02	1.1	3.0×10^{-2}	4.8×10^{-5}	–	–	–	16	4.4×10^{-1}	7.0×10^{-4}
MWD-06	–	–	–	–	–	–	20	5.5×10^{-1}	8.8×10^{-4}
MWD-09	1.2	3.3×10^{-2}	5.3×10^{-5}	0.8	2.2×10^{-2}	3.5×10^{-5}	12	3.3×10^{-1}	5.3×10^{-4}
MWD-23	3.1	8.5×10^{-2}	1.4×10^{-4}	–	–	–	20	5.5×10^{-1}	8.8×10^{-4}
MWD-106	1.8	4.9×10^{-2}	7.9×10^{-5}	–	–	–	16	4.4×10^{-1}	7.0×10^{-4}
MWS-05	–	–	–	–	–	–	19	5.2×10^{-1}	8.3×10^{-4}
MWS-06	1	2.7×10^{-2}	4.4×10^{-5}	–	–	–	19	5.2×10^{-1}	8.3×10^{-4}
MWS-105	1.3	3.6×10^{-2}	5.7×10^{-5}	–	–	–	11	3.0×10^{-1}	4.8×10^{-4}

TABLE 3.6 (Cont.)

Well ID	Chloride EPC[a] (mg/L)	Chloride Intake (mg/kg-d) Ingestion	Chloride Intake (mg/kg-d) Dermal	Nitrate-N EPC[a] (mg/L)	Nitrate-N Intake (mg/kg-d) Ingestion[b]	Nitrate-N Intake (mg/kg-d) Dermal	Sulfate EPC[a] (mg/L)	Sulfate Intake (mg/kg-d) Ingestion	Sulfate Intake (mg/kg-d) Dermal
Unweathered (cont.)									
MWS-106	1.6	4.4×10^{-2}	7.0×10^{-5}	–	–	–	11	3.0×10^{-1}	4.8×10^{-4}
MWS-109	1	2.7×10^{-2}	4.4×10^{-5}	–	–	–	12	3.3×10^{-1}	5.3×10^{-4}
TIL-4	–	–	–	–	–	–	–	–	–
USGS-1	3.7	1.0×10^{-1}	1.6×10^{-4}	0.79	2.2×10^{-2}	3.5×10^{-5}	15	4.1×10^{-1}	6.6×10^{-4}
USGS-6	1.8	4.9×10^{-2}	7.9×10^{-5}	0.55	1.5×10^{-2}	2.4×10^{-5}	15	4.1×10^{-1}	6.6×10^{-4}
Weathered									
MW-2001	5.9	1.6×10^{-1}	2.6×10^{-4}	49	1.3	2.1×10^{-3}	12	3.3×10^{-1}	5.3×10^{-4}
MW-2002	6.6	1.8×10^{-1}	2.9×10^{-4}	130	3.6	5.7×10^{-3}	120	3.3	5.3×10^{-3}
MW-2003	9	2.5×10^{-1}	3.9×10^{-4}	310	8.5	1.4×10^{-2}	100	2.7	4.4×10^{-3}
MW-2004	–	–	–	–	–	–	–	–	–
MW-2005	3.5	9.6×10^{-2}	1.5×10^{-4}	66	1.8	2.9×10^{-3}	29	7.9×10^{-1}	1.3×10^{-3}
MW-2006	3.7	1.0×10^{-1}	1.6×10^{-4}	4.9	1.3×10^{-1}	2.1×10^{-4}	9.2	2.5×10^{-1}	4.0×10^{-4}
MW-2007	1.2	3.3×10^{-2}	5.3×10^{-5}	2.9	7.9×10^{-2}	1.3×10^{-4}	15	4.1×10^{-1}	6.6×10^{-4}
MW-2008	–	–	–	–	–	–	–	–	–
MW-2009	–	–	–	–	–	–	–	–	–
MW-2010	47	1.3	2.1×10^{-3}	1.4	3.8×10^{-2}	6.1×10^{-5}	41	1.1	1.8×10^{-3}
MW-2011	4.2	1.2×10^{-1}	1.8×10^{-4}	4.8	1.3×10^{-1}	2.1×10^{-4}	13	3.6×10^{-1}	5.7×10^{-4}
MW-2012	48	1.3	2.1×10^{-3}	0.53	1.5×10^{-2}	2.3×10^{-5}	58	1.6	2.5×10^{-3}
MW-2013	5.3	1.5×10^{-1}	2.3×10^{-4}	1	2.7×10^{-2}	4.4×10^{-5}	27	7.4×10^{-1}	1.2×10^{-3}
MW-2014	26	7.1×10^{-1}	1.1×10^{-3}	1.8	4.9×10^{-2}	7.9×10^{-5}	38	1.0	1.7×10^{-3}
MW-2015	1.1	2.9×10^{-2}	4.7×10^{-5}	0.53	1.5×10^{-2}	2.3×10^{-5}	132	3.6	5.8×10^{-3}
MW-2016	–	–	–	–	–	–	–	–	–
MW-2017	15	4.1×10^{-1}	6.6×10^{-4}	5.5	1.5×10^{-1}	2.4×10^{-4}	1,100	31	4.9×10^{-2}
MW-2018	7.9	2.2×10^{-1}	3.5×10^{-4}	0.67	1.8×10^{-2}	2.9×10^{-5}	11	3.0×10^{-1}	4.8×10^{-4}
MW-2020	–	–	–	–	–	–	–	–	–
MW-2030	24	6.5×10^{-1}	1.0×10^{-3}	1.3	3.6×10^{-2}	5.7×10^{-5}	50	1.4	2.2×10^{-3}
MW-2034	26	7.1×10^{-1}	1.1×10^{-3}	4.8	1.3×10^{-1}	2.1×10^{-4}	320	8.8	1.4×10^{-2}
MW-2035	1.1	2.9×10^{-2}	4.6×10^{-5}	0.63	1.7×10^{-2}	2.8×10^{-5}	1.9	5.1×10^{-2}	8.1×10^{-5}
MW-2036	1.2	3.4×10^{-2}	5.4×10^{-5}	4	1.1×10^{-1}	1.8×10^{-4}	3.8	1.0×10^{-1}	1.7×10^{-4}

TABLE 3.6 (Cont.)

Well ID	Chloride EPC[a] (mg/L)	Chloride Intake (mg/kg-d) Ingestion	Chloride Intake (mg/kg-d) Dermal	Nitrate-N EPC[a] (mg/L)	Nitrate-N Intake (mg/kg-d) Ingestion[b]	Nitrate-N Intake (mg/kg-d) Dermal	Sulfate EPC[a] (mg/L)	Sulfate Intake (mg/kg-d) Ingestion	Sulfate Intake (mg/kg-d) Dermal
Weathered (cont.)									
MW-2037	32	8.8×10^{-1}	1.4×10^{-3}	290	7.9	1.3×10^{-2}	130	3.6	5.7×10^{-3}
MW-2038	–	–	–	900	2.5×10^{1}	3.9×10^{-2}	110	3.0	4.8×10^{-3}
MW-2039	49	1.3	2.1×10^{-3}	52	1.4	2.3×10^{-3}	33	9.0×10^{-1}	1.4×10^{-3}
MW-2040	4	1.1×10^{-1}	1.8×10^{-4}	230	6.3	1.0×10^{-2}	14	3.8×10^{-1}	6.1×10^{-4}
MW-2041	7.7	2.1×10^{-1}	3.4×10^{-4}	300	8.2	1.3×10^{-2}	37	1.0	1.6×10^{-3}
MW-2042	8.8	2.4×10^{-1}	3.9×10^{-4}	5.6	1.5×10^{-1}	2.5×10^{-4}	24	6.5×10^{-1}	1.0×10^{-3}
MW-2043	4.2	1.2×10^{-1}	1.8×10^{-4}	5.8	1.6×10^{-1}	2.5×10^{-4}	15	4.1×10^{-1}	6.6×10^{-4}
MW-2044	19	5.2×10^{-1}	8.3×10^{-4}	1.3	3.6×10^{-2}	5.7×10^{-5}	130	3.6	5.7×10^{-3}
MW-3003	12	3.3×10^{-1}	5.3×10^{-4}	300	8.2	1.3×10^{-2}	140	3.7	5.9×10^{-3}
MW-3007	–	–	–	–	–	–	–	–	–
MW-3008	–	–	–	–	–	–	–	–	–
MW-3009	–	–	–	–	–	–	–	–	–
MW-3010	–	–	–	–	–	–	–	–	–
MW-3019	–	–	–	1.2	3.3×10^{-2}	5.3×10^{-5}	–	–	–
MW-3023	9.6	2.6×10^{-1}	4.2×10^{-4}	210	5.8	9.2×10^{-3}	250	6.8	1.1×10^{-2}
MW-3025	11	3.0×10^{-1}	4.8×10^{-4}	520	1.4×10^{1}	2.3×10^{-2}	55	1.5	2.4×10^{-3}
MW-3027	2.4	6.6×10^{-2}	1.1×10^{-4}	62	1.7	2.7×10^{-3}	–	–	–
MW-4001	3.1	8.5×10^{-2}	1.4×10^{-4}	40	1.1	1.8×10^{-3}	65	1.8	2.8×10^{-3}
MW-4002	0.99	2.7×10^{-2}	4.3×10^{-5}	5.2	1.4×10^{-1}	2.3×10^{-4}	14	3.8×10^{-1}	6.1×10^{-4}
MW-4003	4.8	1.3×10^{-1}	2.1×10^{-4}	0.65	1.8×10^{-2}	2.8×10^{-5}	27	7.4×10^{-1}	1.2×10^{-3}
MW-4005	5.7	1.6×10^{-1}	2.5×10^{-4}	1.6	4.4×10^{-2}	7.0×10^{-5}	19	5.2×10^{-1}	8.3×10^{-4}
MW-4006	1.6	4.4×10^{-2}	7.0×10^{-5}	14	3.8×10^{-1}	6.1×10^{-4}	24	6.6×10^{-1}	1.1×10^{-3}
MW-4010	1.1	3.0×10^{-2}	4.8×10^{-5}	–	–	–	23	6.3×10^{-1}	1.0×10^{-3}
MW-4013	7.6	2.1×10^{-1}	3.3×10^{-4}	94	2.6	4.1×10^{-3}	56	1.5	2.5×10^{-3}
MW-4014	1.7	4.7×10^{-2}	7.5×10^{-5}	5.8	1.6×10^{-1}	2.5×10^{-4}	25	6.8×10^{-1}	1.1×10^{-3}
MW-4015	8.1	2.2×10^{-1}	3.6×10^{-4}	4.2	1.2×10^{-1}	1.8×10^{-4}	27	7.4×10^{-1}	1.2×10^{-3}
MW-4016	0.81	2.2×10^{-2}	3.6×10^{-5}	0.04	1.1×10^{-3}	1.8×10^{-6}	14	3.8×10^{-1}	6.1×10^{-4}
MW-4017	–	–	–	–	–	–	–	–	–
MW-4018	–	–	–	2.7	7.4×10^{-2}	1.2×10^{-4}	–	–	–
MW-4019	–	–	–	0.26	7.1×10^{-3}	1.1×10^{-5}	–	–	–

TABLE 3.6 (Cont.)

Well ID	Chloride EPC[a] (mg/L)	Chloride Intake (mg/kg-d) Ingestion	Chloride Intake (mg/kg-d) Dermal	Nitrate-N EPC[a] (mg/L)	Nitrate-N Intake (mg/kg-d) Ingestion[b]	Nitrate-N Intake (mg/kg-d) Dermal	Sulfate EPC[a] (mg/L)	Sulfate Intake (mg/kg-d) Ingestion	Sulfate Intake (mg/kg-d) Dermal
Weathered (cont.)									
MW-4020	–	–	–	–	–	–	–	–	–
MW-4021	–	–	–	–	–	–	–	–	–
MW-4023	–	–	–	2.6	7.1×10^{-2}	1.1×10^{-4}	–	–	–
MW-4024	7.6	2.1×10^{-1}	3.3×10^{-4}	1.4	3.8×10^{-2}	6.5×10^{-5}	680	19	3.0×10^{-2}
MW-4025	8.7	2.4×10^{-1}	3.8×10^{-4}	1.1	3.0×10^{-2}	4.8×10^{-5}	26	7.1×10^{-1}	1.1×10^{-3}
MWD-15	1.4	3.8×10^{-2}	6.1×10^{-5}	4.3	1.2×10^{-1}	1.9×10^{-4}	–	–	–
MWD-25	11	3.0×10^{-1}	4.8×10^{-4}	0.38	1.0×10^{-2}	1.7×10^{-5}	45	1.2	2.0×10^{-3}
MWD-107	3.1	8.5×10^{-2}	1.4×10^{-4}	–	–	–	25	6.8×10^{-1}	1.1×10^{-3}
MWD-112	1.3	3.6×10^{-2}	5.7×10^{-5}	–	–	–	19	5.2×10^{-1}	8.3×10^{-4}
MWS-01	2.3	6.3×10^{-2}	1.0×10^{-4}	2.5	6.8×10^{-2}	1.1×10^{-4}	–	–	–
MWS-02	1	2.7×10^{-2}	4.4×10^{-5}	0.1	2.7×10^{-3}	4.4×10^{-6}	15	4.1×10^{-1}	6.6×10^{-4}
MWS-03	1.3	3.6×10^{-2}	5.7×10^{-5}	–	–	–	23	6.3×10^{-1}	1.0×10^{-3}
MWS-04	2.2	6.0×10^{-2}	9.6×10^{-5}	8.9	2.4×10^{-1}	3.9×10^{-4}	35	9.6×10^{-1}	1.5×10^{-3}
MWS-07	1.9	5.2×10^{-2}	8.3×10^{-5}	2.3	6.3×10^{-2}	1.0×10^{-4}	39	1.1	1.7×10^{-3}
MWS-08	3.9	1.1×10^{-1}	1.7×10^{-4}	1.9	5.2×10^{-2}	8.3×10^{-5}	33	9.0×10^{-1}	1.4×10^{-3}
MWS-09	0.96	2.6×10^{-2}	4.2×10^{-5}	–	–	–	12	3.3×10^{-1}	5.3×10^{-4}
MWS-10	2.1	5.8×10^{-2}	9.2×10^{-5}	8.6	2.4×10^{-1}	3.8×10^{-4}	64	1.8	2.8×10^{-3}
MWS-11	3.2	8.8×10^{-2}	1.4×10^{-4}	8.8	2.4×10^{-1}	3.9×10^{-4}	43	1.2	1.9×10^{-3}
MWS-12	1.9	5.2×10^{-2}	8.3×10^{-5}	2.9	7.9×10^{-2}	1.3×10^{-4}	–	–	–
MWS-13	6.6	1.8×10^{-1}	2.9×10^{-4}	1.2	3.3×10^{-2}	5.3×10^{-5}	600	16	2.6×10^{-2}
MWS-14	11	3.0×10^{-1}	4.8×10^{-4}	0.18	4.9×10^{-3}	7.9×10^{-6}	24	6.6×10^{-1}	1.1×10^{-3}
MWS-15	1.8	4.9×10^{-2}	7.9×10^{-5}	0.91	2.5×10^{-2}	4.0×10^{-5}	33	9.0×10^{-1}	1.4×10^{-3}
MWS-16	9	2.5×10^{-1}	3.9×10^{-4}	7.7	2.1×10^{-1}	3.4×10^{-4}	23	6.3×10^{-1}	1.0×10^{-3}
MWS-17	4.3	1.2×10^{-1}	1.9×10^{-4}	3.1	8.5×10^{-2}	1.4×10^{-4}	45	1.2	2.0×10^{-3}
MWS-19	1.4	3.8×10^{-2}	6.1×10^{-5}	0.15	4.1×10^{-3}	6.6×10^{-6}	20	5.5×10^{-1}	8.8×10^{-4}
MWS-20	2.4	6.6×10^{-2}	1.1×10^{-4}	5.6	1.5×10^{-1}	2.5×10^{-4}	17	4.7×10^{-1}	7.5×10^{-4}
MWS-21	26	7.1×10^{-1}	1.1×10^{-3}	520	1.4×10^{1}	2.3×10^{-2}	95	2.6	4.2×10^{-3}
MWS-22	4.3	1.2×10^{-1}	1.9×10^{-4}	3	8.2×10^{-2}	1.3×10^{-4}	18	4.9×10^{-1}	7.9×10^{-4}
MWS-24	–	–	–	–	–	–	–	–	–
MWS-25	6.8	1.9×10^{-1}	3.0×10^{-4}	0.6	1.6×10^{-2}	2.6×10^{-5}	37	1.0	1.6×10^{-3}

TABLE 3.6 (Cont.)

Well ID	Chloride EPC[a] (mg/L)	Chloride Intake (mg/kg-d) Ingestion	Chloride Intake (mg/kg-d) Dermal	Nitrate-N EPC[a] (mg/L)	Nitrate-N Intake (mg/kg-d) Ingestion[b]	Nitrate-N Intake (mg/kg-d) Dermal	Sulfate EPC[a] (mg/L)	Sulfate Intake (mg/kg-d) Ingestion	Sulfate Intake (mg/kg-d) Dermal
Weathered (cont.)									
MWS-26	–	–	–	0.52	1.4×10^{-2}	2.3×10^{-5}	–	–	–
MWS-104	–	–	–	–	–	–	11	3.0×10^{-1}	4.8×10^{-4}
MWS-107	3.9	1.1×10^{-1}	1.7×10^{-4}	1.6	4.4×10^{-2}	7.0×10^{-5}	16	4.4×10^{-1}	7.0×10^{-4}
MWS-110	1.6	4.4×10^{-2}	7.0×10^{-5}	0.8	2.2×10^{-2}	3.5×10^{-5}	20	5.5×10^{-1}	8.8×10^{-4}
MWS-112	3.1	8.5×10^{-2}	1.4×10^{-4}	0.13	3.6×10^{-3}	5.7×10^{-6}	20	5.5×10^{-1}	8.8×10^{-4}
USGS-2	1.2	3.3×10^{-2}	5.3×10^{-5}	–	–	–	10	2.7×10^{-1}	4.4×10^{-4}
USGS-3	2.2	6.0×10^{-2}	9.6×10^{-5}	0.88	2.4×10^{-2}	3.9×10^{-5}	17	4.7×10^{-1}	7.5×10^{-4}
USGS-4	2.8	7.7×10^{-2}	1.2×10^{-4}	1.5	4.1×10^{-2}	6.6×10^{-5}	25	6.8×10^{-1}	1.1×10^{-3}
USGS-5	1.2	3.3×10^{-2}	5.3×10^{-5}	0.23	6.3×10^{-3}	1.0×10^{-5}	8.1	2.2×10^{-1}	3.6×10^{-4}
USGS-7	–	–	–	–	–	–	–	–	–
USGS-8	2.9	7.9×10^{-2}	1.3×10^{-4}	3.2	8.8×10^{-2}	1.4×10^{-4}	13	3.6×10^{-1}	5.7×10^{-4}
USGS-9	5.1	1.4×10^{-1}	2.2×10^{-4}	3.2	8.8×10^{-2}	1.4×10^{-4}	19	5.2×10^{-1}	8.3×10^{-4}

[a] EPC = exposure point concentration, which is the maximum uranium value for each spring from the 1995 joint DOE/DA sampling rounds.

[b] Intakes of nitrate by an infant can be calculated by multiplying the EPC by 0.16. Intakes for ingestion of nitrate by an infant range from 8.0×10^{-4} (MW-2021) to 140 (MW-2038).

[c] A hyphen (–) indicates the parameter was not detected.

TABLE 3.7 Estimated Noncarcinogenic Intakes of Organic Compound COPCs for the Hypothetical Future Resident

Well ID	1,3,5-TNB EPC[a] (µg/L)	1,3,5-TNB Intake (mg/kg-d) Ingestion	1,3,5-TNB Intake (mg/kg-d) Dermal	1,3-DNB EPC[a] (µg/L)	1,3-DNB Intake (mg/kg-d) Ingestion	1,3-DNB Intake (mg/kg-d) Dermal	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal
Deep Wells												
MWD-05	–[b]	–	–	–	–	–	–	–	–	–	–	–
MWD-18	–	–	–	–	–	–	–	–	–	–	–	–
MWGS-01	–	–	–	–	–	–	–	–	–	–	–	–
MWGS-02	–	–	–	–	–	–	–	–	–	–	–	–
MWS-18	–	–	–	–	–	–	–	–	–	–	–	–
MWS-101	–	–	–	–	–	–	–	–	–	–	–	–
MWS-102	–	–	–	–	–	–	–	–	–	–	–	–
MWS-103	–	–	–	–	–	–	–	–	–	–	–	–
TIL-3	–	–	–	–	–	–	–	–	–	–	–	–
Overburden												
MW-2031	–	–	–	–	–	–	–	–	–	–	–	–
MW-2032	4.9	1.3×10^{-4}	2.1×10^{-7}	–	–	–	6.7	1.8×10^{-4}	2.9×10^{-7}	0.14	3.8×10^{-6}	6.1×10^{-9}
MW-2033	4.5	1.2×10^{-4}	2.0×10^{-7}	–	–	–	1.2	3.3×10^{-5}	5.3×10^{-8}	0.55	1.5×10^{-5}	2.4×10^{-8}
MW-3001	–	–	–	–	–	–	–	–	–	–	–	–
MW-3013	–	–	–	–	–	–	–	–	–	–	–	–
MW-3018	–	–	–	–	–	–	–	–	–	–	–	–
MW-3022	–	–	–	–	–	–	–	–	–	–	–	–
USGS-2A	–	–	–	–	–	–	–	–	–	–	–	–
MWV-01	0.034	1.0×10^{-6}	1.7×10^{-9}	–	–	–	11	3.0×10^{-4}	4.8×10^{-7}	0.11	3.0×10^{-6}	4.8×10^{-9}
MWV-02	–	–	–	–	–	–	0.11	3.0×10^{-6}	4.8×10^{-9}	0.059	1.6×10^{-6}	2.6×10^{-9}
MWV-09	14	3.8×10^{-4}	6.1×10^{-7}	0.40	1.1×10^{-5}	1.8×10^{-8}	30	8.2×10^{-4}	1.3×10^{-6}	20	5.5×10^{-4}	8.8×10^{-7}
MWV-13	–	–	–	–	–	–	–	–	–	–	–	–
MWV-16	0.33	9.0×10^{-6}	1.4×10^{-8}	–	–	–	0.27	7.4×10^{-6}	1.2×10^{-8}	–	–	–
MWV-17	–	–	–	–	–	–	–	–	–	–	–	–
MWV-18	–	–	–	–	–	–	–	–	–	–	–	–
MWV-22	–	–	–	–	–	–	–	–	–	–	–	–
MWV-24R	3.1	8.5×10^{-5}	1.4×10^{-7}	–	–	–	1.1	3.0×10^{-5}	4.8×10^{-8}	0.33	3.6×10^{-6}	5.7×10^{-9}

TABLE 3.7 (Cont.)

Well ID	1,3,5-TNB EPC[a] (µg/L)	1,3,5-TNB Intake (mg/kg-d) Ingestion	1,3,5-TNB Intake (mg/kg-d) Dermal	1,3-DNB EPC[a] (µg/L)	1,3-DNB Intake (mg/kg-d) Ingestion	1,3-DNB Intake (mg/kg-d) Dermal	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal
Unweathered												
MW-2019	–	–	–	–	–	–	–	–	–	–	–	–
MW-2021	–	–	–	–	–	–	–	–	–	–	–	–
MW-2022	–	–	–	–	–	–	–	–	–	–	–	–
MW-2023	–	–	–	–	–	–	–	–	–	–	–	–
MW-2024	–	–	–	–	–	–	–	–	–	–	–	–
MW-2025	–	–	–	–	–	–	–	–	–	–	–	–
MW-2026	–	–	–	–	–	–	–	–	–	–	–	–
MW-2027	–	–	–	–	–	–	–	–	–	–	–	–
MW-2028	–	–	–	–	–	–	–	–	–	–	–	–
MW-2029	–	–	–	–	–	–	–	–	–	–	–	–
MW-3002	–	–	–	–	–	–	–	–	–	–	–	–
MW-3006	–	–	–	–	–	–	–	–	–	–	–	–
MW-3024	–	–	–	–	–	–	–	–	–	0.13	3.6×10^{-6}	5.7×10^{-9}
MW-3026	0.14	3.8×10^{-6}	6.1×10^{-9}	–	–	–	–	–	–	0.072	2.0×10^{-6}	3.2×10^{-9}
MW-4004	–	–	–	–	–	–	–	–	–	–	–	–
MW-4007	–	–	–	–	–	–	–	–	–	–	–	–
MW-4008	–	–	–	–	–	–	–	–	–	–	–	–
MW-4009	–	–	–	–	–	–	–	–	–	–	–	–
MW-4011	–	–	–	–	–	–	–	–	–	–	–	–
MW-4012	–	–	–	–	–	–	–	–	–	–	–	–
MW-4022	–	–	–	–	–	–	–	–	–	–	–	–
MWD-02	–	–	–	–	–	–	–	–	–	–	–	–
MWD-06	–	–	–	–	–	–	–	–	–	–	–	–
MWD-09	0.065	1.8×10^{-6}	2.8×10^{-9}	–	–	–	–	–	–	0.042	1.2×10^{-6}	1.8×10^{-9}
MWD-23	–	–	–	–	–	–	–	–	–	–	–	–
MWD-106	–	–	–	–	–	–	–	–	–	–	–	–
MWS-05	–	–	–	–	–	–	–	–	–	–	–	–
MWS-06	–	–	–	–	–	–	–	–	–	–	–	–
MWS-105	–	–	–	–	–	–	–	–	–	–	–	–
MWS-106	–	–	–	–	–	–	–	–	–	–	–	–
MWS-109	–	–	–	–	–	–	–	–	–	–	–	–
TIL-4	–	–	–	–	–	–	–	–	–	–	–	–
USGS-1	0.063	1.7×10^{-6}	2.8×10^{-9}	0.14	3.8×10^{-6}	6.1×10^{-9}	–	–	–	0.051	1.4×10^{-6}	2.2×10^{-9}
USGS-6	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.7 (Cont.)

Well ID	1,3,5-TNB EPC[a] (µg/L)	1,3,5-TNB Intake (mg/kg-d) Ingestion	1,3,5-TNB Intake (mg/kg-d) Dermal	1,3-DNB EPC[a] (µg/L)	1,3-DNB Intake (mg/kg-d) Ingestion	1,3-DNB Intake (mg/kg-d) Dermal	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal
Weathered												
MW-2001	0.054	1.5×10^{-6}	2.4×10^{-9}	–	–	–	–	–	–	0.13	3.6×10^{-6}	5.7×10^{-9}
MW-2002	–	–	–	–	–	–	–	–	–	0.070	1.9×10^{-6}	3.1×10^{-9}
MW-2003	–	–	–	–	–	–	–	–	–	0.15	4.1×10^{-6}	6.6×10^{-9}
MW-2004	–	–	–	–	–	–	–	–	–	–	–	–
MW-2005	0.035	9.6×10^{-7}	1.5×10^{-9}	–	–	–	–	–	–	0.061	1.7×10^{-6}	2.7×10^{-9}
MW-2006	–	–	–	–	–	–	–	–	–	0.14	3.8×10^{-6}	6.1×10^{-9}
MW-2007	–	–	–	–	–	–	–	–	–	–	–	–
MW-2008	–	–	–	–	–	–	–	–	–	–	–	–
MW-2009	–	–	–	–	–	–	–	–	–	–	–	–
MW-2010	0.15	4.1×10^{-6}	6.6×10^{-9}	–	–	–	0.34	9.3×10^{-6}	1.5×10^{-8}	0.094	2.6×10^{-6}	4.1×10^{-9}
MW-2011	0.4	1.1×10^{-5}	1.8×10^{-8}	–	–	–	–	–	–	0.20	5.5×10^{-6}	8.8×10^{-9}
MW-2012	1.4	3.8×10^{-5}	6.1×10^{-8}	–	–	–	0.46	1.3×10^{-5}	2.0×10^{-8}	0.099	2.7×10^{-6}	4.3×10^{-9}
MW-2013	6.2	1.7×10^{-4}	2.7×10^{-7}	–	–	–	0.85	2.3×10^{-5}	3.7×10^{-8}	0.36	9.9×10^{-6}	1.6×10^{-8}
MW-2014	1.9	5.2×10^{-5}	8.3×10^{-8}	0.86	2.4×10^{-5}	3.8×10^{-8}	0.044	1.2×10^{-6}	1.9×10^{-9}	0.16	4.4×10^{-6}	7.0×10^{-9}
MW-2015	–	–	–	–	–	–	–	–	–	–	–	–
MW-2016	–	–	–	–	–	–	–	–	–	–	–	–
MW-2017	–	–	–	–	–	–	–	–	–	–	–	–
MW-2018	–	–	–	–	–	–	–	–	–	–	–	–
MW-2020	–	–	–	–	–	–	–	–	–	–	–	–
MW-2030	8.3	2.3×10^{-4}	3.6×10^{-7}	–	–	–	29	7.9×10^{-4}	1.3×10^{-6}	0.25	6.8×10^{-6}	1.1×10^{-8}
MW-2034	–	–	–	–	–	–	–	–	–	–	–	–
MW-2035	–	–	–	–	–	–	–	–	–	–	–	–
MW-2036	–	–	–	–	–	–	–	–	–	–	–	–
MW-2037	0.19	5.2×10^{-6}	8.3×10^{-9}	–	–	–	–	–	–	0.56	1.5×10^{-5}	2.5×10^{-8}
MW-2038	0.24	6.6×10^{-6}	1.1×10^{-8}	–	–	–	–	–	–	1.7	4.7×10^{-5}	7.5×10^{-8}
MW-2039	7.3	2.0×10^{-4}	3.2×10^{-7}	–	–	–	–	–	–	0.12	3.3×10^{-6}	5.3×10^{-9}
MW-2040	–	–	–	–	–	–	–	–	–	–	–	–
MW-2041	–	–	–	–	–	–	–	–	–	–	–	–
MW-2042	–	–	–	–	–	–	–	–	–	–	–	–
MW-2043	–	–	–	–	–	–	–	–	–	–	–	–
MW-2044	–	–	–	–	–	–	–	–	–	0.087	2.4×10^{-6}	1.8×10^{-9}
MW-3003	–	–	–	–	–	–	–	–	–	–	–	–
										0.17	4.7×10^{-6}	7.5×10^{-9}

TABLE 3.7 (Cont.)

Well ID	1,3,5-TNB EPC[a] (µg/L)	1,3,5-TNB Intake (mg/kg-d) Ingestion	1,3,5-TNB Intake (mg/kg-d) Dermal	1,3-DNB EPC[a] (µg/L)	1,3-DNB Intake (mg/kg-d) Ingestion	1,3-DNB Intake (mg/kg-d) Dermal	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal
Weathered (cont.)												
MW-3007	–	–	–	–	–	–	–	–	–	–	–	–
MW-3008	–	–	–	–	–	–	–	–	–	–	–	–
MW-3009	–	–	–	–	–	–	–	–	–	–	–	–
MW-3010	–	–	–	–	–	–	–	–	–	–	–	–
MW-3019	–	–	–	–	–	–	–	–	–	–	–	–
MW-3023	–	–	–	–	–	–	–	–	–	5	1.4×10^{-3}	2.2×10^{-7}
MW-3025	–	–	–	–	–	–	–	–	–	0.094	2.6×10^{-6}	4.1×10^{-9}
MW-3027	0.074	2.0×10^{-6}	3.2×10^{-9}	–	–	–	–	–	–	0.058	1.6×10^{-6}	2.5×10^{-9}
MW-4001	39	1.1×10^{-3}	1.7×10^{-6}	–	–	–	1.8	4.9×10^{-5}	7.9×10^{-8}	1.3	3.6×10^{-5}	5.7×10^{-8}
MW-4002	0.062	1.7×10^{-6}	2.7×10^{-9}	–	–	–	1.8	4.9×10^{-5}	7.9×10^{-8}	0.14	3.8×10^{-6}	6.1×10^{-9}
MW-4003	–	–	–	–	–	–	–	–	–	–	–	–
MW-4005	–	–	–	–	–	–	–	–	–	–	–	–
MW-4006	19	5.2×10^{-4}	8.3×10^{-7}	–	–	–	–	–	–	0.16	4.4×10^{-6}	7.0×10^{-9}
MW-4010	–	–	–	–	–	–	–	–	–	–	–	–
MW-4013	27	7.4×10^{-4}	1.2×10^{-6}	–	–	–	0.046	1.3×10^{-6}	2.0×10^{-9}	0.077	2.1×10^{-6}	3.4×10^{-9}
MW-4014	0.11	3.0×10^{-6}	4.8×10^{-9}	–	–	–	–	–	–	0.026	7.1×10^{-7}	1.1×10^{-9}
MW-4015	1.8	4.9×10^{-5}	7.9×10^{-8}	–	–	–	–	–	–	0.19	5.2×10^{-6}	8.3×10^{-9}
MW-4016	–	–	–	–	–	–	–	–	–	–	–	–
MW-4017	–	–	–	–	–	–	–	–	–	–	–	–
MW-4018	–	–	–	–	–	–	–	–	–	–	–	–
MW-4019	–	–	–	–	–	–	–	–	–	–	–	–
MW-4020	–	–	–	–	–	–	–	–	–	–	–	–
MW-4021	–	–	–	–	–	–	–	–	–	–	–	–
MW-4023	0.088	2.4×10^{-6}	3.9×10^{-9}	–	–	–	–	–	–	0.067	1.8×10^{-6}	2.9×10^{-9}
MW-4024	–	–	–	–	–	–	–	–	–	–	–	–
MW-4025	–	–	–	–	–	–	–	–	–	–	–	–
MWD-15	–	–	–	–	–	–	–	–	–	–	–	–
MWD-25	–	–	–	–	–	–	–	–	–	–	–	–
MWD-107	0.047	1.3×10^{-6}	2.1×10^{-9}	–	–	–	–	–	–	0.02	5.5×10^{-7}	8.8×10^{-10}
MWD-112	–	–	–	–	–	–	–	–	–	–	–	–
MWS-01	–	–	–	–	–	–	–	–	–	–	–	–
MWS-02	–	–	–	–	–	–	–	–	–	–	–	–
MWS-03	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.7 (Cont.)

Well ID	1,3,5-TNB EPC[a] (µg/L)	1,3,5-TNB Intake (mg/kg-d) Ingestion	1,3,5-TNB Intake (mg/kg-d) Dermal	1,3-DNB EPC[a] (µg/L)	1,3-DNB Intake (mg/kg-d) Ingestion	1,3-DNB Intake (mg/kg-d) Dermal	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal
Weathered (cont.)												
MWS-04	11	3.0×10^{-4}	4.8×10^{-7}	–	–	–	1.2	3.3×10^{-5}	5.3×10^{-8}	0.1	2.7×10^{-6}	4.4×10^{-9}
MWS-07	18	4.9×10^{-4}	7.9×10^{-7}	–	–	–	2.6	7.1×10^{-5}	1.1×10^{-7}	0.049	1.3×10^{-6}	2.1×10^{-9}
MWS-08	–	–	–	–	–	–	–	–		–	–	–
MWS-09	–	–	–	–	–	–	–	–		–	–	–
MWS-10	0.3	8.2×10^{-6}	1.3×10^{-8}	–	–	–	0.028	7.7×10^{-7}	1.2×10^{-9}	0.082	2.2×10^{-6}	3.6×10^{-9}
MWS-11	0.037	1.0×10^{-6}	1.6×10^{-9}	–	–	–	0.046	1.3×10^{-6}	2.0×10^{-9}	0.055	1.5×10^{-6}	2.4×10^{-9}
MWS-12	1.9	5.2×10^{-5}	8.3×10^{-8}	0.27	7.4×10^{-6}	1.2×10^{-8}	0.18	4.9×10^{-6}	7.9×10^{-9}	8.8	2.4×10^{-4}	3.9×10^{-7}
MWS-13	–	–	–	–	–	–	–	–	–	–	–	–
MWS-14	–	–	–	–	–	–	–	–	–	–	–	–
MWS-15	1.8	4.9×10^{-5}	7.9×10^{-8}	–	–	–	5.9	1.6×10^{-4}	2.6×10^{-7}	0.081	2.2×10^{-6}	3.6×10^{-9}
MWS-16	10	2.7×10^{-4}	4.4×10^{-7}	–	–	–	2.9	7.9×10^{-5}	1.3×10^{-7}	0.092	2.5×10^{-6}	4.0×10^{-9}
MWS-17	0.07	1.9×10^{-6}	3.1×10^{-9}	–	–	–	0.15	4.1×10^{-6}	6.6×10^{-9}	1.1	3.0×10^{-5}	4.8×10^{-8}
MWS-19	0.051	1.4×10^{-6}	2.2×10^{-9}	–	–	–	–	–	–	0.08	2.2×10^{-6}	3.5×10^{-9}
MWS-20	–	–	–	–	–	–	–	–	–	–	–	–
MWS-21	–	–	–	–	–	–	–	–	–	0.94	2.6×10^{-5}	4.1×10^{-8}
MWS-22	–	–	–	–	–	–	–	–	–	0.025	6.8×10^{-7}	1.1×10^{-9}
MWS-24	–	–	–	–	–	–	–	–	–	–	–	–
MWS-25	–	–	–	–	–	–	–	–	–	–	–	–
MWS-26	–	–	–	–	–	–	–	–	–	–	–	–
MWS-104	–	–	–	–	–	–	–	–	–	–	–	–
MWS-107	0.065	1.8×10^{-6}	2.8×10^{-9}	–	–	–	–	–	–	0.059	1.6×10^{-6}	2.6×10^{-9}
MWS-110	0.19	5.2×10^{-6}	8.3×10^{-9}	–	–	–	–	–	–	–	–	–
MWS-112	–	–	–	–	–	–	–	–	–	0.056	1.5×10^{-6}	2.5×10^{-9}
USGS-2	–	–	–	–	–	–	–	–	–	–	–	–
USGS-3	0.1	2.7×10^{-6}	4.4×10^{-9}	–	–	–	–	–	–	0.022	6.0×10^{-7}	9.6×10^{-10}
USGS-4	1.8	4.9×10^{-5}	7.9×10^{-8}	–	–	–	–	–	–	1.5	4.1×10^{-5}	6.6×10^{-8}
USGS-5	–	–	–	–	–	–	–	–	–	–	–	–
USGS-7	–	–	–	–	–	–	–	–	–	–	–	–
USGS-8	–	–	–	–	–	–	–	–	–	–	–	–
USGS-9	–	–	–	–	–	–	–	–	–	0.092	2.5×10^{-6}	4.0×10^{-9}

TABLE 3.7 (Cont.)

Well ID	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	2-Amino-4,6-DNT EPC[a] (µg/L)	2-Amino-4,6-DNT Intake (mg/kg-d) Ingestion	2-Amino-4,6-DNT Intake (mg/kg-d) Dermal	4-Amino-2,6-DNT EPC[a] (µg/L)	4-Amino-2,6-DNT Intake (mg/kg-d) Ingestion	4-Amino-2,6-DNT Intake (mg/kg-d) Dermal	Nitrobenzene EPC[a] (µg/L)	Nitrobenzene Intake (mg/kg-d) Ingestion	Nitrobenzene Intake (mg/kg-d) Dermal
Deep Wells												
MWD-05	–	–	–	–	–	–	–	–	–	–	–	–
MWD-18	–	–	–	–	–	–	–	–	–	–	–	–
MWGS-01	–	–	–	–	–	–	–	–	–	–	–	–
MWGS-02	–	–	–	–	–	–	–	–	–	–	–	–
MWS-18	–	–	–	–	–	–	–	–	–	–	–	–
MWS-101	–	–	–	–	–	–	–	–	–	–	–	–
MWS-102	–	–	–	–	–	–	–	–	–	–	–	–
MWS-103	–	–	–	–	–	–	–	–	–	–	–	–
TIL-3	–	–	–	–	–	–	–	–	–	–	–	–
Overburden												
MW-2031	–	–	–	–	–	–	–	–	–	–	–	–
MW-2032	4.4	1.2×10^{-4}	1.9×10^{-7}	3.6	9.9×10^{-5}	1.6×10^{-7}	2.8	7.7×10^{-5}	1.2×10^{-7}	–	–	–
MW-2033	4.9	1.3×10^{-4}	2.1×10^{-7}	3.6	9.9×10^{-5}	1.6×10^{-7}	3.3	9.0×10^{-5}	1.4×10^{-7}	–	–	–
MW-3001	–	–	–	–	–	–	–	–	–	–	–	–
MW-3013	–	–	–	–	–	–	–	–	–	–	–	–
MW-3018	–	–	–	–	–	–	–	–	–	–	–	–
MW-3022	–	–	–	–	–	–	–	–	–	–	–	–
USGS-2A	–	–	–	–	–	–	–	–	–	–	–	–
MWV-01	1.0	2.7×10^{-5}	4.4×10^{-8}	3.8	1.0×10^{-4}	1.7×10^{-7}	6.8	1.9×10^{-4}	3.0×10^{-7}	–	–	–
MWV-02	0.048	1.3×10^{-6}	2.1×10^{-9}	0.50	1.4×10^{-5}	2.2×10^{-8}	1	2.7×10^{-5}	4.4×10^{-8}	–	–	–
MWV-09	2.9	7.9×10^{-5}	1.3×10^{-7}	35	9.6×10^{-4}	1.5×10^{-6}	26	7.1×10^{-4}	1.1×10^{-6}	–	–	–
MWV-13	–	–	–	–	–	–	–	–	–	–	–	–
MWV-16	0.069	1.9×10^{-6}	3.0×10^{-9}	0.32	8.8×10^{-6}	1.4×10^{-8}	0.57	1.6×10^{-5}	2.5×10^{-8}	–	–	–
MWV-17	–	–	–	–	–	–	–	–	–	–	–	–
MWV-18	–	–	–	–	–	–	–	–	–	–	–	–
MWV-22	0.14	3.8×10^{-6}	6.1×10^{-9}	0.057	1.6×10^{-6}	2.5×10^{-9}	0.21	5.8×10^{-6}	9.2×10^{-9}	–	–	–
MWV-24R	1.4	3.8×10^{-5}	6.1×10^{-8}	0.47	1.3×10^{-5}	2.1×10^{-8}	1	2.7×10^{-5}	4.4×10^{-8}	–	–	–

TABLE 3.7 (Cont.)

Well ID	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	2-Amino-4,6-DNT EPC[a] (µg/L)	2-Amino-4,6-DNT Intake (mg/kg-d) Ingestion	2-Amino-4,6-DNT Intake (mg/kg-d) Dermal	4-Amino-2,6-DNT EPC[a] (µg/L)	4-Amino-2,6-DNT Intake (mg/kg-d) Ingestion	4-Amino-2,6-DNT Intake (mg/kg-d) Dermal	Nitrobenzene EPC[a] (µg/L)	Nitrobenzene Intake (mg/kg-d) Ingestion	Nitrobenzene Intake (mg/kg-d) Dermal
Unweathered												
MW-2019	–	–	–	–	–	–	–	–	–	–	–	–
MW-2021	–	–	–	–	–	–	–	–	–	–	–	–
MW-2022	–	–	–	–	–	–	–	–	–	–	–	–
MW-2023	–	–	–	–	–	–	–	–	–	–	–	–
MW-2024	–	–	–	–	–	–	–	–	–	–	–	–
MW-2025	–	–	–	–	–	–	–	–	–	–	–	–
MW-2026	–	–	–	–	–	–	–	–	–	–	–	–
MW-2027	–	–	–	–	–	–	–	–	–	–	–	–
MW-2028	–	–	–	–	–	–	–	–	–	–	–	–
MW-2029	–	–	–	–	–	–	–	–	–	–	–	–
MW-3002	–	–	–	–	–	–	–	–	–	–	–	–
MW-3006	–	–	–	–	–	–	–	–	–	–	–	–
MW-3024	0.45	1.2×10^{-5}	2.0×10^{-8}	0.032	8.8×10^{-7}	1.4×10^{-9}	0.057	1.6×10^{-6}	2.5×10^{-9}	–	–	–
MW-3026	0.046	1.3×10^{-6}	2.0×10^{-9}	0.30	8.2×10^{-6}	1.3×10^{-8}	0.37	1.0×10^{-5}	1.6×10^{-8}	–	–	–
MW-4004	–	–	–	–	–	–	–	–	–	–	–	–
MW-4007	–	–	–	–	–	–	0.017	4.7×10^{-7}	7.5×10^{-10}	–	–	–
MW-4008	–	–	–	–	–	–	–	–	–	–	–	–
MW-4009	–	–	–	–	–	–	–	–	–	–	–	–
MW-4011	0.065	1.8×10^{-6}	2.8×10^{-9}	0.77	2.1×10^{-5}	3.4×10^{-8}	1.8	4.9×10^{-5}	7.9×10^{-8}	–	–	–
MW-4012	–	–	–	–	–	–	–	–	–	–	–	–
MW-4022	–	–	–	–	–	–	–	–	–	–	–	–
MWD-02	–	–	–	–	–	–	–	–	–	–	–	–
MWD-06	–	–	–	–	–	–	–	–	–	–	–	–
MWD-09	0.16	4.4×10^{-6}	7.0×10^{-9}	0.095	2.6×10^{-6}	4.2×10^{-9}	0.5	1.4×10^{-5}	2.2×10^{-8}	–	–	–
MWD-23	–	–	–	–	–	–	–	–	–	–	–	–
MWD-106	–	–	–	–	–	–	–	–	–	–	–	–
MWS-05	–	–	–	–	–	–	–	–	–	–	–	–
MWS-06	–	–	–	–	–	–	–	–	–	–	–	–
MWS-105	–	–	–	–	–	–	–	–	–	–	–	–
MWS-106	–	–	–	–	–	–	–	–	–	–	–	–
MWS-109	–	–	–	–	–	–	–	–	–	–	–	–
TIL-4	–	–	–	–	–	–	–	–	–	–	–	–
USGS-1	0.022	6.0×10^{-7}	9.6×10^{-10}	0.057	1.6×10^{-6}	2.5×10^{-9}	0.2	5.5×10^{-6}	8.8×10^{-9}	–	–	–
USGS-6	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.7 (Cont.)

Well ID	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	2-Amino-4,6-DNT EPC[a] (µg/L)	2-Amino-4,6-DNT Intake (mg/kg-d) Ingestion	2-Amino-4,6-DNT Intake (mg/kg-d) Dermal	4-Amino-2,6-DNT EPC[a] (µg/L)	4-Amino-2,6-DNT Intake (mg/kg-d) Ingestion	4-Amino-2,6-DNT Intake (mg/kg-d) Dermal	Nitrobenzene EPC[a] (µg/L)	Nitrobenzene Intake (mg/kg-d) Ingestion	Nitrobenzene Intake (mg/kg-d) Dermal
Weathered												
MW-2001	0.056	1.5×10^{-6}	2.5×10^{-9}	–	–	–	–	–	–	–	–	–
MW-2002	0.41	1.1×10^{-5}	1.8×10^{-8}	0.83	2.3×10^{-5}	3.6×10^{-8}	0.93	2.5×10^{-5}	4.1×10^{-8}	–	–	–
MW-2003	0.45	1.2×10^{-5}	2.0×10^{-8}	0.18	4.9×10^{-6}	7.9×10^{-9}	0.46	1.3×10^{-5}	2.0×10^{-8}	–	–	–
MW-2004	–	–	–	–	–	–	–	–	–	–	–	–
MW-2005	0.090	2.5×10^{-6}	3.9×10^{-9}	0.12	3.3×10^{-6}	5.3×10^{-9}	0.12	3.3×10^{-6}	5.3×10^{-9}	–	–	–
MW-2006	0.0090	2.5×10^{-7}	3.9×10^{-10}	–	–	–	–	–	–	0.042	1.2×10^{-6}	1.8×10^{-9}
MW-2007	–	–	–	–	–	–	–	–	–	–	–	–
MW-2008	–	–	–	–	–	–	–	–	–	–	–	–
MW-2009	–	–	–	–	–	–	–	–	–	–	–	–
MW-2010	0.75	2.1×10^{-5}	3.3×10^{-8}	0.72	2.0×10^{-5}	3.2×10^{-8}	0.81	2.2×10^{-5}	3.6×10^{-8}	–	–	–
MW-2011	1.6	4.4×10^{-5}	7.0×10^{-8}	2.0	5.5×10^{-5}	8.8×10^{-8}	0.98	2.7×10^{-5}	4.3×10^{-8}	–	–	–
MW-2012	0.65	1.8×10^{-5}	2.8×10^{-8}	0.31	8.5×10^{-6}	1.4×10^{-8}	0.37	1.0×10^{-5}	1.6×10^{-8}	–	–	–
MW-2013	4.4	1.2×10^{-4}	1.9×10^{-7}	2.4	6.6×10^{-5}	1.1×10^{-7}	2.2	6.0×10^{-5}	9.6×10^{-8}	–	–	–
MW-2014	0.41	1.1×10^{-5}	1.8×10^{-8}	0.41	1.1×10^{-5}	1.8×10^{-8}	0.63	1.7×10^{-5}	2.8×10^{-8}	–	–	–
MW-2015	–	–	–	–	–	–	–	–	–	–	–	–
MW-2016	–	–	–	–	–	–	–	–	–	–	–	–
MW-2017	–	–	–	–	–	–	–	–	–	–	–	–
MW-2018	–	–	–	–	–	–	–	–	–	–	–	–
MW-2020	–	–	–	–	–	–	–	–	–	–	–	–
MW-2030	11	3.0×10^{-4}	4.8×10^{-7}	5.5	1.5×10^{-4}	2.4×10^{-7}	4.4	1.2×10^{-4}	1.9×10^{-7}	–	–	–
MW-2034	–	–	–	–	–	–	–	–	–	–	–	–
MW-2035	–	–	–	–	–	–	–	–	–	–	–	–
MW-2036	–	–	–	–	–	–	–	–	–	–	–	–
MW-2037	0.13	3.6×10^{-6}	5.7×10^{-9}	0.11	3.0×10^{-6}	4.8×10^{-9}	0.11	3.0×10^{-6}	4.8×10^{-9}	–	–	–
MW-2038	0.32	8.8×10^{-6}	1.4×10^{-8}	0.40	1.1×10^{-5}	1.8×10^{-8}	0.46	1.3×10^{-5}	2.0×10^{-8}	0.062	1.7×10^{-6}	2.7×10^{-9}
MW-2039	1.7	4.7×10^{-5}	7.5×10^{-8}	2.0	5.5×10^{-5}	8.8×10^{-8}	1.6	4.4×10^{-5}	7.0×10^{-8}	0.054	1.5×10^{-6}	2.4×10^{-9}
MW-2040	–	–	–	–	–	–	–	–	–	–	–	–
MW-2041	–	–	–	–	–	–	–	–	–	–	–	–
MW-2042	–	–	–	–	–	–	–	–	–	–	–	–
MW-2043	–	–	–	–	–	–	–	–	–	–	–	–
MW-2044	–	–	–	0.022	6.0×10^{-7}	9.6×10^{-10}	0.033	9.0×10^{-7}	1.4×10^{-9}	–	–	–
MW-3003	0.085	2.3×10^{-6}	3.7×10^{-9}	–	–	–	0.034	9.3×10^{-7}	1.5×10^{-9}	–	–	–
MW-3007	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.7 (Cont.)

Well ID	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	2-Amino-4,6-DNT EPC[a] (µg/L)	2-Amino-4,6-DNT Intake (mg/kg-d) Ingestion	2-Amino-4,6-DNT Intake (mg/kg-d) Dermal	4-Amino-2,6-DNT EPC[a] (µg/L)	4-Amino-2,6-DNT Intake (mg/kg-d) Ingestion	4-Amino-2,6-DNT Intake (mg/kg-d) Dermal	Nitrobenzene EPC[a] (µg/L)	Nitrobenzene Intake (mg/kg-d) Ingestion	Nitrobenzene Intake (mg/kg-d) Dermal
Weathered (cont.)												
MW-3008	–	–	–	–	–	–	–	–	–	–		
MW-3009	–	–	–	–	–	–	–	–	–	–		
MW-3010	–	–	–	–	–	–	–	–	–	–	–	–
MW-3019	–	–	–	–	–	–	–	–	–	–	–	–
MW-3023	5	1.4×10^{-4}	2.2×10^{-7}	0.17	4.7×10^{-6}	7.5×10^{-9}	0.32	8.8×10^{-6}	1.4×10^{-8}	–	–	–
MW-3025	–	–	–	–	–	–	0.03	8.2×10^{-7}	1.3×10^{-9}	–	–	–
MW-3027	0.04	1.1×10^{-6}	1.8×10^{-9}	0.19	5.2×10^{-6}	8.3×10^{-9}	0.18	4.9×10^{-6}	7.9×10^{-9}	–	–	–
MW-4001	3.1	8.5×10^{-5}	1.4×10^{-7}	16	4.4×10^{-4}	7.0×10^{-7}	22	6.0×10^{-4}	9.6×10^{-7}	–	–	–
MW-4002	0.29	7.9×10^{-6}	1.3×10^{-8}	1.4	3.8×10^{-5}	6.1×10^{-8}	2.3	6.3×10^{-5}	1.0×10^{-7}	–	–	–
MW-4003	–	–	–	0.016	4.4×10^{-7}	7.0×10^{-10}	0.028	7.7×10^{-7}	1.2×10^{-9}	–	–	–
MW-4005	–	–	–	–	–	–	–	–	–	–	–	–
MW-4006	3.1	8.5×10^{-5}	1.4×10^{-7}	1.8	4.9×10^{-5}	7.9×10^{-8}	2.5	6.8×10^{-5}	1.1×10^{-7}	–	–	–
MW-4010	–	–	–	–	–	–	–	–	–	–	–	–
MW-4013	0.74	2.0×10^{-5}	3.2×10^{-8}	1.7	4.7×10^{-5}	7.5×10^{-8}	2.0	5.5×10^{-5}	8.8×10^{-8}	–	–	–
MW-4014	0.087	2.4×10^{-6}	3.8×10^{-9}	0.28	7.7×10^{-6}	1.2×10^{-8}	0.52	1.4×10^{-5}	2.3×10^{-8}	–	–	–
MW-4015	1.1	3.0×10^{-5}	4.8×10^{-8}	3.2	8.8×10^{-5}	1.4×10^{-7}	4.1	1.1×10^{-4}	1.8×10^{-7}	–	–	–
MW-4016	–	–	–	–	–	–	–	–	–	–	–	–
MW-4017	–	–	–	–	–	–	–	–	–	–	–	–
MW-4018	–	–	–	–	–	–	–	–	–	–	–	–
MW-4019	–	–	–	–	–	–	–	–	–	–	–	–
MW-4020	–	–	–	–	–	–	–	–	–	–	–	–
MW-4021	–	–	–	–	–	–	–	–	–	–	–	–
MW-4023	0.023	6.3×10^{-7}	1.0×10^{-9}	0.038	1.0×10^{-6}	1.7×10^{-9}	0.05	1.4×10^{-6}	2.2×10^{-9}	–	–	–
MW-4024	–	–	–	–	–	–	–	–	–	–	–	–
MW-4025	–	–	–	–	–	–	–	–	–	–	–	–
MWD-15	0.64	1.8×10^{-5}	2.8×10^{-8}	0.71	1.9×10^{-5}	3.1×10^{-8}	1.7	4.7×10^{-5}	7.5×10^{-8}	–	–	–
MWD-25	–	–	–	–	–	–	–	–	–	–	–	–
MWD-107	0.09	2.5×10^{-6}	3.9×10^{-9}	0.04	1.1×10^{-6}	1.8×10^{-9}	0.51	1.4×10^{-5}	2.2×10^{-8}	–	–	–
MWD-112	–	–	–	–	–	–	–	–	–	–	–	–
MWS-01	0.64	1.8×10^{-5}	2.8×10^{-8}	–	–	–	0.044	1.2×10^{-6}	1.9×10^{-9}	–	–	–
MWS-02	–	–	–	–	–	–	–	–	–	–	–	–
MWS-03	–	–	–	–	–	–	–	–	–	–	–	–
MWS-04	1.2	3.3×10^{-5}	5.3×10^{-8}	7.6	2.1×10^{-4}	3.3×10^{-7}	8.3	2.3×10^{-4}	3.6×10^{-7}	–	–	–
MWS-07	1.2	3.3×10^{-5}	5.3×10^{-8}	5.6	1.5×10^{-4}	2.5×10^{-7}	11	3.0×10^{-4}	4.8×10^{-7}	–	–	–

TABLE 3.7 (Cont.)

Well ID	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	2-Amino-4,6-DNT EPC[a] (µg/L)	2-Amino-4,6-DNT Intake (mg/kg-d) Ingestion	2-Amino-4,6-DNT Intake (mg/kg-d) Dermal	4-Amino-2,6-DNT EPC[a] (µg/L)	4-Amino-2,6-DNT Intake (mg/kg-d) Ingestion	4-Amino-2,6-DNT Intake (mg/kg-d) Dermal	Nitrobenzene EPC[a] (µg/L)	Nitrobenzene Intake (mg/kg-d) Ingestion	Nitrobenzene Intake (mg/kg-d) Dermal
Weathered (cont.)												
MWS-08	–	–	–	–	–	–	–	–	–	–	–	–
MWS-09	–	–	–	–	–	–	–	–	–	–	–	–
MWS-10	2	5.5×10^{-5}	8.8×10^{-8}	6.3	1.7×10^{-4}	2.8×10^{-7}	16	4.4×10^{-4}	7.0×10^{-7}	–	–	–
MWS-11	0.54	1.5×10^{-5}	2.4×10^{-8}	0.48	1.3×10^{-5}	2.1×10^{-8}	2.3	6.3×10^{-5}	1.0×10^{-7}	–	–	–
MWS-12	15	4.1×10^{-4}	6.6×10^{-7}	1.1	3.0×10^{-5}	4.8×10^{-8}	2.5	6.8×10^{-5}	1.1×10^{-7}	–	–	–
MWS-13	–	–	–	–	–	–	–	–	–	–	–	–
MWS-14	–	–	–	–	–	–	–	–	–	–	–	–
MWS-15	1	2.7×10^{-5}	4.4×10^{-8}	11	3.0×10^{-4}	4.8×10^{-7}	20	5.5×10^{-4}	8.8×10^{-7}	–	–	–
MWS-16	1.2	3.3×10^{-5}	5.3×10^{-8}	4.7	1.3×10^{-4}	2.1×10^{-7}	8.4	2.3×10^{-4}	3.7×10^{-7}	–	–	–
MWS-17	13	3.6×10^{-4}	5.7×10^{-7}	3.9	1.1×10^{-4}	1.7×10^{-7}	4.6	1.3×10^{-4}	2.0×10^{-7}	–	–	–
MWS-19	0.14	3.8×10^{-6}	6.1×10^{-9}	0.27	7.4×10^{-6}	1.2×10^{-8}	0.39	1.1×10^{-5}	1.7×10^{-8}	–	–	–
MWS-20	0.013	3.6×10^{-7}	5.7×10^{-10}	–	–	–	0.057	1.6×10^{-6}	2.5×10^{-9}	–	–	–
MWS-21	0.17	4.7×10^{-6}	7.5×10^{-9}	0.23	6.3×10^{-6}	1.0×10^{-8}	0.51	1.4×10^{-5}	2.2×10^{-8}	–	–	–
MWS-22	0.13	3.6×10^{-6}	5.7×10^{-9}	0.073	2.0×10^{-6}	3.2×10^{-9}	0.19	5.2×10^{-6}	8.3×10^{-9}	–	–	–
MWS-24	–	–	–	–	–	–	–	–	–	–	–	–
MWS-25	–	–	–	–	–	–	–	–	–	–	–	–
MWS-26	–	–	–	–	–	–	–	–	–	–	–	–
MWS-104	–	–	–	–	–	–	–	–	–	–	–	–
MWS-107	0.16	4.4×10^{-6}	7.0×10^{-9}	0.059	1.6×10^{-6}	2.6×10^{-9}	0.65	1.8×10^{-5}	2.8×10^{-8}	–	–	–
MWS-110	0.054	1.5×10^{-6}	2.4×10^{-9}	0.18	4.9×10^{-6}	7.9×10^{-9}	0.37	1.0×10^{-5}	1.6×10^{-8}	–	–	–
MWS-112	0.018	4.9×10^{-7}	7.9×10^{-10}	0.056	1.5×10^{-6}	2.5×10^{-9}	0.14	3.8×10^{-6}	6.1×10^{-9}	0.062	1.7×10^{-6}	2.7×10^{-9}
USGS-2	–	–	–	–	–	–	–	–	–	–	–	–
USGS-3	0.19	5.2×10^{-6}	8.3×10^{-9}	0.025	6.8×10^{-7}	1.1×10^{-9}	0.25	6.8×10^{-6}	1.1×10^{-8}	–	–	–
USGS-4	2.1	5.8×10^{-5}	9.2×10^{-8}	2	5.5×10^{-5}	8.8×10^{-8}	2.2	6.0×10^{-5}	9.6×10^{-8}	–	–	–
USGS-5	–	–	–	–	–	–	–	–	–	–	–	–
USGS-7	–	–	–	–	–	–	–	–	–	–	–	–
USGS-8	–	–	–	–	–	–	–	–	–	–	–	–
USGS-9	0.015	4.1×10^{-7}	6.6×10^{-10}	2.6	7.1×10^{-5}	1.1×10^{-7}	3.7	1.0×10^{-4}	1.6×10^{-7}	–	–	–

TABLE 3.7 (Cont.)

Well ID	o-Nitrotoluene EPC[a] (µg/L)	o-Nitrotoluene Intake (mg/kg-d) Ingestion	o-Nitrotoluene Intake (mg/kg-d) Dermal	m-Nitrotoluene EPC[a] (µg/L)	m-Nitrotoluene Intake (mg/kg-d) Ingestion	m-Nitrotoluene Intake (mg/kg-d) Dermal	p-Nitrotoluene EPC[a] (µg/L)	p-Nitrotoluene Intake (mg/kg-d) Ingestion	p-Nitrotoluene Intake (mg/kg-d) Dermal	1,2-DCE EPC[a] (µg/L)	1,2-DCE Intake (mg/kg-d) Ingestion	1,2-DCE Intake (mg/kg-d) Dermal
Deep Wells												
MWD-05	–	–	–	–	–	–	–	–	–	–	–	–
MWD-18	–	–	–	–	–	–	–	–	–	–	–	–
MWGS-01	–	–	–	–	–	–	–	–	–	–	–	–
MWGS-02	–	–	–	–	–	–	–	–	–	–	–	–
MWS-18	–	–	–	–	–	–	–	–	–	–	–	–
MWS-101	–	–	–	–	–	–	–	–	–	–	–	–
MWS-102	–	–	–	–	–	–	–	–	–	–	–	–
MWS-103	–	–	–	–	–	–	–	–	–	–	–	–
TIL-3	–	–	–	–	–	–	–	–	–	–	–	–
Overburden												
MW-2031	–	–	–	–	–	–	–	–	–	–	–	–
MW-2032	0.21	5.8×10^{-6}	9.2×10^{-9}	0.043	1.2×10^{-6}	1.9×10^{-9}	–	–	–	3.9[c]	1.1×10^{-4}	7.3×10^{-8}
MW-2033	0.65	1.8×10^{-5}	2.8×10^{-8}	0.047	1.3×10^{-6}	2.1×10^{-9}	0.09	2.5×10^{-6}	3.9×10^{-9}	–	–	–
MW-3001	–	–	–	–	–	–	–	–	–	–	–	–
MW-3013	–	–	–	–	–	–	–	–	–	–	–	–
MW-3018	–	–	–	–	–	–	–	–	–	–	–	–
MW-3022	–	–	–	–	–	–	–	–	–	–	–	–
USGS-2A	–	–	–	–	–	–	–	–	–	–	–	–
MWV-01	0.16	4.4×10^{-6}	7.0×10^{-9}	–	–	–	–	–	–	–	–	–
MWV-02	–	–	–	–	–	–	–	–	–	–	–	–
MWV-09	–	–	–	–	–	–	–	–	–	–	–	–
MWV-13	–	–	–	0.13	3.6×10^{-6}	5.7×10^{-9}	0.22	6.0×10^{-6}	9.6×10^{-9}	–	–	–
MWV-16	–	–	–	–	–	–	–	–	–	–	–	–
MWV-17	–	–	–	–	–	–	–	–	–	–	–	–
MWV-18	–	–	–	–	–	–	–	–	–	–	–	–
MWV-22	–	–	–	–	–	–	–	–	–	–	–	–
MWV-24R	0.36	9.9×10^{-6}	1.6×10^{-8}	–	–	–	0.063	1.7×10^{-6}	2.8×10^{-9}	–	–	–

TABLE 3.7 (Cont.)

Well ID	o-Nitrotoluene EPC[a] (µg/L)	o-Nitrotoluene Intake (mg/kg-d) Ingestion	o-Nitrotoluene Intake (mg/kg-d) Dermal	m-Nitrotoluene EPC[a] (µg/L)	m-Nitrotoluene Intake (mg/kg-d) Ingestion	m-Nitrotoluene Intake (mg/kg-d) Dermal	p-Nitrotoluene EPC[a] (µg/L)	p-Nitrotoluene Intake (mg/kg-d) Ingestion	p-Nitrotoluene Intake (mg/kg-d) Dermal	1,2-DCE EPC[a] (µg/L)	1,2-DCE Intake (mg/kg-d) Ingestion	1,2-DCE Intake (mg/kg-d) Dermal
Unweathered												
MW-2019	–	–	–	–	–	–	–	–	–	–	–	–
MW-2021	–	–	–	–	–	–	–	–	–	–	–	–
MW-2022	–	–	–	–	–	–	–	–	–	–	–	–
MW-2023	–	–	–	–	–	–	–	–	–	–		
MW-2024	–	–	–	–	–	–	–	–	–	–	–	–
MW-2025	–	–	–	–	–	–	–	–	–	–	–	–
MW-2026	–	–	–	–	–	–	–	–	–	–	–	–
MW-2027	–	–	–	–	–	–	–	–	–	–	–	–
MW-2028	–	–	–	–	–	–	–	–	–	–	–	–
MW-2029	–	–	–	–	–	–	–	–	–	–	–	–
MW-3002	–	–	–	–	–	–	–	–	–	–	–	–
MW-3006	–	–	–	–	–	–	–	–	–	–	–	–
MW-3024	0.3	8.2×10^{-6}	1.3×10^{-8}	0.041	1.1×10^{-6}	1.8×10^{-9}	–	–	–	0.61[c]	1.7×10^{-5}	1.1×10^{-8}
MW-3026	–	–	–	–	–	–	–	–	–	–	–	–
MW-4004	–	–	–	–	–	–	–	–	–	–	–	–
MW-4007	–	–	–	–	–	–	–	–	–	–	–	–
MW-4008	–	–	–	–	–	–	–	–	–	–	–	–
MW-4009	–	–	–	–	–	–	–	–	–	–	–	–
MW-4011	–	–	–	–	–	–	–	–	–	–	–	–
MW-4012	–	–	–	–	–	–	–	–	–	–	–	–
MW-4022	–	–	–	–	–	–	–	–	–	–	–	–
MWD-02	–	–	–	–	–	–	–	–	–	–	–	–
MWD-06	–	–	–	–	–	–	–	–	–	–	–	–
MWD-09	0.054	1.5×10^{-6}	2.4×10^{-9}	–	–	–	–	–	–	–	–	–
MWD-23	–	–	–	–	–	–	–	–	–	–	–	–
MWD-106	–	–	–	–	–	–	–	–	–	–	–	–
MWS-05	–	–	–	–	–	–	–	–	–	–	–	–
MWS-06	–	–	–	–	–	–	–	–	–	–	–	–
MWS-105	–	–	–	–	–	–	–	–	–	–	–	–
MWS-106	–	–	–	–	–	–	–	–	–	–	–	–
MWS-109	–	–	–	–	–	–	–	–	–	–	–	–
TIL-4	–	–	–	–	–	–	–	–	–	–	–	–
USGS-1	–	–	–	–	–	–	–	–	–	–	–	–
USGS-6	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.7 (Cont.)

Well ID	o-Nitrotoluene EPC[a] (µg/L)	o-Nitrotoluene Intake (mg/kg-d) Ingestion	o-Nitrotoluene Intake (mg/kg-d) Dermal	m-Nitrotoluene EPC[a] (µg/L)	m-Nitrotoluene Intake (mg/kg-d) Ingestion	m-Nitrotoluene Intake (mg/kg-d) Dermal	p-Nitrotoluene EPC[a] (µg/L)	p-Nitrotoluene Intake (mg/kg-d) Ingestion	p-Nitrotoluene Intake (mg/kg-d) Dermal	1,2-DCE EPC[a] (µg/L)	1,2-DCE Intake (mg/kg-d) Ingestion	1,2-DCE Intake (mg/kg-d) Dermal
Weathered												
MW-2001	–	–	–	–	–	–	–	–	–	–	–	–
MW-2002	–	–	–	–	–	–	–	–	–	–		
MW-2003	0.18	4.9×10^{-6}	7.9×10^{-9}	–	–	–	–	–	–	–		
MW-2004	–	–	–	–	–	–	–	–	–	–		
MW-2005	–	–	–	–	–	–	–	–	–	–		
MW-2006	–	–	–	–	–	–	–	–	–	–	–	–
MW-2007	–	–	–	–	–	–	–	–	–	–	–	–
MW-2008	–	–	–	–	–	–	–	–	–	–	–	–
MW-2009	–	–	–	–	–	–	–	–	–	–	–	–
MW-2010	0.083	2.3×10^{-6}	3.6×10^{-9}	–	–	–	–	–	–	–	–	–
MW-2011	0.22	6.0×10^{-6}	9.6×10^{-9}	–	–	–	–	–	–	–	–	–
MW-2012	–	–	–	–	–	–	–	–	–	–	–	–
MW-2013	0.26	7.1×10^{-6}	1.1×10^{-8}	0.058	1.6×10^{-6}	2.5×10^{-9}	0.28	7.7×10^{-6}	1.2×10^{-8}	–	–	–
MW-2014	0.22	6.0×10^{-6}	9.6×10^{-9}	–	–	–	–	–	–	16[c]	4.4×10^{-4}	3.0×10^{-7}
MW-2015	–	–	–	–	–	–	–	–	–	–	–	–
MW-2016	–	–	–	–	–	–	–	–	–	–	–	–
MW-2017	–	–	–	–	–	–	–	–	–	–	–	–
MW-2018	–	–	–	–	–	–	–	–	–	–	–	–
MW-2020	–	–	–	–	–	–	–	–	–	–	–	–
MW-2030	–	–	–	0.06	1.6×10^{-6}	2.6×10^{-9}	–	–	–	–	–	–
MW-2034	–	–	–	–	–	–	–	–	–	–	–	–
MW-2035	–	–	–	–	–	–	–	–	–	–	–	–
MW-2036	–	–	–	–	–	–	–	–	–	–	–	–
MW-2037	–	–	–	–	–	–	–	–	–	22[c]	6.0×10^{-4}	4.1×10^{-7}
MW-2038	0.26	7.1×10^{-6}	1.1×10^{-8}	–	–	–	–	–	–	25[c]	6.8×10^{-4}	4.6×10^{-7}
MW-2039	0.63	1.7×10^{-5}	2.8×10^{-8}	–	–	–	–	–	–	–	–	–
MW-2040	–	–	–	–	–	–	–	–	–	–	–	–
MW-2041	–	–	–	–	–	–	–	–	–	–	–	–
MW-2042	–	–	–	–	–	–	–	–	–	–	–	–
MW-2043	–	–	–	–	–	–	–	–	–	–	–	–
MW-2044	–	–	–	–	–	–	–	–	–	–	–	–
MW-2046	–	–	–	–	–	–	–	–	–	2[c]	5.5×10^{-5}	3.8×10^{-8}
MW-3003	0.5	1.4×10^{-5}	2.2×10^{-8}	0.14	3.8×10^{-6}	6.1×10^{-9}	0.15	4.1×10^{-6}	6.6×10^{-9}	–	–	–
MW-3007	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.7 (Cont.)

Well ID	o-Nitrotoluene EPC[a] (µg/L)	o-Nitrotoluene Intake (mg/kg-d) Ingestion	o-Nitrotoluene Intake (mg/kg-d) Dermal	m-Nitrotoluene EPC[a] (µg/L)	m-Nitrotoluene Intake (mg/kg-d) Ingestion	m-Nitrotoluene Intake (mg/kg-d) Dermal	p-Nitrotoluene EPC[a] (µg/L)	p-Nitrotoluene Intake (mg/kg-d) Ingestion	p-Nitrotoluene Intake (mg/kg-d) Dermal	1,2-DCE EPC[a] (µg/L)	1,2-DCE Intake (mg/kg-d) Ingestion	1,2-DCE Intake (mg/kg-d) Dermal
Weathered (cont.)												
MW-3008	–	–	–	–	–	–	–	–	–	–	–	–
MW-3009	–	–	–	–	–	–	–	–	–	–	–	–
MW-3010	–	–	–	–	–	–	–	–	–	–	–	–
MW-3019	–	–	–	–	–	–	–	–	–	–	–	–
MW-3023	54	1.5×10^{-3}	2.4×10^{-6}	4.3	1.2×10^{-4}	1.9×10^{-7}	0.7	1.9×10^{-5}	3.1×10^{-8}	–	–	–
MW-3025	0.2	5.5×10^{-6}	8.8×10^{-9}	–	–	–	–	–	–	–	–	–
MW-3027	–	–	–	–	–	–	–	–	–	–	–	–
MW-4001	0.83	2.3×10^{-5}	3.6×10^{-8}	–	–	–	–	–	–	–	–	–
MW-4002	–	–	–	–	–	–	–	–	–	–	–	–
MW-4003	–	–	–	–	–	–	–	–	–	–	–	–
MW-4005	–	–	–	–	–	–	–	–	–	–	–	–
MW-4006	0.69	1.9×10^{-5}	3.0×10^{-8}	0.032	8.8×10^{-7}	1.4×10^{-9}	–	–	–	–	–	–
MW-4010	–	–	–	–	–	–	–	–	–	–	–	–
MW-4013	–	–	–	–	–	–	–	–	–	–	–	–
MW-4014	–	–	–	–	–	–	–	–	–	–	–	–
MW-4015	0.11	3.0×10^{-6}	4.8×10^{-9}	–	–	–	–	–	–	–	–	–
MW-4016	–	–	–	–	–	–	–	–	–	–	–	–
MW-4017	–	–	–	–	–	–	–	–	–	–	–	–
MW-4018	–	–	–	–	–	–	–	–	–	–	–	–
MW-4019	–	–	–	–	–	–	–	–	–	–	–	–
MW-4020	–	–	–	–	–	–	–	–	–	–	–	–
MW-4021	–	–	–	–	–	–	–	–	–	–	–	–
MW-4023	–	–	–	–	–	–	–	–	–	–	–	–
MW-4024	–	–	–	–	–	–	–	–	–	–	–	–
MW-4025	–	–	–	–	–	–	–	–	–	–	–	–
MWD-15	–	–	–	–	–	–	–	–	–	–	–	–
MWD-25	–	–	–	–	–	–	–	–	–	–	–	–
MWD-107	–	–	–	–	–	–	–	–	–	–	–	–
MWD-112	–	–	–	–	–	–	–	–	–	–	–	–
MWS-01	–	–	–	–	–	–	–	–	–	–	–	–
MWS-02	–	–	–	–	–	–	–	–	–	–	–	–
MWS-03	–	–	–	–	–	–	–	–	–	–	–	–
MWS-04	0.21	5.8×10^{-6}	9.2×10^{-9}	–	–	–	–	–	–	–	–	–
MWS-07	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.7 (Cont.)

Well ID	o-Nitrotoluene EPC[a] (µg/L)	o-Nitrotoluene Intake (mg/kg-d) Ingestion	o-Nitrotoluene Intake (mg/kg-d) Dermal	m-Nitrotoluene EPC[a] (µg/L)	m-Nitrotoluene Intake (mg/kg-d) Ingestion	m-Nitrotoluene Intake (mg/kg-d) Dermal	p-Nitrotoluene EPC[a] (µg/L)	p-Nitrotoluene Intake (mg/kg-d) Ingestion	p-Nitrotoluene Intake (mg/kg-d) Dermal	1,2-DCE EPC[a] (µg/L)	1,2-DCE Intake (mg/kg-d) Ingestion	1,2-DCE Intake (mg/kg-d) Dermal
Weathered (cont.)												
MWS-08	–	–	–	–	–	–	–	–	–	–	–	–
MWS-09	–	–	–	–	–	–	–	–	–	–	–	–
MWS-10	0.1	2.7×10^{-6}	4.4×10^{-9}	–	–	–	–	–	–	–	–	–
MWS-11	–	–	–	–	–	–	–	–	–	–	–	–
MWS-12	100	2.7×10^{-3}	4.4×10^{-6}	7.7	2.1×10^{-4}	3.4×10^{-7}	30	8.2×10^{-4}	1.3×10^{-6}	–	–	–
MWS-13	–	–	–	–	–	–	–	–	–	–	–	–
MWS-14	–	–	–	–	–	–	–	–	–	–	–	–
MWS-15	–	–	–	–	–	–	–	–	–	–	–	–
MWS-16	0.16	4.4×10^{-6}	7.0×10^{-9}	–	–	–	–	–	–	–	–	–
MWS-17	8.8	2.4×10^{-4}	3.9×10^{-7}	0.31	8.5×10^{-6}	1.4×10^{-8}	0.93	2.5×10^{-5}	4.1×10^{-8}	–	–	–
MWS-19	–	–	–	–	–	–	–	–	–	–	–	–
MWS-20	–	–	–	–	–	–	–	–	–	–	–	–
MWS-21	0.15	4.1×10^{-6}	6.6×10^{-9}	–	–	–	–	–	–	–	–	–
MWS-22	–	–	–	–	–	–	–	–	–	–	–	–
MWS-24	–	–	–	–	–	–	–	–	–	–	–	–
MWS-25	–	–	–	–	–	–	–	–	–	–	–	–
MWS-26	–	–	–	–	–	–	–	–	–	–	–	–
MWS-104	–	–	–	–	–	–	–	–	–	–	–	–
MWS-107	–	–	–	–	–	–	–	–	–	–	–	–
MWS-110	–	–	–	–	–	–	–	–	–	–	–	–
MWS-112	–	–	–	–	–	–	–	–	–	–	–	–
USGS-2	–	–	–	–	–	–	–	–	–	–	–	–
USGS-3	–	–	–	–	–	–	–	–	–	–	–	–
USGS-4	1.0	2.7×10^{-5}	4.4×10^{-8}	0.11	3.0×10^{-6}	4.8×10^{-9}	–	–	–	–	–	–
USGS-5	–	–	–	–	–	–	–	–	–	–	–	–
USGS-7	–	–	–	–	–	–	–	–	–	–	–	–
USGS-8	–	–	–	–	–	–	–	–	–	–	–	–
USGS-9	–	–	–	–	–	–	–	–	–	–	–	–

[a] EPC values are the maximum concentrations reported from the 1995 joint DOE/DA sampling rounds or the maximum 95% UCL from 1996-1997 (indicated by footnote c).

[b] A hyphen (–) indicates the parameter was not detected.

[c] EPC values are the maximum 95% UCL reported from samples collected in 1996-1997.

TABLE 3.8 Estimated Carcinogenic Intakes of Organic Compound COPCs for the Hypothetical Future Resident

Well ID	2,4,6-TNT			2,4-DNT			2,6-DNT			TCE[b]		
	EPC[a] (µg/L)	Intake (mg/kg-d) Ingestion	Intake (mg/kg-d) Dermal	EPC[a] (µg/L)	Intake (mg/kg-d) Ingestion	Intake (mg/kg-d) Dermal	EPC[a] (µg/L)	Intake (mg/kg-d) Ingestion	Intake (mg/kg-d) Dermal	EPC[a] (µg/L)	Intake (mg/kg-d) Ingestion	Intake (mg/kg-d) Dermal
Deep Wells												
MWD-05	–[c]	–	–	–	–	–	–	–	–	–	–	–
MWD-18	–	–	–	–	–	–	–	–	–	–	–	–
MWGS-01	–	–	–	–	–	–	–	–	–	–	–	–
MWGS-02	–	–	–	–	–	–	–	–	–	–	–	–
MWS-18	–	–	–	–	–	–	–	–	–	–	–	–
MWS-101	–	–	–	–	–	–	–	–	–	–	–	–
MWS-102	–	–	–	–	–	–	–	–	–	–	–	–
MWS-103	–	–	–	–	–	–	–	–	–	–	–	–
TIL-3	–	–	–	–	–	–	–	–	–	–	–	–
Overburden												
MW-2031	–	–	–	–	–	–	–	–	–	–	–	–
MW-2032	6.7	7.9×10^{-5}	1.3×10^{-7}	0.14	1.6×10^{-6}	2.6×10^{-9}	4.4	5.2×10^{-5}	8.3×10^{-8}	0.63	7.4×10^{-6} (2.0×10^{-5})	1.9×10^{-8}
MW-2033	1.2	1.4×10^{-5}	2.3×10^{-8}	0.55	6.5×10^{-6}	1.0×10^{-8}	4.9	5.8×10^{-5}	9.2×10^{-8}	–	–	–
MW-3001	–	–	–	–	–	–	–	–	–	–	–	–
MW-3013	–	–	–	–	–	–	–	–	–	–	–	–
MW-3018	–	–	–	–	–	–	–	–	–	–	–	–
MW-3022	–	–	–	–	–	–	–	–	–	–	–	–
USGS-2A	–	–	–	–	–	–	–	–	–	–	–	–
MWV-01	11	1.3×10^{-4}	2.1×10^{-7}	0.11	1.3×10^{-6}	2.1×10^{-9}	1.0	1.2×10^{-5}	1.9×10^{-8}	–	–	–
MWV-02	0.11	1.3×10^{-6}	2.1×10^{-9}	0.059	6.9×10^{-7}	1.1×10^{-9}	0.048	5.6×10^{-7}	9.0×10^{-10}	–	–	–
MWV-09	30	3.5×10^{-4}	5.6×10^{-7}	20	2.3×10^{-4}	3.8×10^{-7}	2.9	3.4×10^{-5}	5.4×10^{-8}	–	–	–
MWV-13	–	–	–	–	–	–	–	–	–	–	–	–
MWV-16	0.27	3.2×10^{-6}	5.1×10^{-9}	–	–	–	0.069	8.1×10^{-7}	1.3×10^{-9}	–	–	–
MWV-17	–	–	–	–	–	–	–	–	–	–	–	–
MWV-18	–	–	–	–	–	–	–	–	–	–	–	–
MWV-22	–	–	–	–	–	–	0.14	1.6×10^{-6}	2.6×10^{-9}	–	–	–
MWV-24R	1.1	1.3×10^{-5}	2.1×10^{-8}	0.13	1.5×10^{-6}	2.4×10^{-9}	1.4	1.6×10^{-5}	2.6×10^{-8}	–	–	–

TABLE 3.8 (Cont.)

Well ID	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	TCE[b] EPC[a] (µg/L)	TCE[b] Intake (mg/kg-d) Ingestion	TCE[b] Intake (mg/kg-d) Dermal
Unweathered												
MW-2019	–	–	–	–	–	–	–	–	–	–	–	–
MW-2021	–	–	–	–	–	–	–	–	–	–	–	–
MW-2022	–	–	–	–	–	–	–	–	–	–	–	–
MW-2023	–	–	–	–	–	–	–	–	–	–	–	–
MW-2024	–	–	–	–	–	–	–	–	–	–	–	–
MW-2025	–	–	–	–	–	–	–	–	–	–	–	–
MW-2026	–	–	–	–	–	–	–	–	–	–	–	–
MW-2027	–	–	–	–	–	–	–	–	–	–	–	–
MW-2028	–	–	–	–	–	–	–	–	–	–	–	–
MW-2029	–	–	–	–	–	–	–	–	–	–	–	–
MW-3002	–	–	–	–	–	–	–	–	–	–	–	–
MW-3006	–	–	–	–	–	–	–	–	–	–	–	–
MW-3024	–	–	–	0.13	1.5×10^{-6}	2.4×10^{-9}	0.45	5.3×10^{-6}	8.5×10^{-9}	50	5.9×10^{-1} (1.6×10^{-3})	1.5×10^{-6}
MW-3026	–	–	–	0.072	8.5×10^{-7}	1.4×10^{-9}	0.046	5.4×10^{-7}	8.6×10^{-10}	–	–	–
MW-4004	–	–	–	–	–	–	–	–	–	–	–	–
MW-4007	–	–	–	–	–	–	–	–	–	–	–	–
MW-4008	–	–	–	–	–	–	–	–	–	–	–	–
MW-4009	–	–	–	–	–	–	–	–	–	–	–	–
MW-4011	–	–	–	–	–	–	0.065	7.6×10^{-7}	1.2×10^{-9}	–	–	–
MW-4012	–	–	–	–	–	–	–	–	–	–	–	–
MW-4022	–	–	–	–	–	–	–	–	–	–	–	–
MWD-02	–	–	–	–	–	–	–	–	–	–	–	–
MWD-06	–	–	–	–	–	–	–	–	–	–	–	–
MWD-09	–	–	–	0.042	4.9×10^{-7}	7.9×10^{-10}	0.16	1.9×10^{-6}	3.0×10^{-9}	–	–	–
MWD-23	–	–	–	–	–	–	–	–	–	–	–	–
MWD-106	–	–	–	–	–	–	–	–	–	–	–	–
MWS-05	–	–	–	–	–	–	–	–	–	–	–	–
MWS-06	–	–	–	–	–	–	–	–	–	–	–	–
MWS-105	–	–	–	–	–	–	–	–	–	–	–	–
MWS-106	–	–	–	–	–	–	–	–	–	–	–	–
MWS-109	–	–	–	–	–	–	–	–	–	–	–	–
TIL-4	–	–	–	–	–	–	–	–	–	–	–	–
USGS-1	–	–	–	0.051	6.0×10^{-7}	9.6×10^{-10}	0.022	2.6×10^{-7}	4.1×10^{-10}	–	–	–
USGS-6	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.8 (Cont.)

Well ID	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	TCE[b] EPC[a] (µg/L)	TCE[b] Intake (mg/kg-d) Ingestion	TCE[b] Intake (mg/kg-d) Dermal
Weathered												
MW-2001	–	–	–	0.13	1.5×10^{-6}	2.4×10^{-9}	0.056	6.6×10^{-7}	1.1×10^{-9}	–	–	–
MW-2002	–	–	–	0.07	8.2×10^{-7}	1.3×10^{-9}	0.41	4.8×10^{-6}	7.7×10^{-8}	–	–	–
MW-2003	–	–	–	0.15	1.8×10^{-6}	2.8×10^{-9}	0.45	5.3×10^{-6}	8.5×10^{-8}	–	–	–
MW-2004	–	–	–	–	–	–	–	–	–	–	–	–
MW-2005	–	–	–	0.061	7.2×10^{-7}	1.1×10^{-9}	0.090	1.1×10^{-6}	1.7×10^{-8}	–	–	–
MW-2006	–	–	–	0.14	1.6×10^{-6}	2.6×10^{-9}	0.0090	1.1×10^{-7}	1.7×10^{-10}	–	–	–
MW-2007	–	–	–	–	–	–	–	–	–	–	–	–
MW-2008	–	–	–	–	–	–	–	–	–	–	–	–
MW-2009	–	–	–	–	–	–	–	–	–	–	–	–
MW-2010	0.34	4.0×10^{-6}	6.4×10^{-9}	0.094	1.1×10^{-6}	1.8×10^{-9}	0.75	8.8×10^{-6}	1.4×10^{-8}	–	–	–
MW-2011	–	–	–	0.20	2.3×10^{-6}	3.8×10^{-9}	1.6	1.9×10^{-5}	3.0×10^{-8}	–	–	–
MW-2012	0.46	5.4×10^{-6}	8.6×10^{-9}	0.099	1.2×10^{-6}	1.9×10^{-9}	0.65	7.6×10^{-6}	1.2×10^{-8}	–	–	–
MW-2013	0.85	1.0×10^{-5}	1.6×10^{-8}	0.36	4.2×10^{-6}	6.8×10^{-9}	4.4	5.2×10^{-5}	8.3×10^{-8}	2.0	2.3×10^{-5} (6.5×10^{-5})	6.0×10^{-8}
MW-2014	0.044	5.2×10^{-7}	8.3×10^{-10}	0.16	1.9×10^{-6}	3.0×10^{-9}	0.41	4.8×10^{-6}	7.7×10^{-9}	–	–	–
MW-2015	–	–	–	–	–	–	–	–	–	–	–	–
MW-2016	–	–	–	–	–	–	–	–	–	–	–	–
MW-2017	–	–	–	–	–	–	–	–	–	–	–	–
MW-2018	–	–	–	–	–	–	–	–	–	–	–	–
MW-2020	–	–	–	–	–	–	–	–	–	–	–	–
MW-2030	29	3.4×10^{-4}	5.4×10^{-7}	0.25	2.9×10^{-6}	4.7×10^{-9}	11	1.3×10^{-4}	2.1×10^{-7}	–	–	–
MW-2034	–	–	–	–	–	–	–	–	–	–	–	–
MW-2035	–	–	–	–	–	–	–	–	–	–	–	–
MW-2036	–	–	–	–	–	–	–	–	–			
MW-2037	–	–	–	0.56	6.6×10^{-6}	1.1×10^{-8}	0.13	1.5×10^{-6}	2.4×10^{-9}	1,200	1.5×10^{-2} (4.0×10^{-2})	3.7×10^{-5}
MW-2038	–	–	–	1.7	2.0×10^{-5}	3.2×10^{-8}	0.32	3.8×10^{-6}	6.0×10^{-9}	3,800	4.5×10^{-2} (1.2×10^{-1})	1.1×10^{-4}
MW-2039	–	–	–	0.12	1.4×10^{-6}	2.3×10^{-9}	1.7	2.0×10^{-5}	3.2×10^{-8}	–	–	–
MW-2040	–	–	–	–	–	–	–	–	–	–	–	–
MW-2041	–	–	–	–	–	–	–	–	–	–	–	–
MW-2042	–	–	–	–	–	–	–	–	–	–	–	–
MW-2043	–	–	–	0.087	1.0×10^{-6}	1.6×10^{-9}	–	–	–	–	–	–
MW-2044	–	–	–	–	–	–	–	–	–	–	–	–
MW-3003	–	–	–	0.17	2.0×10^{-6}	3.2×10^{-9}	0.085	1.0×10^{-6}	1.6×10^{-9}	–	–	–

TABLE 3.8 (Cont.)

Well ID	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	TCE[b] EPC[a] (µg/L)	TCE[b] Intake (mg/kg-d) Ingestion	TCE[b] Intake (mg/kg-d) Dermal
Weathered (cont.)												
MW-3007	–	–	–	–	–	–	–	–	–	–	–	–
MW-3008	–	–	–	–	–	–	–	–	–	–	–	–
MW-3009	–	–	–	–	–	–	–	–	–	–	–	–
MW-3010	–	–	–	–	–	–	–	–	–	–	–	–
MW-3019	–	–	–	–	–	–	–	–	–	–	–	–
MW-3023	–	–	–	5.0	5.9×10^{-5}	9.4×10^{-8}	5.0	5.9×10^{-5}	9.4×10^{-8}	–	–	–
MW-3025	–	–	–	0.094	1.1×10^{-6}	1.8×10^{-9}	–	–	–	36	4.3×10^{-4} (1.2×10^{-3})	1.1×10^{-6}
MW-3027	–	–	–	0.058	6.8×10^{-7}	1.1×10^{-9}	0.040	4.7×10^{-7}	7.5×10^{-10}	2.7	3.1×10^{-5} (8.7×10^{-5})	8.0×10^{-8}
MW-4001	1.8	2.1×10^{-5}	3.4×10^{-8}	1.3	1.5×10^{-5}	2.4×10^{-8}	3.1	3.6×10^{-5}	5.8×10^{-8}	4.0	4.7×10^{-5} (1.3×10^{-4})	1.2×10^{-7}
MW-4002	1.8	2.1×10^{-5}	3.4×10^{-8}	0.14	1.6×10^{-6}	2.6×10^{-9}	0.29	3.4×10^{-6}	5.4×10^{-9}	–	–	–
MW-4003	–	–	–	–	–	–	–	–	–	–	–	–
MW-4005	–	–	–	–	–	–	–	–	–	–	–	–
MW-4006	–	–	–	0.16	1.9×10^{-6}	3.0×10^{-9}	3.1	3.6×10^{-5}	5.8×10^{-8}	–	–	–
MW-4010	–	–	–	–	–	–	–	–	–	–	–	–
MW-4013	0.046	5.4×10^{-7}	8.6×10^{-10}	0.077	9.0×10^{-7}	1.4×10^{-9}	0.74	8.7×10^{-6}	1.4×10^{-8}	–	–	–
MW-4014	–	–	–	0.026	3.1×10^{-7}	4.9×10^{-10}	0.087	1.0×10^{-6}	1.6×10^{-9}	–	–	–
MW-4015	–	–	–	0.19	2.2×10^{-6}	3.6×10^{-9}	1.1	1.3×10^{-5}	2.1×10^{-8}	–	–	–
MW-4016	–	–	–	–	–	–	–	–	–	–	–	–
MW-4017	–	–	–	–	–	–	–	–	–	–	–	–
MW-4018	–	–	–	–	–	–	–	–	–	–	–	–
MW-4019	–	–	–	–	–	–	–	–	–	–	–	–
MW-4020	–	–	–	–	–	–	–	–	–	–	–	–
MW-4021	–	–	–	–	–	–	–	–	–	–	–	–
MW-4023	–	–	–	0.067	7.9×10^{-7}	1.3×10^{-9}	0.023	2.7×10^{-7}	4.3×10^{-10}	–	–	–
MW-4024	–	–	–	–	–	–	–	–	–	–	–	–
MW-4025	–	–	–	–	–	–	–	–	–	–	–	–
MWD-15	–	–	–	–	–	–	0.64	7.5×10^{-6}	1.2×10^{-8}	–	–	–
MWD-25	–	–	–	–	–	–	–	–	–	–	–	–
MWD-107	–	–	–	0.020	2.3×10^{-7}	3.8×10^{-10}	0.090	1.1×10^{-6}	1.7×10^{-9}	–	–	–
MWD-112	–	–	–	–	–	–	–	–	–	–	–	–
MWS-01	–	–	–	–	–	–	0.64	7.5×10^{-6}	1.2×10^{-8}	–	–	–
MWS-02	–	–	–	–	–	–	–	–	–	–	–	–
MWS-03	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3.8 (Cont.)

Well ID	2,4,6-TNT EPC[a] (µg/L)	2,4,6-TNT Intake (mg/kg-d) Ingestion	2,4,6-TNT Intake (mg/kg-d) Dermal	2,4-DNT EPC[a] (µg/L)	2,4-DNT Intake (mg/kg-d) Ingestion	2,4-DNT Intake (mg/kg-d) Dermal	2,6-DNT EPC[a] (µg/L)	2,6-DNT Intake (mg/kg-d) Ingestion	2,6-DNT Intake (mg/kg-d) Dermal	TCE[b] EPC[a] (µg/L)	TCE[b] Intake (mg/kg-d) Ingestion	TCE[b] Intake (mg/kg-d) Dermal
Weathered (cont.)												
MWS-01	1.2	1.4×10^{-5}	2.3×10^{-8}	0.10	1.2×10^{-6}	1.9×10^{-9}	1.2	1.4×10^{-5}	2.3×10^{-8}	–	–	–
MWS-07	2.6	3.1×10^{-5}	4.9×10^{-8}	0.049	5.8×10^{-7}	9.2×10^{-10}	1.2	1.4×10^{-5}	2.3×10^{-8}	–	–	–
MWS-08	–	–	–	–	–	–	–	–	–	–	–	–
MWS-09	–	–	–	–	–	–	–	–	–	–		
MWS-10	0.028	3.3×10^{-7}	5.3×10^{-10}	0.082	9.6×10^{-7}	1.5×10^{-9}	2.0	2.3×10^{-5}	3.8×10^{-8}	–	–	
MWS-11	0.046	5.4×10^{-7}	8.6×10^{-10}	0.055	6.5×10^{-7}	1.0×10^{-9}	0.54	6.3×10^{-6}	1.0×10^{-8}	–	–	–
MWS-12	0.18	2.1×10^{-6}	3.4×10^{-9}	8.8	1.0×10^{-4}	1.7×10^{-7}	15	1.8×10^{-4}	2.8×10^{-7}	–	–	–
MWS-13	–	–	–	–	–	–	–	–	–	–	–	–
MWS-14	–	–		–	–	–	–	–	–	–	–	
MWS-15	5.9	6.9×10^{-5}	1.1×10^{-7}	0.081	9.5×10^{-7}	1.5×10^{-9}	1.0	1.2×10^{-5}	1.9×10^{-8}	–	–	–
MWS-16	2.9	3.4×10^{-5}	5.4×10^{-8}	0.092	1.1×10^{-6}	1.7×10^{-9}	1.2	1.4×10^{-5}	2.3×10^{-8}	–	–	–
MWS-17	0.15	1.8×10^{-6}	2.8×10^{-9}	1.1	1.3×10^{-5}	2.1×10^{-8}	13	1.5×10^{-4}	2.4×10^{-7}	–	–	–
MWS-19	–	–	–	0.08	9.4×10^{-7}	1.5×10^{-9}	0.14	1.6×10^{-6}	2.6×10^{-9}	–	–	–
MWS-20	–	–	–	–	–	–	0.013	1.5×10^{-7}	2.4×10^{-10}	–	–	–
MWS-21	–	–	–	0.94	1.1×10^{-5}	1.8×10^{-8}	0.17	2.0×10^{-6}	3.2×10^{-9}	800	9.4×10^{-3} (2.6×10^{-2})	2.4×10^{-5}
MWS-22	–	–	–	0.025	2.9×10^{-7}	4.7×10^{-10}	0.13	1.5×10^{-6}	2.4×10^{-9}	–	–	–
MWS-24	–	–	–	–	–	–	–	–	–	–	–	–
MWS-25	–	–	–	–	–	–	–	–	–	–	–	–
MWS-26	–	–	–	–	–	–	–	–	–	–	–	–
MWS-104	–	–	–	–	–	–	–	–	–	–	–	–
MWS-107	–	–	–	0.059	6.9×10^{-7}	1.1×10^{-9}	0.16	1.9×10^{-6}	3.0×10^{-9}	–	–	–
MWS-110	–	–	–	–	–	–	0.054	6.3×10^{-7}	1.0×10^{-9}	–	–	–
MWS-112	–	–	–	0.056	6.6×10^{-7}	1.1×10^{-9}	0.018	2.1×10^{-7}	3.4×10^{-10}	–	–	–
USGS-2	–	–	–	–	–	–	–	–	–	–	–	–
USGS-3	–	–	–	0.022	2.6×10^{-7}	4.1×10^{-10}	1.9	2.2×10^{-6}	3.6×10^{-9}	–	–	–
USGS-4	–	–	–	1.5	1.8×10^{-5}	2.8×10^{-8}	2.1	2.5×10^{-5}	3.9×10^{-8}	–	–	–
USGS-5	–	–	–	–	–	–	–	–	–	–	–	–
USGS-7	–	–	–	–	–	–	–	–	–	–	–	–
USGS-8	–	–	–	–	–	–	–	–	–	–	–	–
USGS-9	–	–	–	0.092	1.1×10^{-6}	1.7×10^{-9}	0.015	1.8×10^{-7}	2.8×10^{-10}	–	–	–

[a] EPC values are maximum concentrations reported from the 1995 joint DOE/DA sampling rounds.

[b] Values in parentheses are inhalation intake estimates for TCE. The EPCs for TCE were derived from data obtained in 1996 and 1997 sampling activities at chemical plant area wells.

[c] A hyphen (–) indicates the parameter was not detected.

TABLE 3.9 Estimated Intakes of Uranium for the Hypothetical Future Resident

Well ID	Uranium EPC[a] (pCi/L)	Uranium Intake (pCi) Ingestion	Uranium Intake (pCi) Dermal
Deep Wells			
MWD-05	0.58	1.2×10^4	1.9×10^1
MWD-18	0.78	1.6×10^4	2.6×10^1
MWGS-01	–	–	–
MWGS-02	–	–	–
MWS-18	1.5	3.2×10^4	5.2×10^1
MWS-101	0.53	1.1×10^4	1.8×10^1
MWS-102	2.6	5.4×10^4	8.7×10^1
MWS-103	0.76	1.6×10^4	2.6×10^1
TIL-3	0.11	2.2×10^3	3.6
Overburden			
MW-2031	–	–	–
MW-2032	4.2	8.8×10^4	1.4×10^2
MW-2033	2.4	4.9×10^4	7.9×10^1
MW-3001	–	–	–
MW-3013	–	–	–
MW-3018	–	–	–
MW-3022	–	–	–
MW-3024	–	–	–
MWV-01	4.1	8.7×10^4	1.4×10^2
MWV-02	3	6.4×10^4	1.0×10^2
MWV-09	0.72	1.5×10^4	2.4×10^1
MWV-13	1.5	3.0×10^4	4.9×10^1
MWV-16	1.2	2.4×10^4	3.9×10^1
MWV-17	0.061	1.3×10^3	2.0
MWV-18	–	–	–
MWV-22	0.88	1.9×10^4	3.0×10^1
MWV-24R	1.5	3.2×10^4	5.0×10^1
Unweathered			
MW-2019	3.0	6.3×10^4	1.0×10^2
MW-2021	0.87	1.8×10^4	2.9×10^1
MW-2022	1.3	2.6×10^4	4.2×10^1
MW-2023	2.5	5.3×10^4	8.5×10^1
MW-2024	0.11	2.3×10^3	3.8
MW-2025	–	–	–
MW-2026	0.81	1.7×10^4	2.7×10^1
MW-2027	0.81	1.7×10^4	2.7×10^1
MW-2028	1.3	2.7×10^4	4.3×10^1
MW-2029	–	–	–
MW-3002	–	–	–
Unweathered (cont.)			
MW-3006	0.7	1.5×10^4	2.4×10^1
MW-3024	3.1	6.4×10^4	1.0×10^2
MW-3026	4.2	9.0×10^4	1.4×10^2
MW-4004	2.1	4.5×10^4	7.2×10^1
MW-4007	1.8	3.6×10^4	5.9×10^1
MW-4008	0.83	1.7×10^4	2.8×10^1
MW-4009	1.7	3.6×10^4	5.7×10^1
MW-4011	3.1	6.6×10^4	1.0×10^2
MW-4012	5.0	1.1×10^5	1.7×10^2
MW-4022	5.2	1.1×10^5	1.7×10^2
MWD-02	2.6	5.4×10^4	8.6×10^1
MWD-06	0.58	1.2×10^4	1.9×10^1
MWD-09	0.93	2.0×10^4	3.1×10^1
MWD-23	5.0	1.1×10^5	1.7×10^2
MWD-106	–	–	–
MWS-05	0.99	2.1×10^4	3.3×10^1
MWS-06	2.9	6.0×10^4	9.6×10^1
MWS-105	1.3	3.6×10^{-2}	5.5
MWS-106	1.6	4.4×10^{-2}	3.9×10^1
MWS-109	1.0	2.7×10^{-2}	3.4×10^1
TIL-4	–	–	–
USGS-1	1.1	2.2×10^4	3.5×10^1
USGS-6	1.8	4.9×10^{-2}	1.3×10^2
Weathered			
MW-2001	0.65	1.4×10^4	2.2×10^1
MW-2002	0.48	1.0×10^4	1.6×10^1
MW-2003	1.1	2.2×10^4	3.6×10^1
MW-2004	–	–	–
MW-2005	0.45	9.6×10^3	1.5×10^1
MW-2006	0.48	1.0×10^4	1.6×10^1
MW-2007	1.0	2.1×10^4	3.4×10^1
MW-2008	–	–	–
MW-2009	–	–	–
MW-2010	1.2	2.6×10^4	4.1×10^1
MW-2011	0.3	6.3×10^3	9.9
MW-2012	0.33	6.9×10^3	1.1×10^1
MW-2013	0.66	1.4×10^4	2.2×10^1
MW-2014	0.49	1.0×10^4	1.6×10^1
MW-2015	1.9	4.0×10^4	6.5×10^1
MW-2016	–	–	–

TABLE 3.9 (Cont.)

Well ID	Uranium EPC[a] (pCi/L)	Uranium Intake (pCi) Ingestion	Uranium Intake (pCi) Dermal
Weathered (cont.)			
MW-2017	12	2.5×10^5	4.0×10^2
MW-2018	1.6	3.3×10^4	5.2×10^1
MW-2020	–	–	–
MW-2030	13	2.6×10^5	4.2×10^2
MW-2034	3.0	6.3×10^4	1.0×10^2
MW-2035	0.4	8.4×10^3	1.3×10^1
MW-2036	0.77	1.6×10^4	2.6×10^1
MW-2037	1.2	2.6×10^5	4.2×10^1
MW-2038	1.5	3.0×10^4	4.9×10^1
MW-2039	3.1	6.6×10^4	1.0×10^2
MW-2040	3.0	6.3×10^4	1.0×10^2
MW-2041	3.4	6.9×10^4	1.1×10^2
MW-2042	2.6	5.4×10^4	8.7×10^1
MW-2043	1.8	3.9×10^4	6.0×10^1
MW-2044	2.3	4.8×10^4	7.6×10^1
MW-3003	19	3.9×10^5	6.3×10^2
MW-3007	–	–	–
MW-3008	–	–	–
MW-3009	–	–	–
MW-3010	–	–	–
MW-3019	2.1	4.5×10^4	7.1×10^1
MW-3023	13	2.7×10^5	4.3×10^2
MW-3025	2.8	5.8×10^4	9.3×10^1
MW-3027	1.3	2.6×10^4	4.2×10^1
MW-4001	0.41	8.6×10^3	1.4×10^1
MW-4002	0.6	1.3×10^4	2.0×10^1
MW-4003	1.1	2.4×10^4	3.8×10^1
MW-4005	1.6	3.3×10^4	5.3×10^1
MW-4006	0.26	5.5×10^3	8.8
MW-4010	3.1	6.4×10^4	1.0×10^2
MW-4013	1.2	2.5×10^4	4.0×10^1
MW-4014	0.22	4.7×10^3	7.5
MW-4015	0.32	6.7×10^3	1.1×10^1
MW-4016	3.2	6.7×10^4	1.1×10^2
MW-4017	–	–	–
MW-4018	0.64	1.4×10^4	2.1×10^1
MW-4019	1.7	3.6×10^4	5.7×10^1
MW-4020	9.7	2.0×10^5	3.3×10^2
MW-4021	3.1	6.6×10^4	1.0×10^2
Weathered (cont.)			
MW-4023	1.6	3.3×10^4	5.2×10^1
MW-4024	60	1.3×10^6	2.0×10^3
MW-4025	1.0	2.2×10^4	3.5×10^1
MWD-15	0.49	1.0×10^4	1.7×10^1
MWD-25	1.8	3.7×10^4	5.9×10^1
MWD-107	2	4.3×10^4	6.8×10^1
MWD-112	0.77	1.6×10^4	2.6×10^1
MWS-01	1.3	2.7×10^4	4.4×10^1
MWS-02	2	4.2×10^4	6.8×10^1
MWS-03	3.3	6.9×10^4	1.1×10^2
MWS-04	10	2.1×10^5	3.4×10^2
MWS-07	0.73	1.5×10^4	2.4×10^1
MWS-08	1.1	2.4×10^4	3.8×10^1
MWS-09	1.2	2.5×10^4	4.0×10^1
MWS-10	0.13	2.8×10^3	4.5
MWS-11	1.7	3.6×10^4	5.7×10^1
MWS-12	1	2.1×10^4	3.4×10^1
MWS-13	0.54	1.1×10^4	1.8×10^1
MWS-14	2.7	5.6×10^4	9.0×10^1
MWS-15	0.56	1.2×10^4	1.9×10^1
MWS-16	0.66	1.4×10^4	2.2×10^1
MWS-17	1.2	2.5×10^4	3.9×10^1
MWS-19	1.3	2.7×10^4	4.3×10^1
MWS-20	0.69	1.4×10^4	2.3×10^1
MWS-21	3	6.3×10^4	1.0×10^2
MWS-22	1.2	2.5×10^4	4.0×10^1
MWS-24	–	–	–
MWS-25	1.6	3.3×10^4	5.3×10^1
MWS-26	4	8.3×10^4	1.3×10^2
MWS-104	1.3	2.7×10^4	4.4×10^1
MWS-107	1.8	3.8×10^4	6.1×10^1
MWS-110	0.63	1.3×10^4	2.1×10^1
MWS-112	2.7	5.7×10^4	9.1×10^1
USGS-2	0.001	2.1×10^1	3.4×10^{-2}
USGS-3	1.4	3.0×10^4	4.8×10^1
USGS-4	0.54	1.1×10^4	1.8×10^1
USGS-5	4.9	1.0×10^5	1.6×10^2
USGS-8	0.62	1.3×10^4	2.1×10^1
USGS-9	0.35	7.2×10^3	1.2×10^1

[a] EPC values are the maximum concentrations reported for uranium from each well from the 1995 joint DOE/DA sampling rounds.

TABLE 3.10 Exposure Factors for the American Robin[a]

Exposure Factor	Mean	Range or 95% UCL	Geographic Location	Source
Body weight (g)	77	63 – 100	Pennsylvania	Clench and Leberman (1978)
Water ingestion rate (g/g-d)	0.14	–	–	Estimated[b]
Home range (ha)	0.81	–	Ontario	Weatherhead and McRae (1990)

[a] A hyphen (–) indicates that the information was not applicable or not available.

[b] Estimated using the following allometric equations (EPA 1993):

Water Ingestion Rate (L/d) = $0.059W^{0.67}$, where W equals weight (0.077 kg); and

Normalized Water Ingestion Rate (g/g-d) = (Water Ingestion [g/d]) ÷ W (g).

TABLE 3.11 Exposure Factors for the White-Tailed Deer[a]

Exposure Factor	Mean	Range or 95% UCL	Geographic Location	Source
Body weight (g)	90,000	–	Missouri	Schwartz and Schwartz (1981)
Water ingestion rate (g/g-d)	0.06	–	–	Estimated[b]
Home range (ha)	160	260	Missouri	Schwartz and Schwartz (1981)

[a] A hyphen (–) indicates that the information was not applicable or not available.

[b] Estimated using the following allometric equations (EPA 1993):

Water Ingestion Rate (L/d) = $0.099W^{0.90}$, where W equals weight (90.0 kg); and

Normalized Water Ingestion Rate (g/g-d) = (Water Ingestion [g/d]) ÷ W (g).

TABLE 3.12 Results of Acute and Chronic Toxicity Testing of Surface Water from Burgermeister Spring[a]

	Toxicity Test Results at Sampling Location[b]			
Organism/Toxicity Test	SP-6301-1	SP-6301-2	SP-6301-3	SP-6301-4
Daphnia, 96-hour acute survival	-	-	-	-
Hyalella, 96-hour acute survival	-	-	-	-
Pimephales, 96-hour acute survival	+ 37.5% survival	+ 37.5% survival	-	-
Xenopus, 96-hour acute survival	-	-	-	-
Daphnia, 7-day chronic survival	-	-	-	-
Hyalella, 7-day chronic survival	-	-	-	-
Pimephales, 7-day chronic survival and growth	NC[c]	NC	-	-
Xenopus, 7-day chronic survival and growth	-	-	+ 70% survival	-

[a] A minus (-) indicates no significant media toxicity ($p > 0.05$); a plus (+) indicates significant media toxicity ($p \leq 0.05$).

[b] Sampling locations SP-6301-1 through SP-6301-4 are from Burgermeister Spring.

[c] NC = chronic toxicity testing not conducted because media toxicity at this sampling location was indicated by the results of the corresponding acute toxicity test.

TABLE 3.13 Results of Acute and Chronic Toxicity Testing of Sediment from Burgermeister Spring[a]

Organism/Toxicity Test	Toxicity Test Results at Sampling Location[b]			
	SP-6301-1	SP-6301-2	SP-6301-3	SP-6301-4
Daphnia, 96-hour acute survival	-	-	-	-
Hyalella, 96-hour acute survival	-	-	-	-
Pimephales, 96-hour acute survival	-	+ 75% survival	-	-
Xenopus, 96-hour acute survival	-	-	-	-
Daphnia, 7-day chronic survival	-	-	-	-
Hyalella, 7-day chronic survival	+ 82% survival	-	-	-
Pimephales, 7-day chronic survival and growth	-	-	-	+ 50% survival
Xenopus, 7-day chronic survival and growth	-	+ 73% survival	-	-

[a] A minus (-) indicates no significant media toxicity ($p > 0.05$); a plus (+) indicates significant media toxicity ($p \leq 0.05$).

[b] Sampling locations SP-6301-1 through SP-6301-4 are from Burgermeister Spring.

TABLE 3.14 Estimated Applied Daily Dose from the Drinking Water Pathway for the American Robin and White-Tailed Deer

Contaminant	EPC (µg/L)	Applied Daily Dose[a] (mg/kg-d) American Robin	White-Tailed Deer
Metals			
Aluminum	2,800	0.38	< 0.01
Antimony	95	0.01	< 0.01
Arsenic	290	< 0.04	< 0.01
Barium	3,200	0.44	< 0.01
Cadmium	25	< 0.01	< 0.01
Chromium	30	< 0.01	< 0.01
Copper	30	< 0.01	< 0.01
Iron	400,000	55	0.01
Lead	60	< 0.01	< 0.01
Lithium	52	< 0.01	< 0.01
Manganese	20,000	2.8	0.02
Mercury	6,100	0.84	< 0.01
Molybdenum	38	< 0.01	< 0.01
Nickel	44	< 0.01	< 0.01
Selenium	6	< 0.01	< 0.01
Silver	240	< 0.03	< 0.01
Strontium	190	0.03	< 0.01
Thallium	6	< 0.01	< 0.01
Uranium, total	540	0.09	< 0.01
Inorganic anion			
Nitrate-N	10,000	1.4	0.001
Nitroaromatic compounds			
1,3,5-TNB	15	< 0.01	< 0.01
1,3-DNB	1	< 0.01	< 0.01
2,4,6-TNT	280	0.04	< 0.01
2,4-DNT	11	< 0.01	< 0.01
2,6-DNT	18	< 0.01	< 0.01
2-Amino-4,6-DNT	19	< 0.01	< 0.01
4-Amino-2,6-DNT	24	< 0.01	< 0.01
Nitrotoluene	0.08	< 0.01	< 0.01
Nitrobenzene	1	< 0.01	< 0.01

[a] Dose estimates were calculated using Burgermeister Spring as the exposure point area and using the maximum contaminant concentrations reported from all springs in the chemical plant area and the ordnance works area as the EPCs.

4 TOXICITY ASSESSMENT

The toxicities of the radioactive and chemical COPCs and COECs identified for the GWOUs are summarized in Sections 4.1 and 4.2. The methods used to evaluate toxicity are discussed in Section 4.3.

4.1 RADIATION TOXICITY

4.1.1 Human Health

Uranium was identified as the only radioactive COPC for the GWOUs. Natural uranium consists of three isotopes: uranium-234, uranium-235, and uranium-238. These isotopes have very low radioactivity per gram of material (i.e., specific activity) due to their long half-lives. Two hazards are associated with uranium compounds: kidney damage caused by the chemical toxicity and cell damage caused by the ionizing radiation that results from radioactive decay. Alpha, beta, and gamma radiation are released during the radioactive decay of uranium. For internal exposures (e.g., by ingestion or inhalation), alpha and beta radiation are the primary hazards. Within the body, alpha particles result in greater cell damage than beta or gamma radiation because their energy is completely absorbed by the tissue. Beta particles deposit less energy to tissue and therefore induce much less damage than alpha particles. Gamma radiation is primarily an external hazard because it can easily penetrate tissue and reach internal organs.

4.1.2 Ecological Health

Identifying the effects of radionuclides on organisms in the natural environment is complicated because (1) various sources of ionizing radiation are possible; (2) exposure can be internal, external, or both; (3) each radionuclide has unique physical and chemical properties; (4) ecological receptors have different mobilities and varied habitats; and (5) current levels of radionuclides in most areas are too low to detect effects on population and community, even in such areas as weapons testing sites (Whicker and Schultz 1982a-b). Effects due to acute or chronic exposure include mortality, physiological and pathological changes, and developmental and reproductive effects (National Council on Radiation Protection and Measurements [NCRP] 1991; International Atomic Energy Agency [IAEA] 1992; Rose 1992).

Ecological receptors may be affected by both acute and chronic exposure to ionizing radiation. For acute exposure. aquatic invertebrates tend to be more resistant than aquatic vertebrates. The most sensitive periods in the life cycle of aquatic organisms are the early developmental stages; radiation sensitivity generally decreases with increasing development (NCRP 1991). Reproductive and early developmental stages of aquatic organisms are most sensitive to chronic irradiation.

Deleterious effects of chronic irradiation have not been observed in natural populations at dose rates ≤ 1 rad/d (NCRP 1991).

Similar sensitivity and effects have been identified for terrestrial wildlife (IAEA 1992). Terrestrial invertebrates are much less sensitive than terrestrial vertebrates, the invertebrates requiring about 100 times the dose needed for vertebrates to induce mortality. Among vertebrate species, lethal acute doses and sensitivity to chronic radiation vary widely among different taxa; birds, mammals, and a few tree species are among the most sensitive. Acute doses of < 10 rad are considered unlikely to produce persistent, measurable deleterious changes in populations or communities of terrestrial plants or animals (IAEA 1992). Chronic dose rates of < 0.1 rad/d and < 1 rad/d do not appear likely to cause observable changes in terrestrial animal populations, and chronic dose rates of < 1 rad/d are not likely to cause observable changes in plant populations. As with aquatic biota, reproductive and early developmental stages of terrestrial biota are most sensitive to irradiation.

4.2 CHEMICAL TOXICITY

4.2.1 Human Health

The chemical COPCs in groundwater include lithium, molybdenum, uranium, chloride, nitrates, sulfates, nitroaromatic compounds, TCE, and 1,2-DCE. The chemical COPCs in spring water include antimony, iron, lithium, manganese, mercury, molybdenum, silver, uranium, chloride, nitrate, sulfate, and nitroaromatic compounds.

Antimony is typically present in soil as sulfide and oxide compounds. Industrially, antimony is used in many alloys. It has been administered orally to humans and animals as both an emetic and an antiparasitic agent. Toxic effects that have been observed in humans are associated mainly with occupational exposures.

Iron is an essential nutrient present at varying levels in the human diet; the recommended daily allowance (RDA) ranges from 6 to 30 mg/d for infants and pregnant women, respectively; the RDA for adults is 15 mg/d (National Research Council 1989). Approximately 2,000 cases of iron poisoning occur in the United States annually, primarily among young children who ingest adult iron supplements; the lethal dose of iron is about 200 mg/kg, at least 200 times the RDA level.

Lithium is present in the daily human diet at a level of about 2 mg (Venugopal and Luckey 1978). It is safely used as a psychiatric drug at concentrations of about 1 g/d, and lithium carbonate is used clinically to treat depression. Toxic effects that have been observed subsequent to treatment include effects on the neuromuscular and cardiovascular systems, irritation of the gastrointestinal tract, and kidney damage.

Manganese is an essential dietary nutrient for humans and is present in many foods. Studies of humans and experimental animals suggest that oral exposure to elevated levels of manganese can result in decreased fertility and in effects on the cardiovascular and central nervous systems.

Inorganic and organic forms of mercury have been found to be toxic in humans and experimental animals. In general, the organic forms are more toxic that the inorganic forms. Human studies indicate that the kidney and central nervous system are the main sites affected by mercury; however, the degree to which these systems are affected depends on the chemical form of mercury and the route of exposure.

Molybdenum is a trace element present in the daily human diet at levels of about 0.2 mg/d. It is a constituent of several enzymes, but nutritional requirements are low and molybdenum deficiencies are extremely rare. Elevated dietary levels (i.e., in excess of about 10 mg/d) are associated with a condition characterized by swelling, inflammation, and pain in the joints (EPA 1997).

Natural uranium is radioactive, but the primary health effect associated with exposure to uranium is kidney damage caused by chemical toxicity. The oral reference dose (RfD) derived for soluble salts of uranium is based on decreased body weight and moderate kidney damage induced in rabbits fed with uranyl nitrate hexahydrate for 30 days (Maynard and Hodge 1949).

Inorganic anions such as nitrates and chloride occur naturally in the environment in soils and in plant and animal food products. Nitrates are commonly found in the environment as a result of urban sewage treatment, nitrogenous wastes, and nitrogen-based fertilizers. The health hazards associated with nitrates result primarily from the bacterial conversion of ingested nitrates to nitrites, which can result in methemoglobinemia (reduction in the oxygen-carrying capacity of blood), especially in infants. Chloride is the main inorganic anion found in the blood and extracellular fluids and is essential in maintaining fluid and electrolyte balance. Added salt in foods is the primary source of ingested chloride, contributing about 6 g/d (National Research Council 1989). Additional chloride from water is typically insignificant, averaging about 40 mg/d. The toxicity of salts containing the chloride ion depends primarily on the characteristics of the cation (e.g., sodium in table salt, which has been associated with high blood pressure). Sulfates are commonly found in the environment and are widely used for industrial purposes. Sulfates exhibit low toxicity in humans but have been shown to have laxative effects at water concentrations of 630 mg/L or greater (Chien et al. 1968).

Health hazards associated with nitroaromatic compounds include methemoglobinemia and toxic effects on the liver, kidneys, and nervous system. Studies in humans indicate that nitroaromatic compounds are absorbed following inhalation and ingestion and that these compounds are capable of penetrating the skin. Human exposure to TCE primarily affects the central nervous system. Effects include headaches, vertigo, fatigue, and central nervous system depression.

4.2.2 Ecological Health

The COECs include metals and nitroaromatic compounds. Metals have been reported to cause a variety of lethal and sublethal effects in aquatic and terrestrial biota. The toxicity of these contaminants depends on physical and chemical factors in the environment, such as pH and the presence of complexing agents, as well as on the specific taxon being exposed. In vegetation, reported adverse effects of metal exposure include reduced chlorophyll concentrations, reduced growth and biomass production, and reduced seed production and germination. In aquatic biota, metal exposure has been shown to affect reproduction, ion exchange across gill surfaces, behavior, and survival of all life stages. In terrestrial biota, metal exposure can result in developmental abnormalities; renal and central nervous system damage; altered blood chemistry; altered metabolic processes; and behavioral changes affecting foraging, susceptibility to predators, and reproduction.

Relatively little information is available regarding the effects of nitroaromatic compounds on natural populations of plants, fish, and wildlife. Laboratory studies have shown that exposure to nitroaromatic compounds causes a variety of responses in aquatic and terrestrial biota. Effects of exposure on fish and aquatic invertebrates include increased adult mortality, reduced egg production and survival, decreased survival of early life stages, reduced body weights and lengths, and increased physical deformities. Adverse effects on aquatic plants may include depressed growth and cellular deformities.

Effects of nitroaromatic compounds on terrestrial wildlife may include reduced body weights, changes in blood chemistry and cellular composition, changes in metabolic pathways and processes, renal and liver malfunction, and organ necroses and lesions. Reported effects to terrestrial vegetation include reduced leaf and root growth, reduced plant height, and leaf and root necroses.

4.3 METHODS FOR EVALUATING TOXICITY TO HUMAN HEALTH

4.3.1 Radiation Toxicity

The assessment of radiological human health risks in this BRA was limited to carcinogenic effects. This approach is consistent with EPA guidance, which notes that cancer risk is generally the limiting effect for radionuclides and suggests that radiation carcinogenesis be used as the sole basis for assessing radiation-related human health risks (EPA 1989b). Carcinogenic risks were calculated for the radionuclides of concern in a manner similar to existing methods for chemical carcinogens by using an age-averaged lifetime excess cancer incidence per unit intake. To support this evaluation, the EPA has developed cancer incidence factors per unit intake that are synonymous with the slope factors developed for chemical carcinogens.

The following radionuclide slope factors were used in this assessment: uranium-234, 4.4×10^{-11}/pCi; uranium-235, 4.5×10^{-11}/pCi; and uranium-238+D, 6.2×10^{-11}/pCi (EPA 1995c).

The "+D" designation indicates that the risks from associated short-lived decay products (i.e., with radioactive half-lives less than or equal to 6 months) are also included. Only ingestion slope factors have been used because inhalation and external radiation are not pathways of concern for the receptors being assessed. The activity-weighted average of these slope factors for isotopic conditions present in site groundwater (5.3×10^{-11}/pCi) was used in conjunction with the total concentration of uranium (in pCi/L) to estimate the radiological risk.

4.3.2 Chemical Toxicity

The EPA has derived toxicity values for most of the chemical contaminants of human health concern and assigned RfDs to measure the noncarcinogenic effects of chemicals. The chronic RfD is defined as "an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime" (EPA 1989b). To derive an RfD value (expressed in mg/kg-d), EPA reviews all toxicity studies available for a given substance and a given route of exposure, determines a no-observed-adverse-effect level (NOAEL) or a lowest-observed-adverse-effect level (LOAEL) from the study most relevant to humans (the critical study), and applies uncertainty factors to these values. The RfD can be compared with estimated exposure levels to evaluate the potential for deleterious effects. Current available RfD values are specific to either the inhalation or ingestion route of exposure because the toxic mechanism and dose required for toxicity to occur can differ for these routes of exposure. For this BRA, only ingestion RfDs have been used because ingestion has been determined to be the pathway of concern for the receptors being assessed. Oral RfDs are available for the following COPCs for the GWOUs: antimony, lithium, manganese, mercury, molybdenum, silver, uranium, nitrate, 1,3,5-TNB, 1,3-DNB, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, 2-amino-4,6-DNT, 4-amino-2,6-DNT, nitrobenzene, and o-, m-, and p-nitrotoluene.

The toxic effects of short-term exposures to the COPCs are not generally evaluated because the risks estimated for chronic low-level exposures are greater than the short-term toxicity risks. However, nitrate toxicity in infants is an exception; in infants, toxicity may occur after a short period of ingestion. The EPA Office of Drinking Water has derived 1-day and 10-day health advisory levels to assess concentrations of concern for short-term exposures; the 1-day and 10-day health advisory levels for nitrate are both 10 mg/L (EPA 1997). The short-term toxicity of nitrate was assessed by using infant exposure parameters as well as adult exposure parameters to calculate hazard indices (see Chapter 5). The use of infant exposure parameters resulted in a calculated hazard index of 1 for a well with a nitrate concentration of 10 mg/L.

Carcinogenic risks from exposure to known and potential carcinogens are evaluated separately from noncarcinogenic risks because, hypothetically, any exposure to a carcinogen increases the risk of cancer by a finite amount. Therefore, the risk from exposure to a carcinogen at a given level can be derived, but an exposure level at which no carcinogenic effect is likely to occur (as for noncarcinogenic end points) cannot be defined. The EPA has defined two toxicity values for evaluating the potential carcinogenic effects of a given substance: the weight-of-evidence classification and the slope factor. For substances that have weight-of-evidence classifications of A (human

carcinogen), B1 or B2 (probable human carcinogens), and sometimes C (possible human carcinogens). the EPA has calculated slope factors on the basis of data from dose-response studies. The slope factor is defined as a "plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime" (EPA 1989b). Generally, slope factors are derived by extrapolation from experimental high-dose to low-dose ranges, and they are not valid for evaluating high dose levels. Also, carcinogenic risks that have been calculated from slope factors are applicable to exposures that occur over a lifetime. When exposure durations are less than a lifetime, they must be converted to equivalent lifetime values. The following COPCs at the GWOU have verified slope factors: TCE, 2,4,6-TNT, 2,4-DNT, and 2,6-DNT. All RfD values and slope factors are summarized in Tables 4.1 and 4.2

TABLE 4.1 Toxicity Values of COPCs for Ingestion of Groundwater and Surface Water: Potential Systemic Effects

Parameter	Chronic RfD (mg/kg-d)	Level of Confidence	Critical Effect	RfD Basis	RfD Source[a]	Uncertainty Factor[b] (UF)
Metals						
Antimony	0.0004	Low	Reduced lifespan; altered blood chemistry	Oral, rat	IRIS	UF=1,000
Lithium	0.02[c]	Medium	Impaired renal function	Oral	–[c]	UF=100
Manganese	0.14	Medium	Effects on central nervous system	Diet, human	IRIS	UF=1
Mercury (as mercuric chloride)	0.0003	High	Autoimmune effects	Diet, rat	IRIS	UF=1,000
Molybdenum	0.005	NA[d]	Changes in biochemical indexes	Oral, human	IRIS	UF=1
Silver	0.005	Low	Argyria (skin discoloration)	Intravenous	IRIS	UF=3
Uranium	0.003	Medium	Weight loss; moderate kidney activity	Oral, rabbit	IRIS	UF=1,000
Inorganic anion						
Nitrate-N	1.6	High	Methemoglobinemia	Oral, human	IRIS	UF=1
Nitroaromatic compounds						
1,3,5-TNB	0.00005	Low	Increased splenic weight	Oral, rat	IRIS	UF=10,000
1,3-DNB	0.0001	Low	Increased splenic weight	Oral, rat	IRIS	UF=3,000
2,4,6-TNT	0.0005	Medium	Liver effects	Oral, dog	IRIS	UF=1,000
2,4-DNT	0.002	High	Neurotoxicity; biliary tract hyperplasia; Heinz bodies	Oral, dog	IRIS	UF=100
2,6-DNT	0.001	NA	Neurotoxicity; biliary tract hyperplasia; Heinz bodies	Oral	HEAST	UF=3,000
2-Amino-4,6-DNT	0.00006[c]	Low	Neurotoxicity; biliary tract hyperplasia; Heinz bodies	Oral	–[c]	UF=10,000
4-Amino-2,6-DNT	0.00006[c]	Low	Neurotoxicity; biliary tract hyperplasia; Heinz bodies	Oral	–[c]	UF=10,000
Nitrotoluene	0.001	NA	Splenic lesions	Oral, rat	HEAST	UF=10,000
Nitrobenzene	0.0005	Low	Hematological, adrenal, renal, and hepatic lesions	Inhalation, rat and mouse	IRIS	UF=10,000

[a] Source: *Integrated Risk Information System* (EPA 1997), except as indicated.

[b] The NOAEL or LOAEL dose from the critical study can be obtained by multiplication of the chronic RfD by the uncertainty factor.

[c] Provisional value provided by the EPA's Superfund Technical Support Center (Baysinger-Daniel 1996).

[d] NA = not available.

TABLE 4.2 Toxicity Values of COPCs for Ingestion of Groundwater and Spring Water: Potential Carcinogenic Effects

Parameter	Slope Factor [(mg/kg-d)$^{-1}$]	Weight of Evidence Classification	Type of Cancer	Slope Factor	
				Basis	Source[a]
2,4,6-TNT	0.03	C: possible human carcinogen	Urinary bladder; transitional cell papilloma; transitional squamous carcinoma	Diet, rat	IRIS
2,4-DNT	0.68	B2: probable human carcinogen	Liver, mammary gland; adenocarcinomas/ carcinomas	Water, rat	IRIS
2,6-DNT	0.68	B2: probable human carcinogen	Liver, mammary gland; adenocarcinomas/ carcinomas	Water, rat	IRIS
TCE	0.011[b]	B2: probable human carcinogen	Liver	NA[c]	–[b]

[a] Source: *Integrated Risk Information System* (EPA 1997), except as indicated.

[b] TCE slope factor for the inhalation pathway is 0.006 (EPA 1996b).

[c] NA = not available.

5 HUMAN HEALTH RISK CHARACTERIZATION

Radiological and chemical health risks to humans were characterized for exposure to contamination in groundwater and spring water at the chemical plant area and ordnance works area. Potential carcinogenic risks for both radiological and chemical exposures were measured in terms of the increased probability that an individual would develop cancer over a lifetime. The EPA has indicated that for known or suspected carcinogens, acceptable exposure levels for members of the general public at sites on the National Priorities List (NPL) are generally concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between 1×10^{-6} and 1×10^{-4} (EPA 1989b). This range is referred to as the "acceptable risk range" in this BRA and is used as a point of reference for discussing the results of the carcinogenic risk assessment for the GWOU.

Potential health effects from exposure to chemical contaminants were also assessed for effects other than cancer. The quantitative measures of noncarcinogenic health effects are the hazard quotient and hazard index (see Section 5.1.2.2). The EPA has defined a hazard index of greater than 1 as the level of concern for noncarcinogenic health effects.

5.1 RISK CHARACTERIZATION METHODOLOGY

5.1.1 Radiological Risks

Exposures to low levels of ionizing radiation can result in cancer, serious genetic effects, and other detrimental health effects. The induction of cancer is the predominant radiological effect associated with uranium, the only radioactive COPC identified in groundwater and spring water at the chemical plant and ordnance works areas. The radiological health risks presented in this BRA are limited to carcinogenic effects. This approach is consistent with EPA guidance, which notes that, in general, the risk of cancer is limiting and may be used as the sole basis for assessing the radiation-related human health risks for a site contaminated with radionuclides (EPA 1989b).

For this assessment, slope factors were used to estimate the potential risk from exposure to radionuclides. Intakes were estimated (in units of pCi) for the ingestion pathway (see Chapter 3). Radiological risks were then calculated by multiplying the intakes by the appropriate slope factor (see Section 4.3.1).

5.1.2 Chemical Risks and Hazard Quotients

5.1.2.1 Carcinogenic Risks

The risk to human health from exposure to chemical carcinogens is expressed as the probability of a cancer occurring over a lifetime. To calculate the excess cancer risk, the daily intake averaged over a lifetime is multiplied by a chemical-specific slope factor. The EPA has derived slope factors for a number of carcinogens. These slope factors represent the incremental lifetime cancer risk per milligram of carcinogen per kilogram of body weight, assuming that the exposure occurs over a lifetime of 70 years. The estimated daily intakes (averaged over a lifetime) resulting from exposure to the chemical carcinogens in the groundwater and spring water are presented in Section 3.3.1; available slope factors are identified in Section 4.3.2.

5.1.2.2 Hazard Quotients and Hazard Indices

A hazard quotient provides a measure of the potential for adverse health effects other than cancer. For an individual contaminant, the daily intake averaged over the exposure period is divided by the RfD to derive the hazard quotient. The RfD is the average daily dose that can be incurred without an appreciable risk of deleterious health effects during a lifetime. The EPA has derived chronic RfDs for exposure periods of more than 7 years; only chronic RfDs were considered in this assessment.

For an individual contaminant, a hazard quotient of 1 or greater is considered to indicate a potential for adverse health effects. The individual hazard quotients for each contaminant are summed to determine the hazard index.

5.2 HUMAN HEALTH RISK ESTIMATES

5.2.1 Spring Water

The risk to a recreational visitor from exposure to contaminants at the springs was estimated consistent with current and projected future land uses. Calculations were performed for each of the 15 springs to determine both radiological and chemical carcinogenic risks. Hazard indices were determined for each spring to assess potential noncarcinogenic adverse health effects from the chemical contaminants.

5.2.1.1 Chemical Risks and Hazard Indices

The hazard indices estimated for the recreational visitor at the 15 springs are very low; the estimated range is < 0.001 to 0.2. indicating that contaminant concentrations at the springs are not likely to result in noncarcinogenic health effects to the recreational visitor. The highest hazard index of 0.2 was reported for spring SP-5201, located south of the groundwater divide. The second highest hazard index was also reported for a spring south of the groundwater divide, SP-5303, with a hazard index of 0.1. The primary contributors are 2-amino-4,6-DNT, 4-amino-2,6-DNT, and 2,4,6-TNT. Estimated hazard quotients for the COPCs are presented in Table 5.1;[1] the distribution of estimated hazard indices for the recreational visitor is illustrated in Figure 5.1.

The chemical carcinogenic risk estimates for the springs evaluated range from 2×10^{-10} to 3×10^{-7} (Table 5.2); all of these estimates fall below the acceptable risk range. The highest risk estimates were reported for SP-5201 and SP-5303, which are located south of the groundwater divide. These results indicate that chemical carcinogenicity is not a factor at the springs. The distribution of these risk estimates is illustrated in Figure 5.2.

The projected chemical carcinogenic and noncarcinogenic toxicity for the future recreational visitor is expected to be no higher than the estimated current risks due to attenuation of contaminant concentrations expected as a result of source removals. The hazard indices and carcinogenic risks for the Army reservist scenario at the springs can be expected to be no greater than those estimated for the recreational visitor because exposure parameters for the Army reservist scenario are projected to be similar to those assumed for the recreational visitor.

5.2.1.2 Radiological Risks

Potential radiological risks from exposure to contaminants at the springs for the current and future recreational visitor range from 4×10^{-9} (SP-5602) to 2×10^{-6} (SP-5303), as shown in Table 5.3. These values are low, and all but two of the estimates are below the lower end of the acceptable risk range. Overall, these results indicate that there is minimal risk to the recreational visitor, including the Army reservist, from potential exposure to radioactive contaminants at the springs. These results are depicted in Figure 5.2.

5.2.2 Groundwater

A hazard index was calculated for each of the 155 wells in the monitoring networks at the chemical plant area and ordnance works area to determine potential noncarcinogenic or systemic effects for a hypothetical future resident exposed to water from these wells. Estimated radiological and chemical carcinogenic risks to this hypothetical receptor were also calculated. Hazard quotients

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[1] All tables in this chapter have been placed at the of the text (Section 5.5).

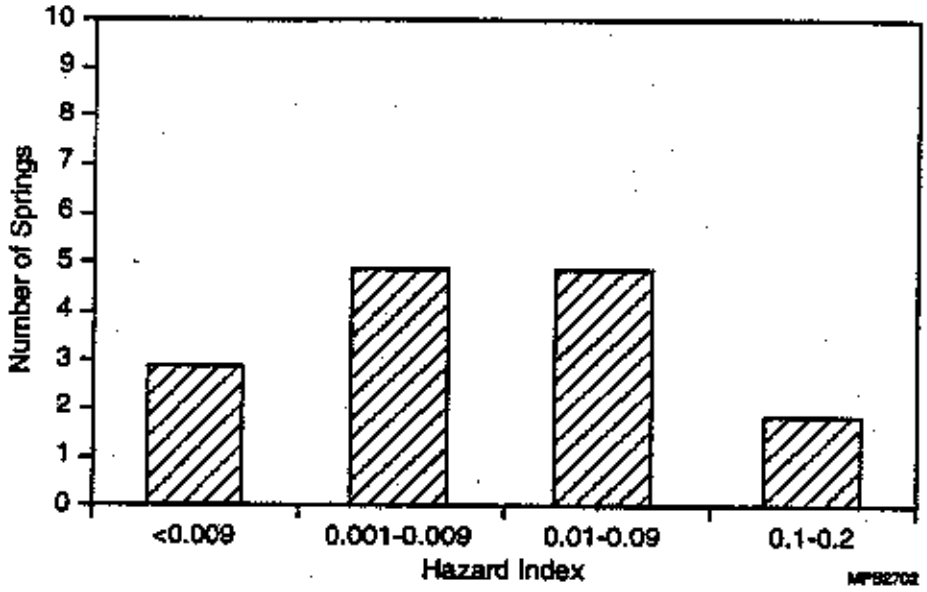

FIGURE 5.1 Distribution of Estimated Hazard Indices for the Current and Future Recreational Visitor at the Chemical Plant Area and Ordnance Works Area

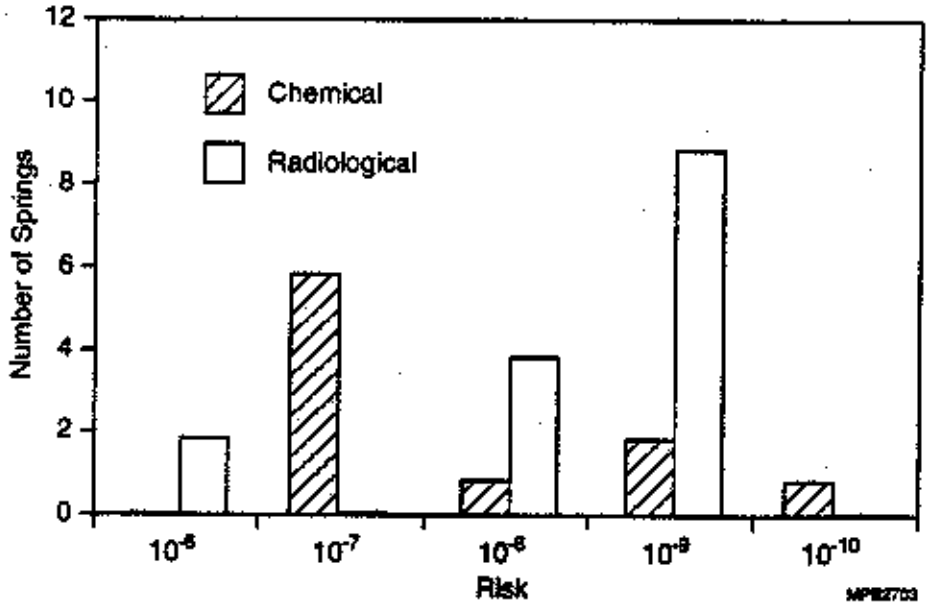

FIGURE 5.2 Distribution of Estimated Chemical and Radiological Carcinogenic Risks for the Current and Future Recreational Visitor at the Chemical Plant Area and Ordnance Works Area

and carcinogenic risks from dermal contact with groundwater while showering were not estimated because intakes from this pathway (see Section 3.3.2) were only a fraction of the ingestion intakes.

5.2.2.1 Chemical Risks and Hazard Indices

The estimated hazard indices for the hypothetical future adult resident range from < 0.01 to 40, as shown in Table 5.4. Overall, the estimated hazard indices were 1 or greater for 43 of the 155 wells evaluated (Figure 5.3 illustrates these estimates). Further analysis of these results indicates that 27 of the 43 estimates greater than 1 were due primarily to nitroaromatic compounds and 15 to nitrates. The hazard index in well MW-4024 was estimated to be 1; uranium contributed to about 0.84 of the total hazard index of 1. Overall, contributions to the hazard index from lithium and uranium were minimal in comparison to nitrates and nitroaromatic compounds. Hazard indices also were generally higher for wells completed in the weathered unit.

The toxic effect of nitrate (i.e., methemoglobinemia, or low blood oxygen levels) is primarily of concern for infants (EPA 1997). Therefore, a separate hazard quotient was calculated for infants ingesting groundwater, assuming an ingestion rate of 0.64 L/d and a body weight of 4 kg (compared with the adult intake of 2 L/d and body weight of 70 kg). The results show an increased hazard quotient for nitrate in each well by a factor of approximately 5.6. By calculating the hazard index assuming infant exposure parameters, an additional 5 wells have a hazard index exceeding 1.

The chemical carcinogenic risk estimates, excluding contributions from TCE, range from 1×10^{-7} to 2×10^{-4}, as shown in Table 5.5. Of the 155 wells evaluated, estimates for only four wells were at or slightly greater than 1×10^{-4}. The highest risk of 2×10^{-4} was estimated for wells MWV-09 and MWS-12. The primary contributors to these estimated risks were 2,4-DNT and 2,6-DNT. Carcinogenic risks tend to be higher for weathered wells, which is consistent with the estimated hazard indices. These risk results indicate that any future residential well completed in the deeper aquifer (i.e., deeper than the unweathered and deep wells presented in this report) would not result in unacceptable risk. In fact, three of the four wells that exceeded the acceptable risk range are weathered wells; the fourth, MWV-09, is an overburden well. Figure 5.4 shows the distribution of the risk estimates.

During 1996 and 1997 sampling activities, TCE was detected in nine wells at or in the vicinity of the chemical plant area, primarily in the area around the raffinate pits. The total risks at these wells, including the TCE contributions, were estimated to be 2×10^{-5} for MW-3024, 4×10^{-4} for MW-2037, 1×10^{-3} for MW-2038, 1×10^{-5} for MW-3025, 1×10^{-6} for MW-4001, 2×10^{-7} for MW-2032, 3×10^{-4} for MWS-21, 9×10^{-7} for MW-3027, and 6×10^{-7} for MW-2013. Of these, estimates for only three wells were greater than the acceptable risk range of 1×10^{-4}.

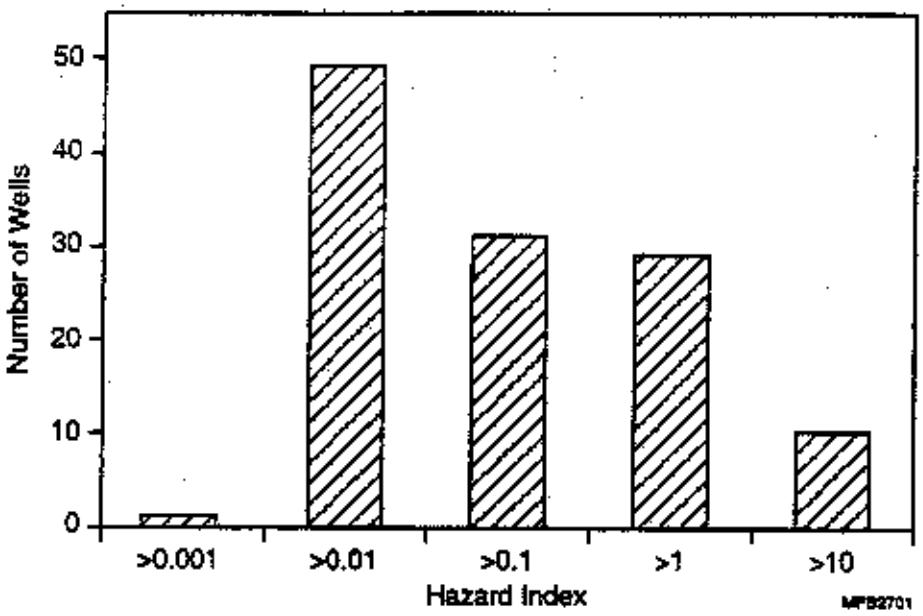

FIGURE 5.3 Distribution of Estimated Hazard Indices for the Hypothetical Future Resident at the Chemical Plant Area and Ordnance Works Area

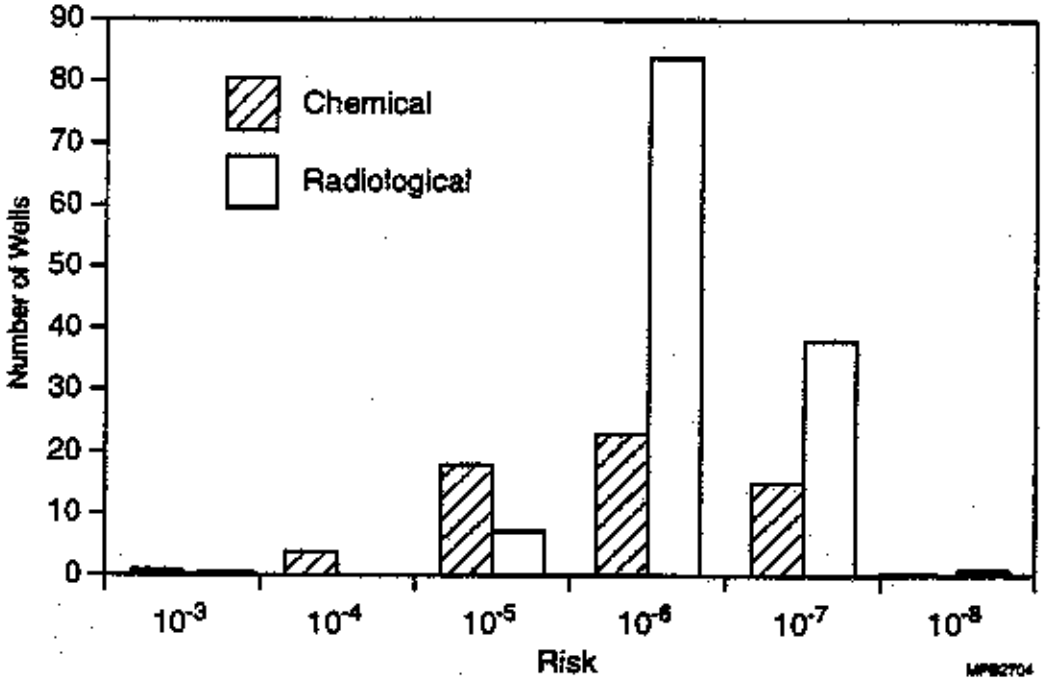

FIGURE 5.4 Distribution of Estimated Chemical and Radiological Carcinogenic Risks for the Hypothetical Future Resident at the Chemical Plant Area and Ordnance Works Area

5.2.2.2 Radiological Risks

The estimated radiological risks for a future resident ingesting water from wells in the chemical plant area and ordnance works area are at the low end of or are lower than the acceptable risk range recommended by the EPA (Table 5.6). The estimated radiological risk ranges from 7×10^{-8} to 7×10^{-5}. The radiological risk estimates for all wells evaluated are depicted in Figure 5.4. Similarly to chemical risk estimates, the higher radiological risk estimates are for weathered wells, mostly located around the raffinate pits and other source areas at the chemical plant area.

5.3 UNCERTAINTIES RELATED TO RISK ESTIMATES

The evaluation of risks to human health presented in this BRA was by necessity based on a number of assumptions. In addition, many uncertainties are inherent in the risk assessment process. The rationale for major assumptions used in this assessment and associated uncertainties are discussed in Sections 5.3.1 through 5.3.4.

5.3.1 Contaminants of Potential Concern

The identification of COPCs for the human health evaluation relied on use of monitoring data for both areas and applying a selection process recommended by the EPA. The monitoring wells at the chemical plant area and ordnance works area are considered to adequately characterize groundwater flow and monitor changes in water quality at these areas. Data from these wells therefore establish the nature and extent of contamination and are expected to provide an adequate database for identifying COPCs with sufficient certainty.

5.3.2 Exposure Assessment

The amount and type of data available and the ability to address fate and transport impacts over time affect the determination of representative EPCs. The quantity of data has been determined to be sufficient for this risk assessment. Exposure point concentrations used to project current and hypothetical future risks were based on current (about 1995) maximum concentrations for both the groundwater and spring water analyses. This approach is considered to be conservative. With source removals currently occurring at both areas, it is expected that the COPC concentrations will decrease with time.

The uranium concentrations detected from the in-situ sampling of groundwater at the Southeast Drainage were higher than the uranium concentrations detected at the current monitoring network wells. The higher uranium concentrations may be an artifact of the field sampling methodology. Initial data from a recently installed monitoring well in this area have indicated uranium to be present at levels below the detection limit (DOE and DA 1997).

Some uncertainty is associated with the assumptions used to identify scenarios and intake parameters. Site-specific factors were used to identify the potential receptors (e.g., recreational visitor to the area springs) and to select the scenario assumptions, such as extent of exposure (i.e., exposure time, frequency, and duration). These assumptions incorporate information on current land use and reasonable projections of future land use that consider the time frame of the assessment. The uncertainty in the selected scenarios is low because federal and state ownership of surrounding land is expected to continue into the foreseeable future. The surrounding wildlife areas are the most heavily used in the state, and future plans include further expansion of the recreational use of the area. Therefore, a recreational visitor scenario is considered appropriate for both current and future conditions.

Considerable information is available for the ingestion pathway with respect to reasonable assumptions for intake parameters (e.g., ingestion rate), so related uncertainty is expected to be low. To estimate the reasonable maximum exposures for the identified receptors, best professional judgment was used in defining the variables that determine the extent of exposure. Intake parameters used in the exposure assessment were derived from data in the literature, including values provided by the EPA (1995b). Default parameters were supplemented on a chemical-specific basis, as appropriate (i.e., by including nitrate exposure estimates for infants). Because the exposure parameters generally represent the 95th percentile of the distributions, combining them results in a point intake estimate that represents an even higher percentile for the overall exposure. Thus, in some cases, the "reasonable" representative exposure may be somewhat overestimated.

The approach used to calculate the dermal pathway tends to be conservative in that critical contaminant-specific factors such as absorption fractions and permeability coefficients are not available. Conservative (high) default values for permeability coefficients were used in the calculations.

5.3.3 Toxicity Assessment

Standard RfDs and slope factors established by the EPA were used to estimate potential noncarcinogenic and carcinogenic health effects from exposure to chemical contaminants at the GWOUs of the chemical plant area and ordnance works area.

No RfD values or slope factors are available for chloride or iron. However, because these substances are naturally occurring and are present at some concentration in food and water, the National Research Council (1989) has published RDA values, which may be used as indicators of safe levels to be ingested in groundwater. The RDAs for a 10-kg infant are 300 and 10 mg/d, for chloride and iron, respectively. Assuming an ingestion rate of 1 L/d for a 10-kg infant, water concentrations of 300 mg/L chloride and 10 mg/L iron could correspond to intake levels exceeding the RDA levels. None of the monitoring wells have EPC levels exceeding 300 mg/L for chloride, and none of the springs exceeded levels of 10 mg/L for iron. This suggests that there is no health

concern associated with chloride in groundwater or iron in spring water at the chemical plant area and the ordnance works area.

Sulfate also does not have an RfD value or slope factor available. Sulfate is generally of low toxicity; the only adverse health impact associated with it is a laxative effect starting at water levels of about 700 mg/L (National Research Council 1977); this water would be unlikely to be ingested because the taste threshold is about 300 mg/L. Only one well has a sulfate EPC exceeding 700 mg/L (MW-2017); water from this well would not be ingested because of its objectionable taste and smell.

5.3.4 Risk Characterization

The radiological and chemical risk assessments have been presented separately because the methodologies for estimating carcinogenic risks from exposures to radionuclides and chemicals differ considerably. However, the total carcinogenic risk to an individual is that resulting from exposure to both the radiological and chemical risks, assuming that carcinogenic effects are neither antagonistic nor synergistic.

5.4 SUMMARY

Carcinogenic (radiological and chemical) risk and systemic toxicity are not indicated for the recreational visitor potentially exposed to contaminants in spring water. The recreational visitor was considered to be the most likely receptor, accounting for current and expected future land uses for both the chemical plant area and ordnance works area. Potential incremental carcinogenic risk and systemic toxicity to the Army reservists are not indicated.

Calculations performed to evaluate potential risks for the hypothetical future resident using groundwater indicate that concentrations of nitroaromatic compounds in a few wells contribute to slightly greater than the upper end of the acceptable risk range (1×10^{-4}) recommended by the EPA. Several wells in the vicinity of known source areas at the chemical plant area (e.g., raffinate pits) contain high concentrations of nitrates that contribute to hazard indices greater than 1; sludge at the pits has been determined to contain high concentrations of nitrates. Several wells at various locations in both the chemical plant area and ordnance works area also contain levels of nitroaromatic compounds that potentially contribute to both carcinogenic and noncarcinogenic toxicity for an individual exposed to these waters. Radiological carcinogenic risk estimates for uranium are within the acceptable risk range; the higher estimates are attributable to chemical plant area wells that monitor known source areas such as the raffinate pits, Ash Pond, and Frog Pond. However, uranium risk estimates from the in-situ samples obtained at the Southeast Drainage indicate that radiological risk could be somewhat higher. In addition, potential risk for the future resident exposed to contaminants at the springs would be minimal relative to the groundwater pathways.

5.5 CUMULATIVE EXPOSURE THROUGH MULTIPLE MEDIA

The current recreational visitor is not expected to incur additional risk from site soil because site areas with contaminated soil are not readily accessible by the general public. For the future recreational visitor scenario, the hazard indices and carcinogenic risks estimated in this analysis should be representative of the potential total exposure incurred by this receptor, accounting for potential exposure to site soil in addition to area springs. Remediation goals for soil cleanup are set to achieve human health protection at levels of 1×10^{-6} and lower.

Similarly, for the hypothetical future resident scenario, the carcinogenic risks and hazard indices incurred from exposure to residual site soil contamination would be minimal (1×10^{-6} or lower and 1 or lower, respectively). Therefore, the potential total exposure incurred by this receptor would be no greater than the value estimated in this analysis (see Section 5.2.2), except possibly for a few locations with radium-226 soil contamination at the chemical plant area. An incremental concentration of radium-226 of 0.075 pCi/g corresponds to a risk of 1×10^{-4}. The background radium-226 concentration is 1.2 pCi/g.

TABLE 5.1 Estimated Hazard Quotients for COPCs for the Current and Future Recreational Visitor

Spring ID	Estimated Hazard Quotient							
	Antimony		Lithium		Manganese		Mercury	
	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal
5101	0.001	0.00002	0.00002	0.0000004	0.00006	0.000001	–[a]	–
5201	0.0008	0.00002	–	–	0.000006	0.0000001	–	–
5303	0.001	0.00002	0.00007	0.000001	0.00003	0.0000007	0.0005	0.00001
5402	0.0007	0.00002	–	–	0.00001	0.0000002	–	–
5501	0.001	0.00002	0.00002	0.0000004	0.00003	0.0000007	–	–
5504	0.0006	0.00001	–	–	0.000007	0.0000001	–	–
5601	0.001	0.00003	–	–	0.0003	0.000005	–	–
5602	0.003	0.00007	–	–	0.0002	0.000005	–	–
5605	0.001	0.00002	–	–	0.00004	0.0000008	–	–
5612	0.005	0.0001	–	–	0.00001	0.0000002	–	–
6301	0.0008	0.00002	0.0001	0.000003	0.00002	0.0000004	–	–
6303	0.002	0.00005	0.00003	0.0000006	0.00006	0.000001	–	–
6306	0.0009	0.00002	–	–	0.01	0.0002	–	–
6501	0.006	0.00001	–	–	0.00003	0.0000007	–	–
6601	0.002	0.00004	–	–	0.00005	0.000001	–	–

TABLE 5.1 (Cont.)

Spring ID	Estimated Hazard Quotient							
	Molybdenum		Silver		Uranium, Total		Nitrate	
	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal
5101	–	–	–	–	0.00003	0.0000006	0.0002	0.000005
5201	–	–	–	–	0.00007	0.000001	0.00002	0.0000004
5303	0.0004	0.000009	–	–	0.01	0.0002	0.0002	0.000004
5402	–	–	–	–	0.00007	0.000002	0.00004	0.0000009
5501	–	–	–	–	0.00006	0.000001	0.00004	0.0000008
5504	–	–	0.00005	0.000001	0.00004	0.0000008	–	–
5601	–	–	–	–	0.00004	0.0000007	–	–
5602	–	–	–	–	0.00003	0.0000005	0.00005	0.000001
5605	–	–	–	–	0.00005	0.000001	0.00001	0.0000003
5612	–	–	–	–	0.00004	0.0000009	–	–
6301	–	–	0.00006	0.000001	0.003	0.0001	0.002	0.00004
6303	–	–	–	–	0.0001	0.000002	0.001	0.00003
6306	0.0002	0.000003	–	–	0.00005	0.000001	–	–
6501	–	–	0.001	0.00002	0.0002	0.000004	0.00004	0.0000009
6601	–	–	–	–	0.00003	0.0000006	0.00007	0.000002

TABLE 5.1 (Cont.)

Spring ID	Estimated Hazard Quotient									
	1,3,5-TNB		1,3-DNB		2,4,6-TNT		2,4-DNT		2,6-DNT	
	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal
5101	–	–	–	–	–	–	–	–	–	–
5201	0.02	0.0004	–	–	0.03	0.0007	0.000006	0.0000001	0.0003	0.000006
5303	0.001	0.00003	–	–	0.04	0.0008	0.00002	0.0000004	0.00006	0.000001
5402	–	–	–	–	–	–	–	–	–	–
5501	–	–	–	–	–	–	0.000004	0.00000008	0.00001	0.0000003
5504	–	–	–	–	–	–	–	–	–	–
5601	–	–	–	–	–	–	0.000003	0.00000007	0.000008	0.0000002
5602	0.0008	0.00002	–	–	0.0003	0.000007	0.00001	0.0000002	0.0003	0.000007
5605	0.0003	0.000006	–	–	0.002	0.00003	0.00001	0.0000003	0.00004	0.0000009
5612	–	–	–	–	0.00002	0.0000005	–	–	–	–
6301	0.00007	0.000002	–	–	0.00008	0.000002	0.000005	0.0000001	0.00004	0.0000007
6303	0.0003	0.000006	–	–	0.0005	0.00001	0.00001	0.0000003	0.00006	0.000001
6306	–	–	–	–	–	–	–	–	–	–
6501	–	–	–	–	–	–	–	–	–	–
6601	–	–	–	–	0.000006	0.0000001	–	–	0.000008	0.0000002

TABLE 5.1 (Cont.)

Spring ID	Estimated Hazard Quotient								
	2-Amino-4,6-DNT		4-Amino-2,6-DNT		Nitrobenzene		Total		
	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Ingestion + Dermal
5101	–	–	–	–	–	–	0.001	0.00003	0.001
5201	0.050	0.0010	0.05	0.001	–	–	0.2	0.003	0.2
5303	0.02	0.00050	0.04	0.0008	–	–	0.1	0.002	0.1
5402	–	–	–	–	–	–	0.0009	0.00002	0.0009
5501	0.0006	0.00001	0.001	0.000020	–	–	0.003	0.00006	0.003
5504	–	–	–	–	–	–	0.0007	0.00001	0.0007
5601	0.0006	0.00001	0.001	0.00002	–	–	0.003	0.00007	0.003
5602	0.002	0.00005	0.003	0.00007	–	–	0.01	0.0002	0.01
5605	0.004	0.00009	0.007	0.0002	–	–	0.01	0.0003	0.01
5612	0.001	0.00003	0.002	0.00003	–	–	0.008	0.0002	0.008
6301	0.002	0.00004	0.004	0.00007	–	–	0.01	0.0003	0.01
6303	0.003	0.00007	0.006	0.0001	–	–	0.01	0.0003	0.01
6306	–	–	–	–	–	–	0.01	0.0002	0.01
6501	0.00005	0.000001	0.00009	0.000002	–	–	0.002	0.00004	0.002
6601	0.001	0.00002	0.002	0.00003	–	–	0.005	0.0001	0.005

[a] A hyphen (–) indicates that the parameter was not detected.

TABLE 5.2 Estimated Chemical Carcinogenic Risks for the Current and Future Recreational Visitor[a]

	Estimated Risk								
	2,4,6-TNT		2,4-DNT		2,6-DNT		Total		
Spring ID	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Ingestion + Dermal
5201	2.2×10^{-7}	4.6×10^{-9}	3.5×10^{-9}	7.3×10^{-11}	8.2×10^{-8}	1.7×10^{-9}	3.1×10^{-7}	6.4×10^{-9}	3×10^{-7}
5303	2.4×10^{-7}	5.1×10^{-9}	9.6×10^{-9}	2.0×10^{-10}	4.9×10^{-8}	3.9×10^{-10}	2.7×10^{-7}	5.7×10^{-9}	3×10^{-7}
5501	–[b]	–	2.1×10^{-9}	4.4×10^{-11}	3.4×10^{-9}	7.2×10^{-11}	5.5×10^{-9}	1.2×10^{-10}	6×10^{-9}
5601	–	–	1.8×10^{-9}	3.8×10^{-11}	2.3×10^{-9}	4.9×10^{-11}	4.1×10^{-9}	8.7×10^{-11}	4×10^{-9}
5602	2.0×10^{-9}	4.2×10^{-11}	5.9×10^{-9}	1.2×10^{-10}	9.1×10^{-8}	1.9×10^{-9}	9.9×10^{-8}	2.1×10^{-9}	1×10^{-7}
5605	9.7×10^{-9}	2.0×10^{-10}	6.8×10^{-9}	1.4×10^{-10}	1.2×10^{-8}	2.6×10^{-10}	2.9×10^{-8}	6.0×10^{-10}	3×10^{-8}
5612	1.5×10^{-10}	3.1×10^{-12}	–	–	–	–	1.5×10^{-10}	3.1×10^{-12}	2×10^{-10}
6301	5.0×10^{-10}	1.1×10^{-11}	2.9×10^{-9}	6.2×10^{-11}	3.0×10^{-8}	2.1×10^{-10}	1.3×10^{-8}	2.8×10^{-10}	1×10^{-8}
6303	3.0×10^{-9}	6.3×10^{-11}	6.8×10^{-9}	1.4×10^{-10}	1.8×10^{-8}	3.8×10^{-10}	2.8×10^{-8}	5.8×10^{-10}	3×10^{-8}
6601	4.0×10^{-11}	8.5×10^{-13}	–	–	2.2×10^{-9}	4.6×10^{-11}	2.2×10^{-9}	4.7×10^{-11}	2×10^{-9}

[a] The COPCs were not detected during the two quarters of joint sampling at SP-5101, SP-5402, SP-6306, and SP-6501.

[b] A hyphen (–) indicates that the parameter was not detected.

TABLE 5.3 Estimated Radiological Carcinogenic Risks for the Current and Future Recreational Visitor

	Estimated Risk		
	Uranium		
Spring ID	Ingestion	Dermal	Total
5101	4.9×10^{-9}	5.1×10^{-11}	5×10^{-9}
5201	1.1×10^{-8}	1.2×10^{-10}	1×10^{-8}
5303	1.5×10^{-6}	1.6×10^{-8}	2×10^{-6}
5402	1.2×10^{-8}	1.3×10^{-10}	1×10^{-8}
5501	9.4×10^{-9}	9.9×10^{-11}	9×10^{-9}
5504	6.4×10^{-9}	6.7×10^{-11}	6×10^{-9}
5601	5.7×10^{-9}	6.0×10^{-11}	6×10^{-9}
5602	4.2×10^{-9}	4.4×10^{-11}	4×10^{-9}
5605	7.9×10^{-9}	8.3×10^{-11}	8×10^{-9}
5612	6.6×10^{-9}	7.0×10^{-11}	7×10^{-9}
6301	1.2×10^{-6}	1.2×10^{-8}	1×10^{-6}
6303	1.7×10^{-8}	1.7×10^{-10}	2×10^{-8}
6306	8.8×10^{-9}	9.3×10^{-11}	9×10^{-9}
6501	3.6×10^{-8}	3.8×10^{-10}	4×10^{-8}
6601	4.9×10^{-9}	5.1×10^{-11}	5×10^{-9}

TABLE 5.4 Estimated Hazard Quotients for the Hypothetical Future Resident

	Estimated Hazard Quotient								
Well ID	Lithium	Molybdenum	Uranium, Total	Nitrate[a]	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT
Deep Wells									
MWD-05	0.027	0.0071	0.0078	0.0022	–[b]	–	–	–	–
MWD-18	0.0092	–	0.011	–	–	–	–	–	–
MWGS-01	–	–	–	–	–	–	–	–	–
MWGS-02	–	–	–	–	–	–	–	–	–
MWS-18	0.013	0.042	0.021	0.0057	–	–	–	–	–
MWS-101	0.0015	–	0.0073	–	–	–	–	–	–
MWS-102	0.010	0.037	0.035	–	–	–	–	–	–
MWS-103	0.0058	–	0.010	–	–	–	–	–	–
TIL-3	0.0051	0.014	0.0015	–	–	–	–	–	–
Overburden									
MW-2031	–	–	–	–	–	–	–	–	–
MW-2032	0.019	0.0099	0.057	0.96	2.7	–	0.37	0.0019	0.12
MW-2033	0.0051	–	0.032	0.019	2.5	–	0.066	0.0075	0.13
MW-3001	–	–	–	–	–	–	–	–	–
MW-3013	–	–	–	–	–	–	–	–	–
MW-3018	–	–	–	–	–	–	–	–	–
MW-3022	–	–	–	–	–	–	–	–	–
MWV-01	0.0032	–	0.056	0.026	0.021	–	0.60	0.0015	0.027
MWV-02	0.0041	0.0088	0.041	0.046	–	–	0.006	0.00081	0.0013
MWV-09	0.0096	–	0.0098	0.014	7.7	0.11	1.6	0.27	0.079
MWV-13	0.0044	–	0.020	0.026	–	–	–	–	–
MWV-16	0.0016	0.006	0.016	0.019	0.18	–	0.013	–	0.0019
MWV-17	0.00036	–	0.00083	0.036	–	–	–	–	–
MWV-18	–	–	–	–	–	–	–	–	–
MWV-22	0.0032	0.0027	0.012	0.058	–	–	–	–	0.0038
MWV-24R	0.011	0.006	0.021	0.0060	1.7	–	0.060	0.0018	0.038
USGS-2A	–	–	–	–	–	–	–	–	–
Unweathered									
MW-2019	0.029	0.15	0.041	–	–	–	–	–	–
MW-2021	0.0052	0.042	0.012	0.000086	–	–	–	–	–
MW-2022	0.0051	0.013	0.017	–	–	–	–	–	–
MW-2023	0.0049	0.036	0.034	–	–	–	–	–	–
MW-2024	0.0073	0.011	0.0015	–	–	–	–	–	–
MW-2025	–	–	–	–	–	–	–	–	–
MW-2026	0.0040	0.045	0.011	–	–	–	–	–	–
MW-2027	0.0056	0.018	0.011	–	–	–	–	–	–
MW-2028	0.026	0.026	0.017	–	–	–	–	–	–
MW-2029	–	–	–	–	–	–	–	–	–
MW-3002	–	–	–	–	–	–	–	–	–
MW-3006	0.017	0.079	0.0095	–	–	–	–	–	–
MW-3024	0.28	–	0.042	6.3	–	–	–	0.0018	0.012
MW-3026	0.048	0.012	0.058	3.8	0.077	–	–	0.00099	0.0013
MW-4004	0.0055	0.026	0.029	0.019	–	–	–	–	–
MW-4007	0.0082	0.032	0.024	–	–	–	–	–	–
MW-4008	0.0036	–	0.011	–	–	–	–	–	–
MW-4009	0.12	0.045	0.023	0.0024	–	–	–	–	–
MW-4011	0.089	0.018	0.043	2.9	–	–	–	–	0.0018
MW-4012	0.11	0.20	0.068	–	–	–	–	–	–

TABLE 5.4 (Cont.)

	Estimated Hazard Quotient								
Well ID	Lithium	Molybdenum	Uranium, Total	Nitrate[3]	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT
Unweathered (cont.)									
MW-4022	0.046	0.036	0.07	0.0067	–	–	–	–	–
MWD-02	0.042	0.044	0.035	–	–	–	–	–	–
MWD-06	0.0056	–	0.0079	–	–	–	–	–	–
MWD-09	0.0074	–	0.013	0.014	0.036	–	–	0.00058	0.0044
MWD-23	0.0059	0.13	0.068	–	–	–	–	–	–
MWD-106	0.0049	–	–	–	–	–	–	–	–
MWS-05	0.0041	–	0.014	–	–	–	–	–	–
MWS-06	0.0059	–	0.039	–	–	–	–	–	–
MWS-105	0.0027	0.024	0.0022	–	–	–	–	–	–
MWS-106	0.0032	0.013	0.016	–	–	–	–	–	–
MWS-109	0.0030	0.010	0.014	–	–	–	–	–	–
TIL-4	–	–	–	–	–	–	–	–	–
USGS-1	0.0052	–	0.014	0.014	0.035	0.038	–	0.00070	0.00060
USGS-6	0.0025	0.018	0.054	0.0094	–	–	–	–	–
Weathered									
MW-2001	0.0036	–	0.0088	0.84	0.030	–	–	0.0018	0.0015
MW-2002	0.37	0.060	0.0065	2.2	–	–	–	0.00096	0.011
MW-2003	0.59	0.012	0.014	5.3	–	–	–	0.0021	0.012
MW-2004	–	–	–	–	–	–	–	–	–
MW-2005	0.13	0.0077	0.0062	1.1	0.019	–	–	0.00084	0.0025
MW-2006	0.022	0.013	0.0066	0.084	–	–	–	0.0019	0.00025
MW-2007	0.0055	0.023	0.014	0.050	–	–	–	–	–
MW-2008	–	–	–	–	–	–	–	–	–
MW-2009	–	–	–	–	–	–	–	–	–
MW-2010	0.023	0.058	0.016	0.024	0.082	–	0.019	0.0013	0.021
MW-2011	0.0088	–	0.0040	0.082	0.22	–	–	0.0027	0.044
MW-2012	0.0025	–	0.0046	0.0091	0.77	–	0.025	0.0014	0.018
MW-2013	0.0084	–	0.0090	0.017	3.4	–	0.047	0.0049	0.012
MW-2014	0.028	–	0.0066	0.031	1.0	0.24	0.0024	0.0022	0.011
MW-2015	0.021	–	0.026	0.0091	–	–	–	–	–
MW-2016	–	–	–	–	–	–	–	–	–
MW-2017	0.15	0.085	0.16	0.094	–	–	–	–	–
MW-2018	0.027	0.025	0.021	0.011	–	–	–	–	–
MW-2020	–	–	–	–	–	–	–	–	–
MW-2030	0.0088	–	0.17	0.022	4.5	–	1.6	0.0034	0.30
MW-2034	0.044	–	0.041	0.082	–	–	–	–	–
MW-2035	0.0037	0.019	0.0055	0.011	–	–	–	–	–
MW-2036	0.0093	–	0.010	0.069	–	–	–	–	–
MW-2037	0.56	–	0.017	5.0	0.10	–	–	0.0077	0.0036
MW-2038	0.71	0.0077	0.020	15	0.13	–	–	0.023	0.0088
MW-2039	0.030	0.024	0.042	0.89	4.0	–	–	0.0016	0.047
MW-2040	0.045	0.036	0.041	3.9	–	–	–	–	–
MW-2041	0.035	0.012	0.046	5.1	–	–	–	–	–
MW-2042	0.028	–	0.035	0.096	–	–	–	–	–
MW-2043	0.023	0.0082	0.024	0.099	–	–	–	0.0012	–
MW-2044	0.039	0.0099	0.031	0.022	–	–	–	–	–
MW-2046	–	–	–	–	–	–	–	–	–
MW-3003	0.89	0.031	0.25	5.1	–	–	–	0.0023	0.0023
MW-3007	–	–	–	–	–	–	–	–	–

TABLE 5.4 (Cont.)

Well ID	Estimated Hazard Quotient								
	Lithium	Molybdenum	Uranium, Total	Nitrate[a]	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT
Weathered (cont.)									
MW-3008	–	–	–	–	–	–	–	–	–
MW-3009	–	–	–	–	–	–	–	–	–
MW-3010	–	–	–	–	–	–	–	–	–
MW-3019	0.020	0.0055	0.029	0.021	–	–	–	–	–
MW-3023	0.88	1.4	0.17	3.6	–	–	–	0.068	0.14
MW-3025	0.22	–	0.038	8.9	–	–	–	0.0013	–
MW-3027	0.025	–	0.017	1.1	0.041	–	–	0.00079	0.0011
MW-4001	0.011	0.0099	0.0056	0.68	21	–	0.099	0.018	0.085
MW-4002	0.0053	0.0060	0.0082	0.089	0.034	–	0.099	0.0019	0.0079
MW-4003	0.0041	–	0.016	0.011	–	–	–	–	–
MW-4005	0.0092	0.027	0.022	0.027	–	–	–	–	–
MW-4006	0.0041	0.006	0.0036	0.024	10	–	–	0.0022	0.085
MW-4010	0.0079	0.020	0.042	–	–	–	–	–	–
MW-4013	0.093	–	0.016	1.6	15	–	0.0025	0.0011	0.020
MW-4014	0.0048	–	0.0030	0.099	0.060	–	–	0.00036	0.0024
MW-4015	0.0026	0.0014	0.0044	0.072	0.99	–	–	0.0026	0.030
MW-4016	0.0051	0.053	0.043	0.0068	–	–	–	–	–
MW-4017	–	–	–	–	–	–	–	–	–
MW-4018	0.0056	–	0.0087	0.046	–	–	–	–	–
MW-4019	0.014	–	0.023	0.0045	–	–	–	–	–
MW-4020	0.031	0.0071	0.13	–	–	–	–	–	–
MW-4021	0.031	–	0.042	–	–	–	–	–	–
MW-4023	0.020	–	0.021	0.045	0.048	–	–	0.00092	0.00063
MW-4024	0.11	0.061	0.82	0.024	–	–	–	–	–
MW-4025	0.016	0.023	0.014	0.019	–	–	–	–	–
MWD-15	0.0016	–	0.0067	0.0074	–	–	–	–	0.018
MWD-25	0.0033	0.010	0.024	0.0065	–	–	–	–	–
MWD-107	0.0074	0.025	0.028	–	0.026	–	–	0.00027	0.0025
MWD-112	0.0037	0.012	0.011	–	–	–	–	–	–
MWS-01	0.0026	–	0.018	0.043	–	–	–	–	0.018
MWS-02	0.0049	0.023	0.028	0.0017	–	–	–	–	–
MWS-03	0.0070	0.019	0.045	–	–	–	–	–	–
MWS-04	0.0055	–	0.14	0.15	6.0	–	0.066	0.0014	0.033
MWS-07	–	–	0.0099	0.039	9.9	–	0.14	0.00067	0.033
MWS-08	0.031	–	0.015	0.033	–	–	–	–	–
MWS-09	0.0090	–	0.016	–	–	–	–	–	–
MWS-10	0.0062	0.0093	0.0018	0.15	0.16	–	0.0015	0.0011	0.055
MWS-11	0.0033	–	0.023	0.15	0.020	–	0.0025	0.00075	0.015
MWS-12	0.0042	–	0.014	0.05	1.0	0.074	0.0099	0.12	0.41
MWS-13	0.0093	0.0029	0.0073	0.821	–	–	–	–	–
MWS-14	0.034	0.0088	0.037	0.0031	–	–	–	–	–
MWS-15	0.0018	–	0.0076	0.016	0.99	–	0.32	0.0011	0.027
MWS-16	–	–	0.0089	0.13	5.5	–	0.16	0.0013	0.033
MWS-17	0.0036	–	0.016	0.053	0.038	–	0.0082	0.015	0.36
MWS-19	0.0016	0.0055	0.018	0.0026	0.028	–	–	0.0011	0.0038
MWS-20	0.0020	–	0.0094	0.096	–	–	–	–	0.00036
MWS-21	0.49	0.027	0.041	8.9	–	–	–	0.013	0.0047
MWS-22	0.0041	0.00070	0.016	0.051	–	–	–	0.00034	0.0036
MWS-24	–	–	–	–	–	–	–	–	–
MWS-25	–	0.0093	0.022	0.010	–	–	–	–	–

TABLE 5.4 (Cont.)

Well ID	Estimated Hazard Quotient								
	Lithium	Molybdenum	Uranium, Total	Nitrate[a]	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT
Weathered (cont.)									
MWS-26	0.021	0.011	0.054	0.0089	–	–	–	–	–
MWS-104	0.0023	0.024	0.018	–	–	–	–	–	–
MWS-107	0.0068	0.0055	0.025	0.027	0.036	–	–	0.00081	0.0044
MWS-110	0.0045	–	0.0085	0.014	0.10	–	–	–	0.0015
MWS-112	0.023	0.19	0.037	0.0022	–	–	–	0.00077	0.00049
USGS-2	–	0.0099	0.000014	–	–	–	–	–	–
USGS-3	0.0066	0.0088	0.019	0.015	0.055	–	–	0.00030	0.0052
USGS-4	0.0053	0.0066	0.0073	0.026	0.99	–	–	0.021	0.058
USGS-5	0.0048	0.030	0.067	0.0039	–	–	–	–	–
USGS-7	–	–	–	–	–	–	–	–	–
USGS-8	0.014	0.0088	0.0085	0.055	–	–	–	–	–
USGS-9	0.0041	–	0.0047	0.055	–	–	–	0.0013	0.00041

Well ID	Estimated Hazard Quotient							
	2-Amino-4,6-DNT	4-Amino-2,6-DNT	Nitro-benzene	o-Nitro-toluene	m-Nitro-toluene	p-Nitro-toluene	1,2-DCE	Total[c]
Deep Wells								
MWD-05	–	–	–	–	–	–	–	0.04
MWD-18	–	–	–	–	–	–	–	0.02
MWGS-01	–	–	–	–	–	–	–	–
MWGS-02	–	–	–	–	–	–	–	–
MWS-18	–	–	–	–	–	–	–	0.08
MWS-101	–	–	–	–	–	–	–	0.009
MWS-102	–	–	–	–	–	–	–	0.08
MWS-103	–	–	–	–	–	–	–	0.02
TIL-3	–	–	–	–	–	–	–	0.02
Overburden								
MW-2031	–	–	–	–	–	–	–	–
MW-2032	1.6	1.3	–	0.00058	0.00012	–	0.0053	7
MW-2033	1.6	1.5	–	0.0018	0.00013	0.00025	–	6
MW-3001	–	–	–	–	–	–	–	–
MW-3013	–	–	–	–	–	–	–	–
MW-3018	–	–	–	–	–	–	–	–
MW-3022	–	–	–	–	–	–	–	–
MWV-01	1.7	3.1	–	0.00044	–	–	–	6
MWV-02	0.23	0.46	–	–	–	–	–	0.8
MWV-09	16	12	–	–	0.00036	0.0006	–	40
MWV-13	–	–	–	–	–	–	–	0.05
MWV-16	0.15	0.26	–	–	–	–	–	0.7
MWV-17	–	–	–	–	–	–	–	0.04
MWV-18	–	–	–	–	–	–	–	–
MWV-22	0.026	0.096	–	–	–	–	–	0.2
MWV-24R	0.21	0.46	–	0.00099	–	0.00017	–	3
USGS-2A	–	–	–	–	–	–	–	–

TABLE 5.4 (Cont.)

Well ID	Estimated Hazard Quotient							
	2-Amino-4,6-DNT	4-Amino-2,6-DNT	Nitro-benzene	o-Nitro-toluene	m-Nitro-toluene	p-Nitro-toluene	1,2-DCE	Total*
Unweathered								
MW-2019	–	–	–	–	–	–	–	0.2
MW-2021	–	–	–	–	–	–	–	0.06
MW-2022	–	–	–	–	–	–	–	0.04
MW-2023	–	–	–	–	–	–	–	0.08
MW-2024	–	–	–	–	–	–	–	0.02
MW-2025	–	–	–	–	–	–	–	–
MW-2026	–	–	–	–	–	–	–	0.06
MW-2027	–	–	–	–	–	–	–	0.04
MW-2028	–	–	–	–	–	–	–	0.07
MW-2029	–	–	–	–	–	–	–	–
MW-3002	–	–	–	–	–	–	–	–
MW-3006	–	–	–	–	–	–	–	0.1
MW-3024	0.015	0.026	–	0.00082	0.00011	–	0.00083	7
MW-3026	0.14	0.17	–	–	–	–	–	4
MW-4004	–	–	–	–	–	–	–	0.08
MW-4007	–	0.0078	–	–	–	–	–	0.07
MW-4008	–	–	–	–	–	–	–	0.02
MW-4009	–	–	–	–	–	–	–	0.2
MW-4011	0.35	0.82	–	–	–	–	–	4
MW-4012	–	–	–	–	–	–	–	0.4
MW-4022	–	–	–	–	–	–	–	0.2
MWD-02	–	–	–	–	–	–	–	0.1
MWD-06	–	–	–	–	–	–	–	0.01
MWD-09	0.043	0.23	–	0.00015	–	–	–	0.4
MWD-23	–	–	–	–	–	–	–	0.2
MWD-106	–	–	–	–	–	–	–	0.005
MWS-05	–	–	–	–	–	–	–	0.02
MWS-06	–	–	–	–	–	–	–	0.05
MWS-105	–	–	–	–	–	–	–	0.03
MWS-106	–	–	–	–	–	–	–	0.03
MWS-109	–	–	–	–	–	–	–	0.03
TIL-4	–	–	–	–	–	–	–	–
USGS-1	0.026	0.091	–	–	–	–	–	0.2
USGS-6	–	–	–	–	–	–	–	0.08
Weathered								
MW-2001	–	–	–	–	–	–	–	0.9
MW-2002	0.38	0.42	–	–	–	–	–	3
MW-2003	0.082	0.21	–	0.00049	–	–	–	6
MW-2004	–	–	–	–	–	–	–	–
MW-2005	0.055	0.055	–	–	–	–	–	1
MW-2006	–	–	0.0023	–	–	–	–	0.1
MW-2007	–	–	–	–	–	–	–	0.09
MW-2008	–	–	–	–	–	–	–	–
MW-2009	–	–	–	–	–	–	–	–
MW-2010	0.33	0.37	–	0.00023	–	–	–	0.9
MW-2011	0.91	0.45	–	0.0006	–	–	–	2
MW-2012	0.14	0.17	–	–	–	0.00077	–	1
MW-2013	1.1	1.0	–	0.00071	0.00016	–	0.022	6
MW-2014	0.19	0.29	–	0.0006	–	–	–	2

TABLE 5.4 (Cont.)

Well ID	Estimated Hazard Quotient							
	2-Amino-4,6-DNT	4-Amino-2,6-DNT	Nitro-benzene	o-Nitro-toluene	m-Nitro-toluene	p-Nitro-toluene	1,2-DCE	Total[a]
Weathered (cont.)								
MW-2015	–	–	–	–	–	–	–	0.06
MW-2016	–	–	–	–	–	–	–	–
MW-2017	–	–	–	–	–	–	–	0.5
MW-2018	–	–	–	–	–	–	–	0.08
MW-2020	–	–	–	–	–	–	–	–
MW-2030	2.5	2.0	–	0.00016	–	–	–	10
MW-2034	–	–	–	–	–	–	–	0.2
MW-2035	–	–	–	–	–	–	–	0.04
MW-2036	–	–	–	–	–	–	–	0.09
MW-2037	0.050	0.05	–	–	–	–	0.03	6
MW-2038	0.18	0.21	0.0034	0.00071	–	–	0.034	20
MW-2039	0.91	0.73	0.0030	0.0017	–	–	–	7
MW-2040	–	–	–	–	–	–	–	4
MW-2041	–	–	–	–	–	–	–	5
MW-2042	–	–	–	–	–	–	–	0.2
MW-2043	–	–	–	–	–	–	–	0.2
MW-2044	0.010	0.015	–	–	–	–	–	0.1
MW-2046	–	–	–	–	–	–	0.0027	0.003
MW-3003	–	0.016	–	0.0014	0.00038	0.00041	–	6
MW-3007	–	–	–	–	–	–	–	–
MW-3008	–	–	–	–	–	–	–	–
MW-3009	–	–	–	–	–	–	–	–
MW-3010	–	–	–	–	–	–	–	–
MW-3019	–	–	–	–	–	–	–	0.08
MW-3023	0.078	0.15	–	0.15	0.012	0.0019	–	7
MW-3025	–	0.014	–	0.00055	–	–	–	9
MW-3027	0.087	0.082	–	–	–	–	–	1
MW-4001	7.3	10	–	0.0023	–	–	–	40
MW-4002	0.64	1.1	–	–	–	–	–	2
MW-4003	0.0073	0.013	–	–	–	–	–	0.05
MW-4005	–	–	–	–	–	–	–	0.09
MW-4006	0.82	1.1	–	0.0019	0.00088	–	–	10
MW-4010	–	–	–	–	–	–	–	0.07
MW-4013	0.78	0.91	–	–	–	–	–	20
MW-4014	0.13	0.24	–	–	–	–	–	0.5
MW-4015	1.5	1.9	–	0.0003	–	–	–	5
MW-4016	–	–	–	–	–	–	–	0.1
MW-4017	–	–	–	–	–	–	–	–
MW-4018	–	–	–	–	–	–	–	0.06
MW-4019	–	–	–	–	–	–	–	0.04
MW-4020	–	–	–	–	–	–	–	0.2
MW-4021	–	–	–	–	–	–	–	0.07
MW-4023	0.017	0.023	–	–	–	–	–	0.2
MW-4024	–	–	–	–	–	–	–	1
MW-4025	–	–	–	–	–	–	–	0.07
MWD-15	0.32	0.78	–	–	–	–	–	1
MWD-25	–	–	–	–	–	–	–	0.04
MWD-107	0.018	0.23	–	–	–	–	–	0.3
MWD-112	–	–	–	–	–	–	–	0.03

TABLE 5.4 (Cont.)

Well ID	Estimated Hazard Quotient							
	2-Amino-4,6-DNT	4-Amino-2,6-DNT	Nitro-benzene	o-Nitro-toluene	m-Nitro-toluene	p-Nitro-toluene	1,2-DCE	Total[c]
Weathered (cont.)								
MWS-01	–	0.020	–	–	–	–	–	0.1
MWS-02	–	–	–	–	–	–	–	0.06
MWS-03	–	–	–	–	–	–	–	0.07
MWS-04	3.5	3.8	–	0.00058	–	–	–	10
MWS-07	2.6	5.0	–	–	–	–	–	20
MWS-08	–	–	–	–	–	–	–	0.08
MWS-09	–	–	–	–	–	–	–	0.03
MWS-10	2.9	7.3	–	0.00027	–	–	–	10
MWS-11	0.22	1.1	–	–	–	–	–	2
MWS-12	0.5	1.1	–	0.27	0.021	0.082	–	4
MWS-13	–	–	–	–	–	–	–	0.04
MWS-14	–	–	–	–	–	–	–	0.08
MWS-15	5.0	9.1	–	–	–	–	–	20
MWS-16	2.1	3.8	–	0.00044	–	–	–	10
MWS-17	1.8	2.1	–	0.024	0.00085	0.0025	–	4
MWS-19	0.12	0.18	–	–	–	–	–	0.4
MWS-20	–	0.026	–	–	–	–	–	0.1
MWS-21	0.11	0.23	–	0.00041	–	–	–	10
MWS-22	0.033	0.087	–	–	–	–	–	0.2
MWS-24	–	–	–	–	–	–	–	–
MWS-25	–	–	–	–	–	–	–	0.04
MWS-26	–	–	–	–	–	–	–	0.1
MWS-104	–	–	–	–	–	–	–	0.04
MWS-107	0.027	0.30	–	–	–	–	–	0.4
MWS-110	0.082	0.17	–	–	–	–	–	0.4
MWS-112	0.026	0.064	0.0034	–	–	–	–	0.4
USGS-2	–	–	–	–	–	–	–	0.01
USGS-3	0.011	0.11	–	–	–	–	–	0.2
USGS-4	0.91	1.0	–	0.0027	0.0003	–	–	3
USGS-5	–	–	–	–	–	–	–	0.1
USGS-7	–	–	–	–	–	–	–	–
USGS-8	–	–	–	–	–	–	–	0.09
USGS-9	1.2	1.7	–	–	–	–	–	3

[a] The hazard quotient for an infant from ingestion of nitrate ranges from 0.0005 (MW-2021) to 90 (MW-2038).

[b] A hyphen (–) indicates the parameter was not detected.

[c] All values in total column rounded to one significant figure.

TABLE 5.5 Estimated Chemical Carcinogenic Risks to the Hypothetical Future Resident for the Ingestion Pathway

	Estimated Risk				
Well ID	2,4,6-TNT	2,4-DNT	2,6-DNT	TCE[a]	Total[b]
Deep Wells					
MWD-05	–[c]	–	–	–	–
MWD-18	–	–	–	–	–
MWGS-01	–	–	–	–	–
MWGS-02	–	–	–	–	–
MWS-18	–	–	–	–	–
MWS-101	–	–	–	–	–
MWS-102	–	–	–	–	–
MWS-103	–	–	–	–	–
TIL-3	–	–	–	–	–
Overburden					
MW-2031	–	–	–	–	–
MW-2032	2.4×10^{-6}	1.1×10^{-6}	3.5×10^{-5}	8.1×10^{-8} (1.2×10^{-7})	4×10^{-5} (2×10^{-7})
MW-2033	4.2×10^{-7}	4.4×10^{-6}	3.9×10^{-5}	–	4×10^{-5}
MW-3001	–	–	–	–	–
MW-3013	–	–	–	–	–
MW-3018	–	–	–	–	–
MW-3022	–	–	–	–	–
MWV-01	3.9×10^{-6}	8.8×10^{-7}	8.0×10^{-6}	–	1×10^{-5}
MWV-02	3.9×10^{-8}	4.7×10^{-7}	3.8×10^{-7}	–	9×10^{-7}
MWV-09	1.1×10^{-5}	1.6×10^{-4}	2.3×10^{-5}	–	2×10^{-4}
MWV-13	–	–	–	–	–
MWV-16	9.5×10^{-8}	–	5.5×10^{-7}	–	7×10^{-7}
MWV-17	–	–	–	–	–
MWV-18	–	–	–	–	–
MWV-22	–	–	1.1×10^{-6}	–	1×10^{-6}
MWV-24R	3.9×10^{-7}	1.0×10^{-6}	1.1×10^{-5}	–	1×10^{-5}
USGS-2A	–	–	–	–	–
Unweathered					
MW-2019	–	–	–	–	–
MW-2021	–	–	–	–	–
MW-2022	–	–	–	–	–
MW-2023	–	–	–	–	–
MW-2024	–	–	–	–	–
MW-2025	–	–	–	–	–
MW-2026	–	–	–	–	–
MW-2027	–	–	–	–	–
MW-2028	–	–	–	–	–
MW-2029	–	–	–	–	–
MW-3002	–	–	–	–	–
MW-3006	–	–	–	–	–
MW-3024	–	1.0×10^{-6}	3.6×10^{-6}	6.5×10^{-6} (9.8×10^{-6})	5×10^{-6} (2×10^{-5})

TABLE 5.5 (Cont.)

Well ID	Estimated Risk				
	2,4,6-TNT	2,4-DNT	2,6-DNT	TCE[a]	Total[b]
Unweathered (cont.)					
MW-3026	–	5.7×10^{-7}	3.7×10^{-7}	–	9×10^{-7}
MW-4004	–	–	–	–	–
MW-4007	–	–	–	–	–
MW-4008	–	–	–	–	–
MW-4009	–	–	–	–	–
MW-4011	–	–	5.2×10^{-7}	–	5×10^{-7}
MW-4012	–	–	–	–	–
MW-4022	–	–	–	–	–
MWD-02	–	–	–	–	–
MWD-06	–	–	–	–	–
MWD-09	–	3.4×10^{-7}	1.3×10^{-6}	–	2×10^{-6}
MWD-23	–	–	–	–	–
MWD-106	–	–	–	–	–
MWS-05	–	–	–	–	–
MWS-06	–	–	–	–	–
MWS-105	–	–	–	–	–
MWS-106	–	–	–	–	–
MWS-109	–	–	–	–	–
TIL-4	–	–	–	–	–
USGS-1	–	4.1×10^{-7}	1.8×10^{-7}	–	6×10^{-7}
USGS-6	–	–	–	–	–
Weathered					
MW-2001	–	1.0×10^{-6}	4.5×10^{-7}	–	2×10^{-6}
MW-2002	–	5.6×10^{-7}	3.3×10^{-6}	–	4×10^{-6}
MW-2003	–	1.2×10^{-6}	3.6×10^{-6}	–	5×10^{-6}
MW-2004	–	–	–	–	–
MW-2005	–	4.9×10^{-7}	7.2×10^{-7}	–	1×10^{-6}
MW-2006	–	1.1×10^{-6}	7.2×10^{-8}	–	1×10^{-6}
MW-2007	–	–	–	–	–
MW-2008	–	–	–	–	–
MW-2009	–	–	–	–	–
MW-2010	1.2×10^{-7}	7.5×10^{-7}	6.0×10^{-6}	–	7×10^{-6}
MW-2011	–	1.6×10^{-6}	1.3×10^{-5}	–	2×10^{-5}
MW-2012	1.6×10^{-7}	7.9×10^{-7}	5.2×10^{-6}	–	6×10^{-6}
MW-2013	3.0×10^{-7}	2.9×10^{-6}	3.5×10^{-5}	2.6×10^{-7} (3.9×10^{-7})	4×10^{-5} (6×10^{-7})
MW-2014	1.5×10^{-8}	1.3×10^{-6}	3.3×10^{-6}	–	5×10^{-6}
MW-2015	–	–	–	–	–
MW-2016	–	–	–	–	–
MW-2017	–	–	–	–	–
MW-2018	–	–	–	–	–
MW-2020	–	–	–	–	–
MW-2030	1.0×10^{-5}	2.0×10^{-6}	8.8×10^{-5}	–	1×10^{-4}
MW-2034	–	–	–	–	–

TABLE 5.5 (Cont.)

Well ID	Estimated Risk				
	2,4,6-TNT	2,4-DNT	2,6-DNT	TCE[a]	Total[b]
Weathered (cont.)					
MW-2035	–	–	–	–	–
MW-2036	–	–	–	–	–
MW-2037	–	4.5×10^{-6}	1.0×10^{-6}	1.6×10^{-4} (2.4×10^{-4})	6×10^{-6} (4×10^{-4})
MW-2038	–	1.4×10^{-5}	2.6×10^{-6}	4.9×10^{-4} (7.4×10^{-4})	2×10^{-5} (1×10^{-3})
MW-2039	–	9.6×10^{-7}	1.4×10^{-5}	–	2×10^{-5}
MW-2040	–	–	–	–	–
MW-2041	–	–	–	–	–
MW-2042	–	–	–	–	–
MW-2043	–	6.9×10^{-7}	–	–	7×10^{-7}
MW-2044	–	–	–	–	–
MW-3003	–	1.4×10^{-6}	6.8×10^{-7}	–	2×10^{-6}
MW-3007	–	–	–	–	–
MW-3008	–	–	–	–	–
MW-3009	–	–	–	–	–
MW-3010	–	–	–	–	–
MW-3019	–	–	–	–	–
MW-3023	–	4.0×10^{-5}	4.0×10^{-5}	–	8×10^{-5}
MW-3025	–	7.5×10^{-7}	–	4.7×10^{-6} (7.1×10^{-6})	8×10^{-7} (1×10^{-5})
MW-3027	–	4.6×10^{-7}	3.2×10^{-7}	3.5×10^{-7} (5.2×10^{-7})	8×10^{-7} (9×10^{-7})
MW-4001	6.3×10^{-7}	1.0×10^{-5}	2.5×10^{-5}	5.2×10^{-7} (7.8×10^{-7})	4×10^{-5} (1×10^{-6})
MW-4002	6.3×10^{-7}	1.1×10^{-6}	2.3×10^{-6}	–	4×10^{-6}
MW-4003	–	–	–	–	–
MW-4005	–	–	–	–	–
MW-4006	–	1.3×10^{-6}	2.5×10^{-5}	–	3×10^{-5}
MW-4010	–	–	–	–	–
MW-4013	1.6×10^{-8}	6.1×10^{-7}	5.9×10^{-6}	–	7×10^{-6}
MW-4014	–	2.1×10^{-7}	6.9×10^{-7}	–	9×10^{-7}
MW-4015	–	1.5×10^{-6}	8.8×10^{-6}	–	1×10^{-5}
MW-4016	–	–	–	–	–
MW-4017	–	–	–	–	–
MW-4018	–	–	–	–	–
MW-4019	–	–	–	–	–
MW-4020	–	–	–	–	–
MW-4021	–	–	–	–	–
MW-4023	–	5.3×10^{-7}	1.8×10^{-7}	–	7×10^{-7}
MW-4024	–	–	–	–	–
MW-4025	–	–	–	–	–
MWD-15	–	–	5.1×10^{-6}	–	5×10^{-6}
MWD-25	–	–	–	–	–
MWD-107	–	1.6×10^{-7}	7.2×10^{-7}	–	9×10^{-7}
MWD-112	–	–	–	–	–

TABLE 5.5 (Cont.)

Well ID	Estimated Risk				
	2,4,6-TNT	2,4-DNT	2,6-DNT	TCE[a]	Total[b]
Weathered (cont.)					
MWS-01	–	–	5.1×10^{-6}	–	5×10^{-6}
MWS-02	–	–	–	–	–
MWS-03	–	–	–	–	–
MWS-04	4.2×10^{-7}	8.0×10^{-7}	9.6×10^{-6}	–	1×10^{-5}
MWS-07	9.2×10^{-7}	3.9×10^{-7}	9.6×10^{-6}	–	1×10^{-5}
MWS-08	–	–	–	–	–
MWS-09	–	–	–	–	–
MWS-10	9.9×10^{-9}	6.5×10^{-7}	1.6×10^{-5}	–	2×10^{-5}
MWS-11	1.6×10^{-8}	4.4×10^{-7}	4.3×10^{-6}	–	5×10^{-6}
MWS-12	6.3×10^{-8}	7.0×10^{-5}	1.2×10^{-4}	–	2×10^{-4}
MWS-13	–	–	–	–	–
MWS-14	–	–	–	–	–
MWS-15	2.1×10^{-6}	6.5×10^{-7}	8.0×10^{-6}	–	1×10^{-5}
MWS-16	1.0×10^{-6}	7.3×10^{-7}	9.6×10^{-6}	–	1×10^{-5}
MWS-17	5.3×10^{-8}	8.8×10^{-6}	1.0×10^{-4}	–	1×10^{-4}
MWS-19	–	6.4×10^{-7}	1.1×10^{-6}	–	2×10^{-6}
MWS-20	–	–	1.0×10^{-7}	–	1×10^{-7}
MWS-21	–	7.5×10^{-6}	1.4×10^{-6}	1.0×10^{-4} (1.6×10^{-4})	9×10^{-6} (3×10^{-4})
MWS-22	–	2.0×10^{-7}	1.0×10^{-6}	–	1×10^{-6}
MWS-24	–	–	–	–	–
MWS-25	–	–	–	–	–
MWS-26	–	–	–	–	–
MWS-104	–	–	–	–	–
MWS-107	–	4.7×10^{-7}	1.3×10^{-6}	–	2×10^{-6}
MWS-110	–	–	4.3×10^{-7}	–	4×10^{-7}
MWS-112	–	4.5×10^{-7}	1.4×10^{-7}	–	6×10^{-7}
USGS-2	–	–	–	–	–
USGS-3	–	1.8×10^{-7}	1.5×10^{-6}	–	2×10^{-6}
USGS-4	–	1.2×10^{-5}	1.7×10^{-5}	–	3×10^{-5}
USGS-5	–	–	–	–	–
USGS-7	–	–	–	–	–
USGS-8	–	–	–	–	–
USGS-9	–	7.3×10^{-7}	1.2×10^{-7}	–	9×10^{-7}

[a] Risk from inhalation was also calculated for TCE because it is a volatile compound. Inhalation risks are shown in parentheses under the ingestion entries.

[b] Total values in parentheses indicate contribution from TCE.

[c] A hyphen (–) indicates that the compound was not detected.

TABLE 5.6 Estimated Radiological Carcinogenic Risks for the Hypothetical Future Resident[a]

Well ID	Uranium Risk	Well ID	Uranium Risk
Deep Wells		***Unweathered (cont.)***	
MWD-05	6×10^{-7}	MW-4004	2×10^{-6}
MWD-18	9×10^{-7}	MW-4007	2×10^{-6}
MWGS-01	–[b]	MW-4008	9×10^{-7}
MWGS-02	–	MW-4009	2×10^{-6}
MWS-18	2×10^{-6}	MW-4011	4×10^{-6}
MWS-101	6×10^{-7}	MW-4012	6×10^{-6}
MWS-102	3×10^{-6}	MW-4022	6×10^{-6}
MWS-103	9×10^{-7}	MWD-02	3×10^{-6}
TIL-3	1×10^{-7}	MWD-06	7×10^{-7}
		MWD-09	1×10^{-6}
Overburden		MWD-23	7×10^{-6}
MW-2031	–	MWD-106	–
MW-2032	5.4×10^{-6}	MWS-05	1×10^{-6}
MW-2033	3×10^{-6}	MWS-06	3×10^{-6}
MW-3001	–	MWS-105	2×10^{-7}
MW-3013	–	MWS-106	1×10^{-6}
MW-3018	–	MWS-109	1×10^{-6}
MW-3022	–	TIL-4	–
MWV-01	5×10^{-6}	USGS-6	5×10^{-6}
MWV-02	3×10^{-6}		
MWV-09	8×10^{-7}	***Weathered***	
MWV-13	2×10^{-6}	MW-2001	2×10^{-6}
MWV-16	1×10^{-6}	MW-2002	2×10^{-6}
MWV-17	7×10^{-8}	MW-2003	2×10^{-6}
MWV-18	–	MW-2004	–
MWV-22	1×10^{-6}	MW-2005	6×10^{-7}
MWV-24R	2×10^{-6}	MW-2006	4×10^{-7}
USGS-2A	–	USGS-1	1×10^{-6}
		MW-2007	1×10^{-6}
Unweathered		MW-2008	–
MW-2019	3×10^{-6}	MW-2009	–
MW-2021	1×10^{-6}	MW-2010	1×10^{-6}
MW-2022	1×10^{-6}	MW-2011	3×10^{-7}
MW-2023	3×10^{-6}	MW-2012	4×10^{-7}
MW-2024	1×10^{-7}	MW-2013	4×10^{-6}
MW-2025	–	MW-2014	5×10^{-7}
MW-2026	9×10^{-7}	MW-2015	2×10^{-6}
MW-2027	1×10^{-6}	MW-2016	–
MW-2028	1×10^{-6}	MW-2017	1×10^{-5}
MW-2029	–	MW-2018	2×10^{-6}
MW-3002	–	MW-2020	–
MW-3006	8×10^{-7}	MW-2030	1×10^{-5}
MW-3024	3×10^{-6}	MW-2034	3×10^{-6}
MW-3026	5×10^{-6}	MW-2035	5×10^{-7}

TABLE 5.6 (Cont.)

Well ID	Uranium Risk[a]	Well ID	Uranium Risk[a]
Weathered (cont.)		*Weathered (cont.)*	
MW-2036	9×10^{-7}	MWD-25	2×10^{-6}
MW-2037	1×10^{-6}	MWD-107	2×10^{-6}
MW-2038	2×10^{-6}	MWD-112	9×10^{-7}
MW-2039	4×10^{-6}	MWS-01	1×10^{-6}
MW-2040	3×10^{-6}	MWS-02	2×10^{-6}
MW-2041	4×10^{-6}	MWS-03	4×10^{-6}
MW-2042	3×10^{-6}	MWS-04	1×10^{-5}
MW-2043	2×10^{-6}	MWS-07	9×10^{-7}
MW-2044	3×10^{-6}	MWS-08	1×10^{-6}
MW-3003	2×10^{-5}	MWS-09	1×10^{-6}
MW-3007	–	MWS-10	2×10^{-7}
MW-3008	–	MWS-11	2×10^{-6}
MW-3009	–	MWS-12	1×10^{-6}
MW-3010	–	MWS-13	6×10^{-7}
MW-3019	2×10^{-6}	MWS-14	3×10^{-6}
MW-3023	1×10^{-5}	MWS-15	6×10^{-7}
MW-3025	3×10^{-6}	MWS-16	7×10^{-7}
MW-3027	1×10^{-6}	MWS-17	1×10^{-6}
MW-4001	5×10^{-7}	MWS-19	1×10^{-6}
MW-4002	7×10^{-7}	MWS-20	8×10^{-7}
MW-4003	2×10^{-6}	MWS-21	3×10^{-6}
MW-4005	2×10^{-6}	MWS-22	1×10^{-6}
MW-4006	3×10^{-7}	MWS-24	
MW-4010	3×10^{-6}	MWS-25	2×10^{-6}
MW-4013	1×10^{-6}	MWS-26	5×10^{-6}
MW-4014	3×10^{-7}	MWS-104	1×10^{-6}
MW-4015	4×10^{-7}	MWS-107	2×10^{-6}
MW-4016	4×10^{-6}	MWS-110	7×10^{-7}
MW-4017	–	MWS-112	3×10^{-6}
MW-4018	7×10^{-7}	USGS-2	4×10^{-7}
MW-4019	2×10^{-6}	USGS-3	2×10^{-6}
MW-4020	1×10^{-5}	USGS-4	6×10^{-7}
MW-4021	4×10^{-6}	USGS-5	6×10^{-6}
MW-4023	2×10^{-6}	USGS-7	–
MW-4024	7×10^{-5}	USGS-8	7×10^{-7}
MW-4025	1×10^{-6}	USGS-9	4×10^{-7}
MWD-15	6×10^{-7}		

[a] Maximum uranium concentrations from the 1995 joint DOE/DA sampling rounds were used as EPCs.

[b] A hyphen (–) indicates samples were not collected as part of joint sampling rounds.

6 ECOLOGICAL RISK CHARACTERIZATION

6.1 METHODOLOGY

Risks to biota were estimated by two methods: (1) determining an ecological effects quotient (EEQ) and (2) evaluating all available lines of evidence in a weight-of-evidence approach. For both approaches, the ecological significance of the potential risks was also considered and incorporated into the final risk characterization.

6.1.1 Ecological Effects Quotient

6.1.1.1 Calculation

For aquatic biota, the EEQ was estimated for each contaminant as the ratio between the exposure point concentration and a "safe" media concentration. For terrestrial biota, the EEQ for each contaminant was estimated as the ratio between the modeled ADD and a safe benchmark dose value. In both cases, values of the EEQ may vary from 0 to infinity, and values greater than 1.0 are considered to demonstrate a potential risk to the receptor from a particular contaminant. Values between 1.0 and 10 indicate a low risk, values between 10 and 50 indicate a moderate risk, values between 50 and 100 indicate a high risk, and values greater than 100 indicate extreme risk.

6.1.1.2 Benchmark Values

Estimating the EEQ requires the use of benchmark values that represent contaminant concentrations considered to be acceptable ("safe") to biota. Benchmark values are contaminant-specific and species-specific, typically represent NOAEL concentrations, and may include media concentrations, food concentrations, tissue concentrations, or dose estimates. For aquatic biota, surface water contaminant benchmark values used in this analysis included EPA ambient water quality criteria (chronic values), EPA ecotox threshold values (EPA 1996a), and values obtained from the literature (Suter and Tsao 1996; Talmage and Opresko 1996). For sediment-based contaminants, benchmark values were obtained from the National Oceanic and Atmospheric Administration, the EPA, and the open scientific literature. For terrestrial biota, EEQ values were estimated using contaminant-specific and species-specific NOAEL or LOAEL benchmark values obtained from the literature (Sample et al. 1996; Talmage and Opresko 1996). The benchmark values used for this risk assessment are presented in Table 6.1.

TABLE 6.1 Benchmark Values Used to Estimate EEQs for Aquatic and Terrestrial Biota

Contaminant	Benchmark Value			
	Aquatic Biota			
	Surface Water[a] (µg/L)	Sediment (mg/kg)	American Robin[b] (mg/kg-d)	White-Tailed Deer[b] (mg/kg-d)
Metals				
Antimony	NC[c]	NC	NBA[c]	0.019
Arsenic	NC	8.2[d]	2.46	0.019
Cadmium	NC	1.2[d]	1.45	0.271
Iron	1,000 (chronic)	NC	NBA	NBA
Lead	NC	47[d]	3.85	2.24
Lithium	NC	NBA	NBA	1.8
Manganese	120[e]	300[f]	997	25.0
Mercury	1.3 (chronic)	0.15[d]	0.064	0.009
Molybdenum	NC	NBA	3.5	0.04
Nickel	NC	21.0[d]	77.4	11.2
Selenium	NC	NBA	0.5	0.056
Silver	NC	1.0[f]	165[g]	5.54[h]
Strontium	NC	NC	82.8[i]	74.0
Uranium, total	570[j]	NBA	16.0	0.46
Inorganic anion				
Nitrate-N	90,000[k]	NBA	NBA	178
Nitroaromatic compounds				
1,3,5-TNB	14.0 (chronic)[l]	0.30[l]	NBA	0.9[m]
1,3-DNB	NC	1.2[l]	NBA	0.03[m]
2,4,6-TNT	130 (chronic)[l]	13[l]	NBA	0.4[m]
2,4-DNT	NC	NBA	NBA	NBA
2,6-DNT	NBA	NBA	NBA	NBA
2-Amino-4,6-DNT	0.02	NBA	NBA	NBA
4-Amino-2,6-DNT	NBA	NBA	NBA	NBA
Nitrotoluene	NBA	NBA	NBA	NBA

[a] Benchmark values are EPA (1986) ambient water quality criteria (AWQC), unless otherwise noted.

[b] Benchmark values are NOAEL toxicological benchmarks developed by Sample et al. (1996), unless otherwise noted.

[c] NBA = no benchmark value available; NC = not a contaminant of ecological concern for the indicated medium.

[d] Based on EPA ecotox threshold value (EPA 1996a).

[e] Based on chronic value developed by Suter and Tsao (1996).

[f] Based on value reported in Hull and Suter (1994).

[g] Based on data from Jensen et al. (1974).

[h] Based on data from Agency for Toxic Substances and Disease Registry (1990).

[i] Based on data from Weber et al. (1968).

[j] No AWQC available; value is lowest concentration reported as chemotoxic to aquatic biota (Poston et al. 1984).

[k] EPA (1986) identifies the concentration as a potentially "safe" maximum concentration; no AWQC available.

[l] Based on chronic value developed by Talmage and Opresko (1996).

[m] Based on NOAEL value developed by Talmage and Opresko (1996).

6.1.2 Weight of Evidence

The potential for adverse impacts to ecological resources was characterized using a weight-of-evidence approach (EPA 1992b). In this approach, the EEQ risk estimates were evaluated together with the results of the biotic surveys and media-based toxicity tests. The potential for risks to ecological resources at the site was based on the frequency that the results of these various evaluations indicated actual or predicted adverse ecological effects and the degree of confidence in these results. Thus, the potential for unacceptable risks to ecological resources is greater if the results indicate a greater frequency for adverse effects and if the degree of confidence in the results is greater. Finally, the risk determination was evaluated with regard to its overall significance to the ecological resources of the area, and a final overall risk characterization was developed for the springs.

6.2 RISK ESTIMATION AND ECOLOGICAL SIGNIFICANCE

6.2.1 Risk Estimation

6.2.1.1 Ecological Effects Quotient

For aquatic biota, the EEQs were calculated by comparing the EPCs in surface water and sediment with suitable benchmark values; these EEQ values are presented in Table 6.2. The EEQ values were estimated for only those surface water and sediment contaminants that were identified as COECs (Tables 2.3 and 2.4) and for which appropriate chronic benchmark values were available (Table 6.1). A high risk (EEQ = 66) was identified for mercury. However, this high risk estimate is due primarily to use of the maximum reported mercury concentration in calculating the 95% UCL EPC. For mercury, the EPC incorporated a concentration of 6,100 µg/L reported from spring SP-6303. This is the highest mercury concentration reported from any of the springs and likely represents an outlier; the next highest reported spring concentration is 340 µg/L. Excluding the 6,100 µg/L mercury concentration from the risk estimation reduces the 95% UCL for mercury and results in a determination of low risk for mercury (EEQ = 10).

Similarly, the low EEQ risk level for iron was estimated using the maximum reported iron concentration, which also appears to be an outlier. This concentration, 400,000 µg/L, was reported from a single spring (SP-6303) and is the highest reported from any of the springs. The next highest iron concentration is 7,300 µg/L, which is 54 times lower than the highest reported concentration. Using the 95% UCL iron concentration (excluding the 400,000 µg/L concentration) results in a determination of no risk from iron (EEQ = 0.86). No high risks (EEQ values between 50 and 100) were identified for any surface water or sediment contaminants, whereas a moderate risk was identified only for manganese (EEQ = 13) in surface water. Low risks or no risks (EEQ < 10) were identified for the sediment contaminants (Table 6.2). These results suggest that although

TABLE 6.2 Estimated EEQs for Aquatic Biota Exposed to Surface Water and Sediment at Burgermeister Spring

	Surface Water			Sediment		
Contaminant[a]	EPC[b] (µg/L)	EEQ	Risk Level[c]	EPC[b] (µg/L)	EEQ	Risk Level[c]
Metals						
Arsenic	NC[d]	NA[e]	NA	43[f]	5.2	Low risk
Iron	6,200	6.2	Low risk	NC	NA	NA
Lead	NC	NA	NA	110[f]	2.3	Low risk
Manganese	1,600	13	Moderate risk	NC	NA	NA
Mercury	86	66	High risk	NC	NA	NA
Selenium	NC	NA	NA	0.96[f]	NBA[d]	NA
Silver	NC	NA	NA	1.7[f]	1.7	Low risk
Uranium, total	84	1.5	Low risk	100[f]	NBA	NA
Nitroaromatic compounds						
1,3-DNB	0.033	0.01	No risk	NC	NA	NA

[a] Included are only those contaminants identified as COECs (see Section 2.2) and for which a benchmark value was available (Table 6.1).

[b] EPC values are the estimated 95% UCL value, unless otherwise noted (footnote *f*).

[c] EEQ values greater than 1.0 are considered to demonstrate a potential risk to the receptor from a particular contaminant. Values between 1.0 and 10 indicate a low risk, values between 10 and 50 indicate a moderate risk, values between 50 and 100 indicate a high risk, and values greater than 100 indicate extreme risk.

[d] NBA = no benchmark available to estimate EEQ; NC = not a COEC for the indicated medium.

[e] NA = not applicable.

[f] EPC values are the maximum reported concentrations.

concentrations of some contaminants might adversely affect aquatic biota, the risks of unacceptable impacts are low.

The EEQ values for terrestrial biota (American robin and white-tailed deer) were calculated using modeled contaminant doses from water ingestion; the EEQ values are presented in Table 6.3. Uptake modeling was performed and EEQ values were estimated for all contaminants detected in spring water from all springs at concentrations exceeding background levels and for which benchmark values were available (Table 6.1). Except for the values calculated for mercury, all EEQ estimates were below 0.05 for both modeled receptor species (typically less than 0.01), indicating that current concentrations of contaminants in surface water at the spring pose no risk to terrestrial receptors that use the spring for drinking water. For mercury, a moderate risk was estimated for the American robin (EEQ = 13). This risk estimate was obtained because the maximum reported

mercury concentration was used as the exposure point concentration for uptake modeling. That concentration, 6,100 µg/L, was a single high value; the next highest mercury concentration was 340 µg/L. Using this latter value as the exposure point concentration results in a determination of no risk for the American robin (EEQ = 0.73).

Overall, the EEQ estimates suggest that concentrations of some contaminants in surface water and sediment might pose low risks to aquatic biota, whereas concentrations in surface water pose no risk to terrestrial biota using the springs as drinking water sources. Ingestion of sediment was not considered a significant pathway for contaminant uptake by terrestrial biota.

6.2.1.2 Weight of Evidence

In total, 19 ecological and/or ecotoxicological parameters were evaluated as part of the ecological risk assessment; the results of these evaluations are summarized in Table 6.4. No adverse effects were evident to the invertebrate or vertebrate communities inhabiting Burgermeister Spring and its drainage. The species present in the system are representative of species typically found in similar habitats throughout the Midwest. Although the fish community was limited in diversity and the invertebrate community was classified as slightly impaired (DOE and DA 1997), these conditions are probably the result of the natural, intermittent, and ephemeral nature of the flow within the drainage and the resultant temporal availability of aquatic habitats.

Some toxicity of environmental media was detected for the spring and its drainage. Toxicity of surface water and sediment from Burgermeister Spring proper was detected for the fish *Pimephales* and the amphipod *Hyalella*, respectively, as evidenced by reduced survival of test organisms. Surface water and sediment toxicity was also measured at some downstream locations, but no clear toxicity gradient was evident extending downstream from the spring proper. One would expect toxicity to decrease in a downstream direction from the spring as contaminant concentrations become reduced via dilution. However, chronic sediment toxicity to *Pimephales* was measured only at the farthest downstream location from the spring, the inflow to Lake 34. Similarly, chronic surface water toxicity to the amphibian *Xenopus*, acute sediment toxicity to *Pimephales*, and chronic sediment toxicity to *Xenopus* were detected only at locations downstream of the spring but upstream of the Lake 34 inflow. These results suggest that the source of the observed toxicity is other than Burgermeister Spring. Furthermore, the presence of apparently unaffected invertebrate, fish, and amphibian communities in the drainage at locations where toxicity was detected suggests that although some toxicity may be associated with surface water and sediment in the drainage, local populations have adapted and are tolerant of the contaminant concentrations present in these media.

Contaminant uptake modeling and EEQ estimation indicates no risks to terrestrial biota drinking from the springs. Aquatic biota inhabiting the springs might be susceptible to low to moderate risks from spring water concentrations of iron, manganese, mercury, and uranium and from sediment concentrations of arsenic, lead, and silver. However, as previously discussed,

TABLE 6.3 Estimated EEQs for Terrestrial Biota Drinking Water from Springs in the Chemical Plant Area and Ordnance Works Area

	American Robin		White-Tailed Deer	
Contaminant[a]	EEQ	Risk Level[b]	EEQ	Risk Level[b]
Metals				
Antimony	NBA[c]	NA[d]	0.01	No risk
Arsenic	0.02	No risk	0.02	No risk
Cadmium	< 0.01	No risk	0.03	No risk
Lead	< 0.01	No risk	< 0.01	No risk
Lithium	NBA	NA	< 0.01	No risk
Manganese	< 0.01	No risk	< 0.01	No risk
Mercury	13	Moderate risk	0.77	No risk
Molybdenum	< 0.01	No risk	< 0.01	No risk
Selenium	< 0.01	No risk	< 0.01	No risk
Uranium, total	< 0.01	No risk	< 0.01	No risk
Silver	< 0.01	No risk	< 0.01	No risk
Inorganic anion				
Nitrate-N	NBA	NA	< 0.01	No risk
Nitroaromatic compounds				
1,3,5-TNB	NBA	NA	< 0.01	No risk
1,3-DNB	NBA	NA	< 0.01	No risk
2,4,6-TNT	NBA	NA	< 0.01	No risk

[a] EEQ values were estimated for all contaminants detected in surface waters from area springs at concentrations above background levels and for which a benchmark value was available.

[b] EEQ values greater than 1.0 are considered to demonstrate a potential risk to the receptor from a particular contaminant. Values between 1.0 and 10 indicate a low risk, values between 10 and 50 indicate a moderate risk, values between 50 and 100 indicate a high risk, and values greater than 100 indicate extreme risk.

[c] NBA = no benchmark available for estimating EEQ.

[d] NA = not applicable.

TABLE 6.4 Summary of the Ecological Effects Assessment of Burgermeister Spring

Organism/ Assessment Method	Expected Result if Adverse Effects Present	Observed and Reported Result	Adverse Effect
Aquatic invertebrate surveys	Low abundance and species diversity; community dominated by only a few taxa	Slightly impaired invertebrate community typical of ephemeral, intermittent habitats	No
Fish surveys	Low abundance; adverse external conditions, such as lesions or tumors, suggestive of contaminant exposure	No fish collected from the spring proper, and none expected due to blocked access from downstream habitats; downstream community comprised of species typical of similar habitats in the Midwest; no evidence of adverse external conditions	No
Amphibian surveys	Low abundance; adverse external conditions, such as lesions or tumors, suggestive of contaminant exposure	Six species collected from spring area, comparable to community from reference location; species typical of similar habitats in the Midwest; no evidence of adverse external conditions	No
Daphnia, surface water, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
Hyalella, surface water, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
Pimephales, surface water, 96-hour acute toxicity	Reduced survival	62.5% reduction in survival at the spring and nearest downstream sampling location	Yes
Xenopus, surface water, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
Daphnia, surface water, 7-day chronic toxicity	Reduced survival	No reduction in survival	No
Hyalella, surface water, 7-day chronic toxicity	Reduced survival	No reduction in survival	No
Pimephales, surface water, 7-day chronic toxicity	Reduced survival and growth	No reduction in survival or growth	No
Xenopus, surface water, 7-day chronic toxicity	Reduced survival and growth	30% reduction in survival at one location downstream of the spring; no reduction in survival at other locations; no reduction in growth	Yes
Daphnia, sediment, 96-hour acute toxicity	Reduced survival	No reduction in survival	No

TABLE 6.4 (Cont.)

Organism/ Assessment Method	Expected Result if Adverse Effects Present	Observed and Reported Result	Adverse Effect
Hyalella, sediment, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
Pimephales, sediment, 96-hour acute toxicity	Reduced survival	25% reduction in survival at the first downstream sampling location below the spring	Yes
Xenopus, sediment, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
Daphnia, sediment, 7-day chronic toxicity	Reduced survival	No reduction in survival	No
Hyalella, sediment, 7-day chronic toxicity	Reduced survival	18% reduction in survival at the spring; no effects at downstream locations	Yes
Pimephales, sediment, 7-day chronic toxicity	Reduced survival and growth	50% reduction in survival at farthest downstream sampling location	Yes
Xenopus, sediment, 7-day chronic toxicity	Reduced survival and growth	27% reduction in survival at first sampling location downstream of the spring; no reduction in survival at other locations; no reduction in growth	Yes

Burgermeister Spring and waters downstream support invertebrate, fish, and amphibian communities typical of similar habitats elsewhere in the Midwest and do not appear to be adversely affected by contaminant concentrations at this time. Because of physical conditions independent of any contamination (such as low flow), other springs in the area are not expected to support extensive aquatic habitats or biota, and risks to these resources from current contaminant levels are expected to be very minor or nonexistent.

6.2.2 Ecological Significance

For most of the contaminants detected in the surface water and sediment from springs, little or no potential is indicated for significant adverse ecological effects to aquatic or terrestrial biota. Because of the small and temporal nature of most of the springs, relatively few biota are anticipated to be exposed to contaminants at these habitats. The most likely exposed biota (and thus those potentially at greatest risk) at the springs (excluding Burgermeister Spring) are aquatic invertebrates. However, the abundance and diversity of biota in the springs is limited by the physical nature of

these habitats and is independent of contaminants. Thus, the magnitude and nature of potential impacts at these springs would be very small and would have little ecological significance to the aquatic invertebrate populations in the area. Furthermore, these springs represent a very small fraction of the total aquatic habitat available in the August A. Busch Memorial Conservation Area.

The receptors most likely at risk at Burgermeister Spring are fish and aquatic invertebrates. Although some sediment and surface water toxicity is indicated for Burgermeister Spring, the ecological significance of this toxicity is very small and should not be expected to adversely affect aquatic resources of the area. The results of the biotic surveys and toxicity tests indicate that the aquatic community in Burgermeister Spring is typical of similar habitats throughout the Midwest and shows no evidence of being adversely affected by contaminants in surface water and sediment.

6.3 UNCERTAINTIES RELATED TO RISK CHARACTERIZATION

A number of uncertainties are inherent in estimating the ADD and EEQ, and these uncertainties could affect both the estimated values of these end points and the final risk characterization.

The principal uncertainties associated with the model assumptions are related to (1) estimation of contaminant uptake and assimilation and (2) use of a constant ingestion rate over the entire home range of a species. The uptake and assimilation of contaminants by the receptor species is affected by a variety of factors not addressed by the uptake models. These factors include, but are not limited to, contaminant solubility in biological fluids, species metabolism, contaminant biotransformation, and depuration. For some biota, it is unlikely that the uptake and assimilation of a contaminant is 100% efficient; for other biota, efficiency may approach 100%. Thus, the 100% uptake and assimilation assumption used in the uptake modeling likely overestimates the true degree of contaminant assimilation by the receptor species.

The assumption that the drinking water ingestion rate is constant over the entire home range is probably inaccurate, particularly for species with large home ranges, such as the white-tailed deer. Most resources in the environment, including water, are not distributed homogeneously but rather in a patchy, heterogeneous manner. As a consequence, drinking would also occur in a patchy manner. However, this assumption is conservative and should not affect the overall ADD estimate.

An additional uncertainty related to the risk characterization is associated with the unavailability of suitable benchmark values for some contaminants and terrestrial receptors. For example, no avian benchmark values were found for nitroaromatic compounds. Although it was possible to model uptake of nitroaromatic compounds by the American robin, it was not possible to estimate risks because of the absence of suitable benchmark values. However, unacceptable risks are not anticipated from the COECs for which benchmark values are not available. For the terrestrial receptors, no risks were identified for those COECs for which benchmark values were available. Even using the maximum reported contaminant concentrations, the estimated risks were very low (typically < 0.01). The estimated doses for the COECs with no benchmark values were similarly

very low, and thus no risks (i.e., very low estimated risk of < 0.01) would be expected for these contaminants.

6.4 SUMMARY

The results of biotic surveys, media toxicity testing, and contaminant uptake modeling indicate that current contaminant levels in surface water and sediment in springs pose little or no risk to the aquatic and terrestrial biota of the area. Although some surface water and sediment toxicity was detected in Burgermeister Spring, and the concentrations of some contaminants exceed ambient water quality criteria for the protection of freshwater aquatic biota, there is no evidence that aquatic biota inhabiting the spring and downstream habitats are being impacted. Uptake modeling indicates no risk to terrestrial biota that use area springs for drinking water. These results show that contaminant concentrations in surface water and sediment at these springs pose little or no risks to ecological resources of the area, and remediation from an ecological perspective is not warranted at this time.

7 SUMMARY AND CONCLUSION

A combined assessment addressing human health and ecological impacts was performed to evaluate conditions at the GWOUs. The human health component of this BRA included an evaluation of the radiological and chemical risks from contamination in the 15 springs and in the shallow aquifer system that is common to both the chemical plant area and ordnance works area. Recent data obtained from the joint DOE/DA sampling rounds of May and August 1995 were used to calculate potential human health impacts. The ecological risk assessment evaluated potential risks to aquatic and terrestrial biota from exposure to contaminants in surface water at the springs. The assessment also focused on laboratory and field studies of Burgermeister Spring because the aquatic habitats associated with this spring are more permanent than the habitats at other springs in the area and thus may be used by a greater variety and number of biota than habitats at other springs.

7.1 HUMAN HEALTH RISK ASSESSMENT

7.1.1 Methodology

The human health risk assessment was conducted in accordance with the procedure recommended by the EPA (1989b). The procedure involves the following four steps: (1) COPC identification, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization.

Chemical COPCs were identified as those determined to be greater than background as discussed in the RI. The groundwater COPCs identified were lithium, molybdenum, uranium, chloride, nitrates, sulfates, nitroaromatic compounds, TCE, and 1,2-DCE. Uranium has also been identified as the only radioactive COPC. The spring water COPCs identified were antimony, cadmium, iron, lithium, manganese, mercury, molybdenum, silver, uranium, and nitroaromatic compounds.

Current and future land-use projections were incorporated into identifying the potential human receptor as part of the exposure assessment. A recreational scenario was considered to be appropriate on the basis of current and projected future land use at the chemical plant area and the ordnance works area. Exposure of Army reservists that visit the training area was not evaluated separately because there are no active springs within the boundaries of the training area. Also, the estiamated risks calculated for the recreational visitor are representative of those for the training troops because the exposure parameters (e.g., duration and frequency) would be similar. Although potential risk to the recreational receptor would likely provide information representative of future conditions at both areas with regard to springs, calculations were also carried out for a hypothetical future resident to provide reasonable upper-bound information regarding potential risk from groundwater contamination.

To determine potential exposure of a recreational visitor, a hazard index and the chemical and radiological carcinogenic risk were calculated for each of the 15 springs evaluated, using the maximum value from the 1995 joint DOE/DA sampling rounds for each COPC in spring water. Similar calculations were performed for each of 155 wells to determine potential exposure of a hypothetical future resident to groundwater contamination. The primary pathway of concern in both cases was ingestion. Standard EPA-recommended exposure parameters were used in the calculations (EPA 1995b). Current contaminant concentrations were also assumed for future scenarios. This approach is considered conservative; contaminant concentrations are expected to decrease with time as a result of source removals currently ongoing at both the chemical plant area and the ordnance works area.

7.1.2 Results

Neither carcinogenic risk nor noncarcinogenic health effects are indicated for the recreational visitor incidentally ingesting spring water at the 15 springs evaluated; these results are expected to be representative of all springs located in the area covered by the GWOUs. The radiological risk estimates range from 4×10^{-9} to 2×10^{-6}. These values are low and well within the acceptable risk range of 1×10^{-6} to 1×10^{-4} recommended by the EPA (1989b). The chemical risk estimates are similarly low, ranging from 2×10^{-10} to 3×10^{-7}. The EPA has provided a quantitative measure for adverse health effects other than cancer: a hazard index greater than 1 indicates potential adverse health effects. The hazard indices estimated for the recreational visitor at the springs range from < 0.001 to 0.2.

The well-by-well calculations for the hypothetical future resident scenario indicate that, excluding TCE contributions at the 155 wells evaluated, chemical risk estimates for four wells are slightly higher than 1×10^{-4}. The chemical risk estimates for these wells range from 1×10^{-7} to 2×10^{-4}. The upper end of this range is attributable to nitroaromatic compounds detected at well MWV-09, located north of the groundwater divide. The radiological risk estimates range from 7×10^{-8} to 7×10^{-5}, all within the acceptable risk range. With the inclusion of risk from TCE, risk estimates at three additional wells exceed 1×10^{-4}: 1×10^{-3} at MW-2038, 4×10^{-4} at MW-2037, and 3×10^{-4} at MWS-21. These wells are weathered wells near the raffinate pits.

The hazard indices for 43 of the 155 wells evaluated are greater than 1. Of the 43, hazard indices for 27 wells are attributable to nitroaromatic compounds. Elevated nitrates occur mostly in the chemical plant area 2000- and 3000-series wells; 15 hazard indices that are greater than 1 are attributable to nitrate concentrations in these wells. The estimated hazard index for well MW-4024 is 1; uranium concentrations in this well contributed to 0.84 of this hazard index of 1.

7.1.3 Summary

The radiological and chemical risk assessments have been presented separately because the methodologies for estimating the carcinogenic risks from exposures to radionuclides and chemicals differ considerably. However, the total carcinogenic risk to an individual is the result of exposure to both radiological and chemical risks, assuming that the carcinogenic effects are neither antagonistic nor synergistic. Summing the radiological and chemical carcinogenic risks for the recreational visitor (considered representative of current and expected future land use) would result in risk levels still below or at the lower end of the acceptable risk range. Similarly, summing the radiological and chemical carcinogenic risks to the hypothetical future resident would not result in a large increase in the overall results because the majority of the radiological risk results are well within the acceptable risk range. Overall, the more significant contributors to potential human health risk from the groundwater pathways are TCE, nitrates, and nitroaromatic compounds.

7.2 ECOLOGICAL RISK ASSESSMENT

7.2.1 Methodology

The ecological risk assessment for the GWOUs employed a number of approaches for evaluating risks to ecological resources that use springs on the chemical plant area and ordnance works area. Risks to aquatic biota were evaluated by using biotic surveys and media toxicity testing and by comparing media concentrations to ecological benchmark ("safe") media concentrations. Risks to terrestrial biota were evaluated by modeling contaminant uptake and comparing the predicted doses to species-specific benchmark doses. Contaminant data used in the assessment included the same surface water data used in the human health risk assessment, as well as sediment data collected specifically for the ecological risk assessment at Bürgermeister Spring and selected downstream locations.

Biotic surveys for aquatic invertebrates, fish, and amphibians were conducted at Burgermeister Spring and its downstream drainage. The data collected from these surveys allowed for a determination of the status of the biotic communities currently exposed to contaminants in surface water and sediment at the spring. Macroinvertebrates and fish samples were collected from Burgermeister Spring and its downstream locations, and tissue analyses were conducted to evaluate contaminant bioconcentration by aquatic biota. Toxicity testing of surface water and sediment from the spring and downstream locations included acute and chronic toxicity testing of aquatic invertebrates, fish, and amphibians. These tests determined whether current contaminant concentrations in the surface water and sediment are toxic to aquatic biota. Contaminant uptake from the ingestion of surface water was modeled for two terrestrial receptor species, the white-tailed deer and the American robin. The uptake modeling employed species-specific exposure factors, and the exposure point concentrations were the maximum reported contaminant concentrations in surface water from springs in the chemical plant area and ordnance works area.

7.2.2 Results

The survey results for macroinvertebrates, fish, and amphibians that inhabit the Burgermeister Spring drainage indicated no evidence of adverse effects to these aquatic biota. The spring was determined to contain generally good aquatic habitat, and the species present are typical of those found in similar habitats throughout the Midwest. Although the fish community was limited in diversity and the macroinvertebrate community was categorized as slightly impaired, the communities are likely affected by the physical nature of the spring and its drainage rather than contaminant levels. Flow in the uppermost portion of Burgermeister Spring is maintained by groundwater discharge at the spring. Under low-flow conditions, as commonly occur in the summer, the stream drainage below the spring becomes intermittent and portions of the habitat become dry. Surveys of the amphibian community identified a community typical of similar habitats in the Midwest.

The results of toxicity testing indicate a potential for some toxicity to fish and invertebrates from surface water and sediment in Burgermeister Spring proper. Surface water and sediment toxicity was also measured at some locations downstream of the spring, but no clear toxicity gradient was evident extending downstream. However, the presence of apparently unaffected macroinvertebrate, fish, and amphibian communities in the drainage at locations where media toxicity was detected suggests that local populations are tolerant of (or have adapted to) the contaminant levels present in surface water and sediment in the Burgermeister Spring drainage. Tissue analyses revealed relatively low levels of contaminant bioconcentration, all below levels of concern.

Modeling results for contaminant uptake by the white-tailed deer and the American robin drinking from Burgermeister Spring (but using maximum contaminant concentrations reported from all springs) predict very low levels of contaminant uptake by these species. Risk estimates for terrestrial biota based on the modeled contaminant doses indicate no risks to terrestrial biota drinking from Burgermeister Spring or other springs in the area.

Risk estimates for aquatic biota based on media concentrations indicate that spring water concentrations of iron, manganese, mercury, and uranium and sediment concentrations of arsenic, lead, and silver might pose low to moderate risks to aquatic biota. However, the aquatic community in Burgermeister Spring is typical of similar habitats elsewhere in the Midwest and does not appear to be adversely affected by contaminant concentrations at this time. Few of the other springs in the area provide suitable habitat and, at best, naturally support only very limited aquatic communities.

7.2.3 Summary

On the basis of the results of biotic surveys, media toxicity testing, tissue analyses, media-based risk calculations, and contaminant uptake modeling, current contaminant levels in surface water and sediment in area springs pose little or no risk to aquatic or terrestrial biota of the Weldon Spring area. Risk calculations indicated a potential for low to moderate risks to aquatic biota from

some contaminants in springs, and surface water and sediment toxicity was detected for Burgermeister Spring. However, biotic surveys of Burgermeister Spring and downstream habitats found no evidence that aquatic biota inhabiting this spring are being adversely impacted, and few other springs naturally provide sufficient permanent habitat to support more than only very limited aquatic communities. Uptake modeling indicates no risks to terrestrial wildlife using the area springs for drinking water.

7.3 CONCLUSION

Carcinogenic (radiological and chemical) risk and noncarcinogenic health effects are not indicated for the recreational visitor at the chemical plant area and the ordnance works area. The recreational visitor potentially exposed to spring water is considered to be representative of current and future land uses at both areas. Potential incremental carcinogenic risk and noncarcinogenic health effects to an Army reservist training at the ordnance works area are also not indicated. The results of the risk assessment for springs presented here are consistent with those in previous risk assessments.

Risk calculations for groundwater ingestion by a hypothetical future resident indicate that high concentrations of nitrates and nitroaromatic compounds in several wells used for monitoring known source areas contribute to high (greater than 1) hazard indices. Several wells in the vicinity of the raffinate pits and sludge in the pits have been determined to contain high concentrations of nitrates. Several wells in both the chemical plant and ordnance works areas also contain amounts of nitroaromatic compounds that could potentially contribute to carcinogenic risks slightly over the upper end of the risk range. The use of the second (lower) data point from the joint DOE/DA sampling rounds would have resulted in lower risk estimates that fall within the acceptable risk range. Radiological risks from uranium are within the acceptable risk range. Monitoring wells and springs with the highest estimated risks and hazard indices are depicted in Figure 7.1.

Additionally, in interpreting the results for groundwater, one should consider that if a future resident did draw groundwater as a household drinking water supply, the COPCs, if present, would be in more dilute concentrations than those used for the calculations in this assessment. In addition, future concentrations for both groundwater and spring water contaminants would most likely be lower because active removal of contaminant sources is currently ongoing and concentrations in groundwater are expected to decrease with time. To provide another perspective, the hazard indices and carcinogenic risks from groundwater use would be two orders of magnitude lower for the hypothetical recreational user than would be expected for the hypothetical residential user.

Finally, the risk estimates indicate that of the COPCs evaluated, nitrates and nitroaromatic compounds may be of concern due to their contributions to relatively high hazard indices. These results also indicate that contaminant concentrations tend to be higher in the weathered unit rather than in the unweathered unit of the aquifer of concern, as evidenced by generally higher risk estimates for the wells completed in the weathered unit.

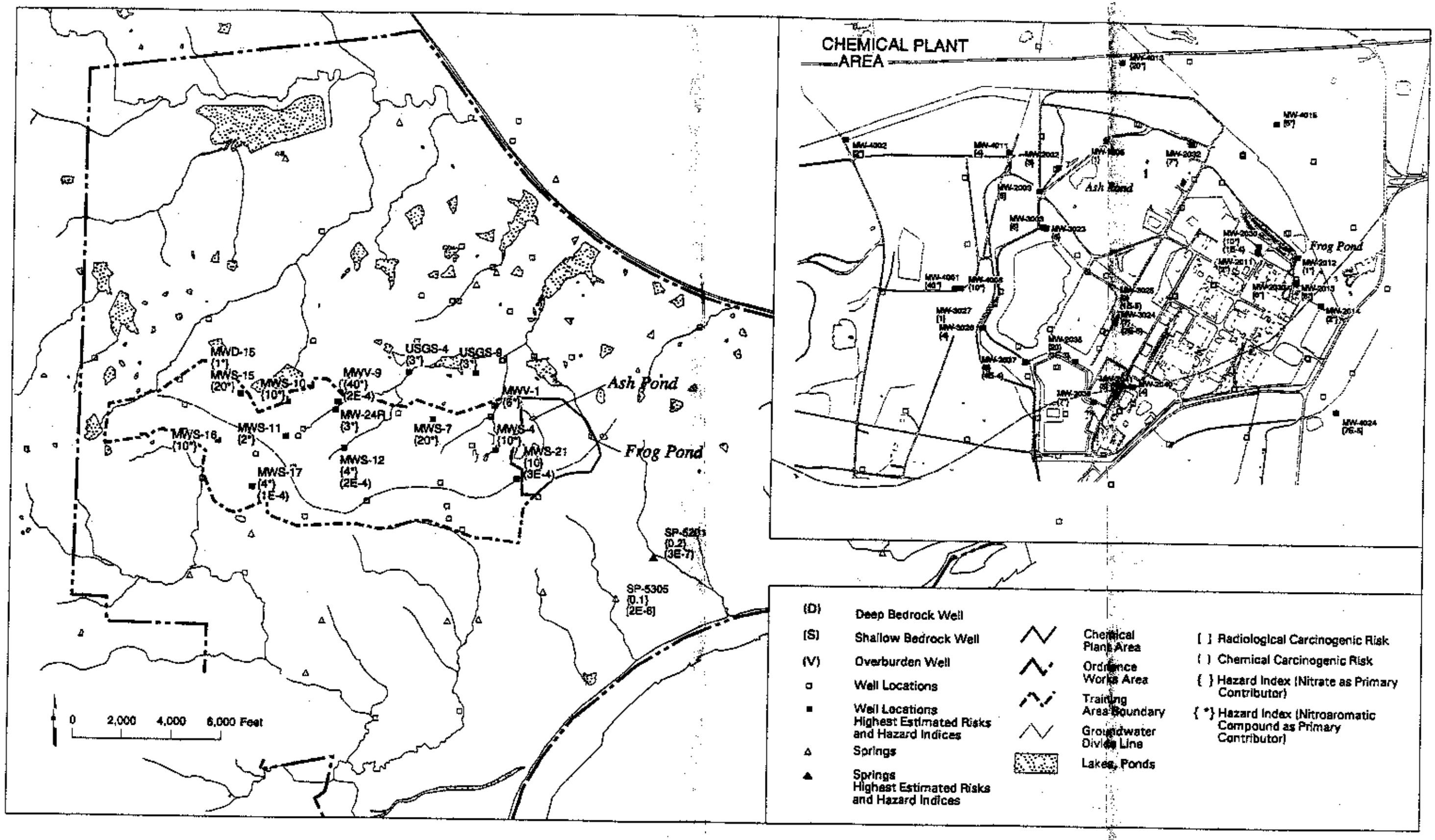

FIGURE 7.1 Monitoring Wells and Springs with the Highest Estimated Risks and Hazard Indices

Although risk calculations for aquatic biota indicate that concentrations of some contaminants in surface water and sediment from springs might pose risks to aquatic biota, most of the risk estimates only slightly exceeded the acceptable risk range. In addition, most springs do not naturally provide permanent habitat to support aquatic biota, and thus the potential risks are not expected to be ecologically significant. Among the springs in the area, Burgermeister Spring probably represents the largest amount of permanent aquatic habitat. Some toxicity has been indicated for surface water and sediment from this spring, but the results of biotic surveys show no evidence that aquatic biota are being adversely impacted by current levels of contamination. Risk calculations for terrestrial wildlife drinking from springs in the chemical plant and ordnance works areas indicate that risks are at least two orders of magnitude below the acceptable risk range.

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