Public Health Assessment for

RADIOACTIVE CONTAMINATION FROM
THE MIDNITE MINE SITE
WELLPINIT, STEVENS COUNTY, WASHINGTON
EPA FACILITY ID: WAD980978753
APRIL 10, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

Comment Period Ends:

MAY 25, 2007

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate. This document represents the agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited time frame. To the extent possible, it presents an assessment of potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR. This revised document has now been released for a 30-day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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You May Contact ATSDR Toll Free at
1-800-CDC-INFO or
Visit our Home Page at: http://www.atsdr.cdc.gov

PUBLIC HEALTH ASSESSMENT

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WELLPINIT, STEVENS COUNTY, WASHINGTON

EPA FACILITY ID: WAD980978753

Prepared by:

Site and Radiological Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

This information is distributed by the Agency for Toxic Substances and Disease Registry for public comment under applicable information quality guidelines. It does not represent and should not be construed to represent final agency conclusions or recommendations.

Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, the U.S. EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment process allows ATSDR scientists and public health assessment cooperative agreement partners flexibility in document format when presenting findings about the public health impact of hazardous waste sites. The flexible format allows health assessors to convey to affected populations important public health messages in a clear and expeditious way.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high-risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to evaluate possible the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the public comments that related to the document are addressed in the final version of the report.

Conclusions: The report presents conclusions about the public health threat posed by a site. Ways to stop or reduce exposure will then be recommended in the public health action plan. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA or other responsible parties. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also recommend health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Manager, ATSDR Record Center Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-60), Atlanta, GA 30333.

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Summary

ATSDR has conducted an evaluation of the impact to public health from radioactive contamination coming from the Midnite Mine site. ATSDR is concurrently preparing an updated Public Health Assessment for Public Comment, on all other contaminants and pathways from the Midnite Mine site. This evaluation included a review of EPA's Record of Decision (EPA 2006), Remedial Investigation and Feasibility Study (RI/FS) (EPA 2005) environmental sampling data, exposure pathway information, and community health concerns.

The Midnite Mine site is an inactive open-pit uranium mine located on the Spokane Indian Reservation in Stevens County, Washington, about 8 miles northwest of Wellpinit. The mine was operated between 1954 and 1981 by the Dawn Mining Company (DMC) on land leased from the Spokane Indian Tribe. Approximately 2.5 million tons of waste rock, unprocessed, and low-grade ore are currently present at the site.

Past site investigations indicate that metals, such as arsenic, cadmium, manganese, and uranium and its related decay products have migrated from on-site source areas (i.e., open pits, ore/protore/waste rock piles) into local groundwater and surface waters as a result of acid mine drainage. EPA has conducted a RI/FS that characterizes the nature and extent of contamination both on the site and in nearby impacted areas.

Current Exposures

Although concentrations of contaminants exceed comparison values, ATSDR found that there was either no current exposure (groundwater), exposure was so infrequent (surface soil, surface water), or the concentrations were now lower (air, fish, ionizing radiation) and that there was not a public health hazard. Additional plant sampling data and information on consumption rates is needed for ATSDR to evaluate the public health impact of plant consumption.

Groundwater On-site and immediately off-site, groundwater has extremely high concentrations of all the naturally occurring uranium isotopes and their decay products. There are no groundwater wells in the area, therefore there is no direct exposure to groundwater.

Surface Soil Though the potential for exposure clearly exists, the actual extent of exposure for tribal members and visitors is currently limited because the site is located in a remote area with no nearby residences. Contact with contaminated soil and surface materials is likely to be infrequent and intermittent.

Surface Water Tribal members could be exposed to contaminants in Blue Creek if it is used for conducting cultural/spiritual ceremonies in sweat lodges. Contaminants in the water from Blue Creek could become airborne and be inhaled inside the sweat lodges during these ceremonies. However, persons are not likely to be exposed to uranium, thorium or radium, because they are not volatile.

Air Current exposures to airborne contaminants from the site are also not known but are likely limited since the mine is closed and its operations that generated large quantities of fugitive dust have been discontinued. This conclusion is based on the 1996 USBM study that indicates there is no measurable exposure to radionuclides, other than radon progeny.

Fish No radionuclides were detected above naturally expected background levels in fish.

Ionizing Radiation Gamma radiation emitted from uranium and its decay chain products, especially radium, is elevated onsite. The measured gamma exposure rates are insufficient to result in adverse health effects from acute exposure. Likewise, the limited access would preclude chronic exposures to exceed EPA's 15 mrem/yr to members of the tribe or the public in general. A person would need to spend in excess of 75 hours per year on the ore stockpiles to exceed EPA's 15 millirem annual limit.

Future Exposures

ATSDR has identified the following potential human exposure pathways that may be completed in the future:

(i) Exposure to radionuclides in on-site surface deposits (waste rock, ore, protore) and onsite and off-site surface soils.

(ii) Exposure to radionuclides in surface water and sediments in on-site and off-site drainages and Blue Creek.

(iii) Exposure to radionuclides in mine-related materials located at off-site residences.

ATSDR agrees that EPA's recent Record of Decision (EPA 2006) and the preferred alternative for remediation of the site would be protective of public health and may prevent future exposures.

Purpose and Health Issues

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal agency within the U.S. Department of Health and Human Services and is located in Atlanta, Georgia. ATSDR is required to conduct public health assessments of sites proposed for the EPA National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and its amendments. The Midnite Mine site was formally listed on the NPL on February 16, 1999.

ATSDR released an initial public health assessment in February 2000. Since the proposed listing of Midnite Mine in February 1999, EPA has completed its Final RI/FS (EPA 2005) and Record of Decision (ROD) (EPA 2006) which address potential off-site impacts and background conditions for sediments, surface water, and ground water. ATSDR is updating its public health assessment to reflect data in EPA's Final RI/FS and ROD.

Background

A. Site Description and History

The Midnite Mine site is an inactive open-pit uranium mine located on the Spokane Indian Reservations in Stevens County, Washington, about 8 miles northwest of Wellpinit (Figure 1). The mine was operated between 1954 and 1981 by the Dawn Mining Company (DMC) on approximately 811 acres of land leased from the Spokane Indian Tribe. The actual area disturbed during mining was about 321 acres. During the life of the mine, about 2.9 million tons of milled ore, averaging 0.2 percent uranium oxide was produced. Ore was extracted from several pits and was transported by truck to DMC's mill located in Ford, Washington, about 25 miles east of the mine. As mining progressed, several of the excavated pits were backfilled with overburden or waste rock. When mining operations ceased, only two open pits remained (Pits 3 and 4). Currently, these two pits are partially filled with water. Waste rock from Pit 3 was deposited to the west and south of Pit 3, into previously mined pits and into the head waters of the central drainage, forming the South Mine Spoils (also referred to as the Gully Waste Dump). Waste rock from Pit 4 was deposited to the west of Pit 4 forming the Hillside Mine Spoils area. Approximately 2.5 million tons of waste rock, unprocessed ore, and protore (low-grade ore) are currently present within the disturbed area of the site. Figure 2 shows the locations of the major waste rock and protore piles at the site.

The Midnite Mine site is drained by three small unnamed streams designated as the West, Central, and East Drainages (Figure 3). These drainages, which collect surface runoff from the site, converge south of the mine to form a common drainage that empties into Blue Creek, a perennial stream that flows westward about 4.5 miles to the Spokane Arm of Lake Roosevelt. Lake Roosevelt is the reservoir created by Grand Coulee Dam.

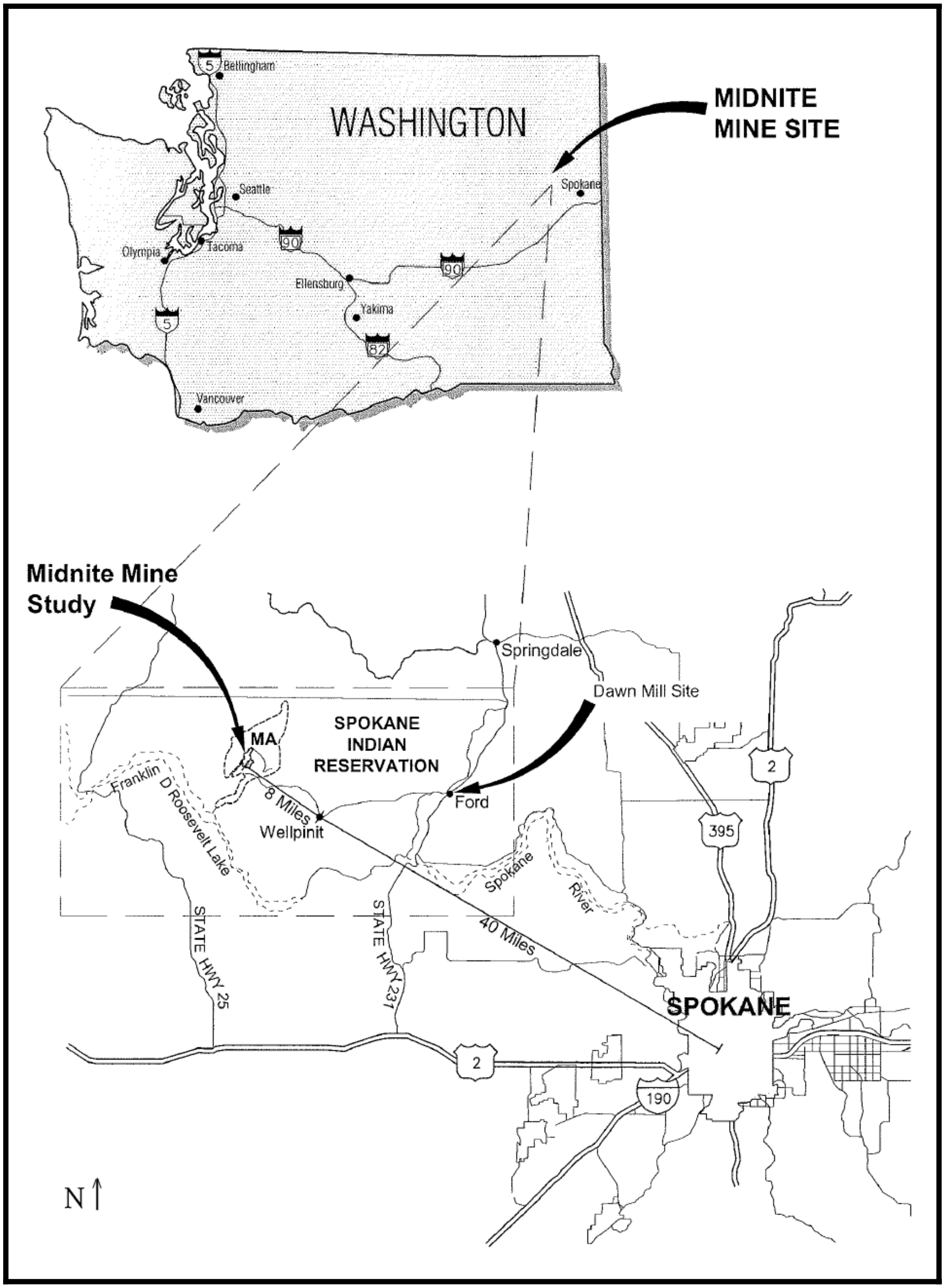

Figure 1 Midnite Mine Site Location

From the opening of the mine in 1954 until 1978, the Midnite Mine had no controls on releases to surface water. Thus, during these years, all contaminants in run-off and groundwater discharge flowed directly into surface waters. In 1978, collection systems were installed at the Boyd Seep, located within mine spoils above the East Drainage, to pump seep water to Pit 3. This collection system also collects water draining from Blood Pool; however some of the water from Blood

Pool is not captured and migrates past the collection system into the East Drainage (Figure 2). Note: Seeps and springs occur where the groundwater surface (water table) intersects the ground surface. Water from these seeps which is not captured flows down through the western, central, and eastern drainages and into Blue Creek.

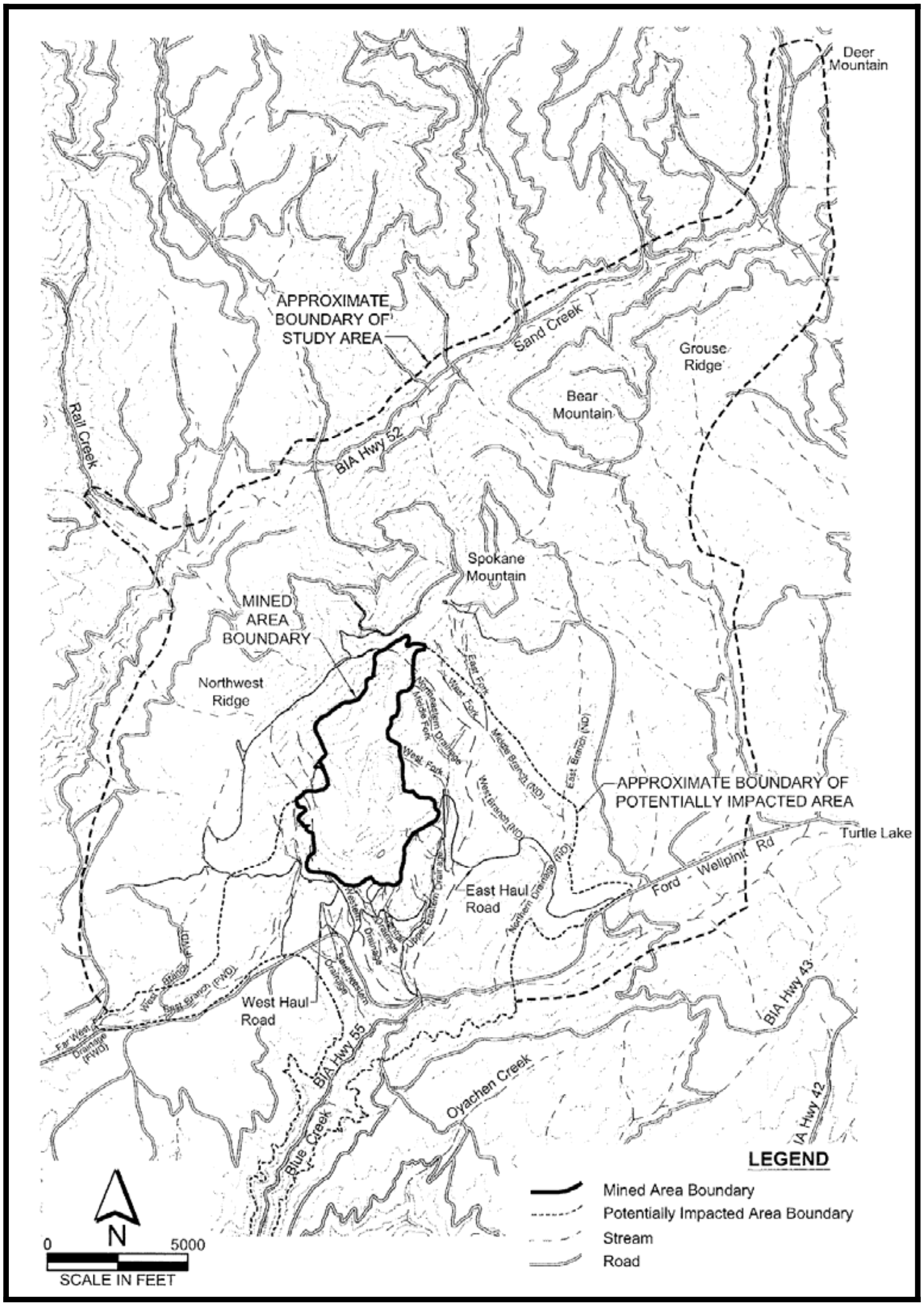

Figure 2 Map of the Midnite Mine Site

In 1979, the Pollution Control Pond (PCP) was constructed at the toe of the South Mine Spoils to collect run-off seeping from waste rock piles (Figure 2). In 1981, pumps were installed at the Pollution Control Pond to transfer water from the pond to Pit 3. In 1987, a pump-back system was installed in the Western Drainage to collect water draining from the west sides of the South Mine Spoils and store it in holding tanks. The water is periodically pumped uphill from the holding tanks to the Pollution Control Pond. However, when seep flow exceeds the capacity of the pump-back system, water is directed back into the Western Drainage through a buried pipe.

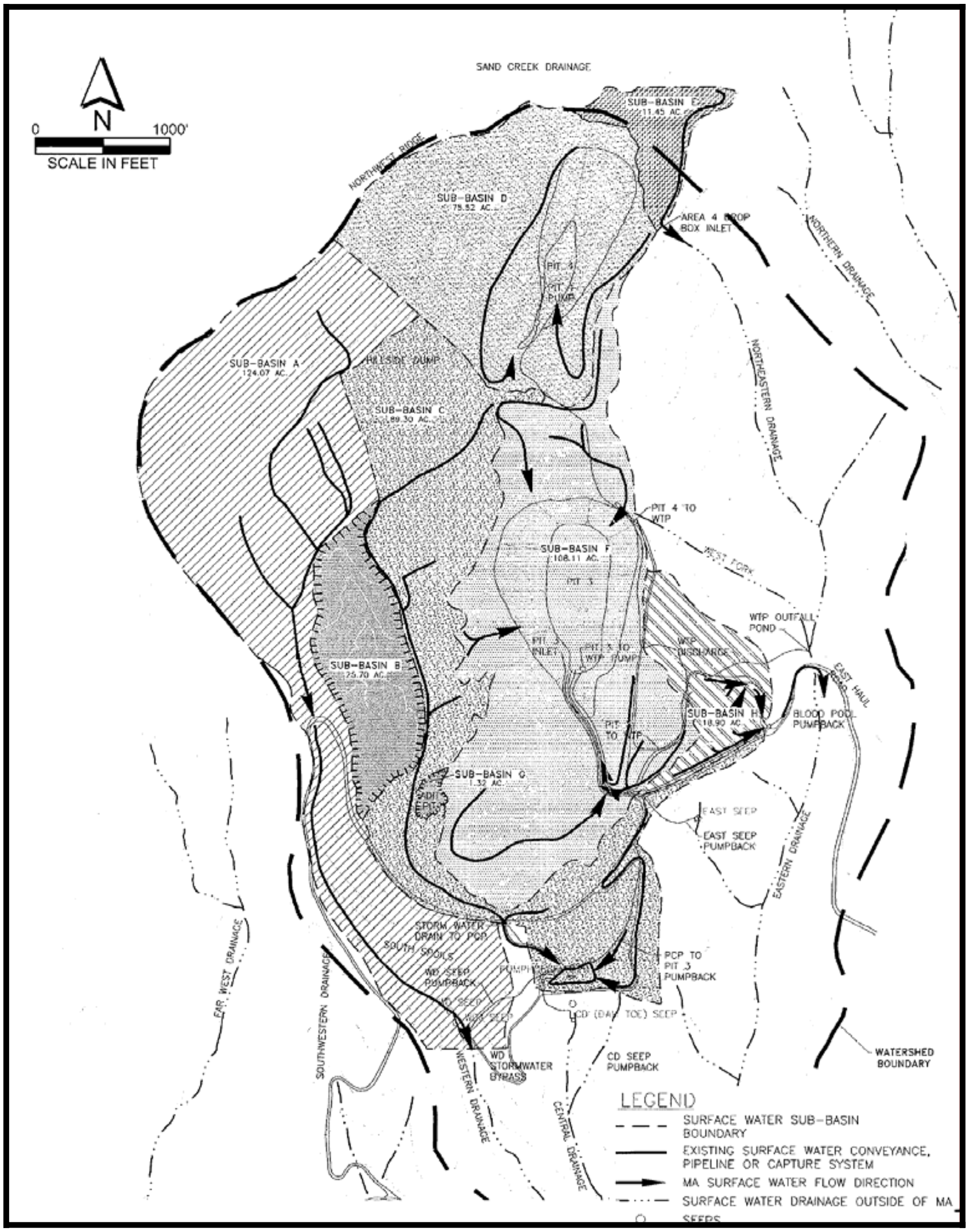

Figure 3 Midnite Mine Watershed

In 1988, Dawn Mining Company (DMC) constructed an on-site wastewater treatment plant (Figure 2) to address the growing quantity of water in Pit 3 and the Pollution Control Pond.

Water from Pit 3 is pumped to the water treatment plant which uses barium chloride and hydrated lime to remove the uranium decay products, radium, and dissolved heavy metals (including uranium). Treated water from the plant is discharged under a National Pollutant Discharge Elimination System (NPDES) permit to the east drainage that eventually flows into Blue Creek. Sludge generated from the treatment plant is trucked to DMC's mill in Ford, Washington, processed to extract uranium, and disposed of in a lined tailings pond at the mill.

In 1998, the seep collection system in the Western Drainage was upgraded. In addition, two collection sumps were placed in the Central Drainage near the toe of the South Mine Spoils. Seep water that collects in the Western and Central Drainages is periodically pumped to the Pollution Control Pond.

B. Previous Site Investigations

Since the late 1970s, numerous environmental studies and investigations have been conducted at the Midnite Mine site to characterize the sources and transport of heavy metals and radionuclides at the mine. These studies and investigations were conducted by a number of different government agencies, including the U.S. Geological Survey (USGS), the U.S. Bureau of Mines (USBM), the U.S. Bureau of Land Management (BLM), and the U.S. Environmental Protection Agency (EPA); private consulting firms, such as Shepherd Miller Inc.(SMI) and Ecology and Environment Inc. (E&E); and the former site operator Dawn Mining Company (DMC).

The results of site studies and investigations indicate that metals and radionuclides have migrated from on-site source areas (i.e., open pits, ore/protore/waste rock piles) into local groundwater and surface waters as a result of acid mine drainage (E&E 1999, EPA 2005, SMI 1996, 1999, STI 2000, USBM 1994, 1996). Acid mine drainage is formed when water, such as runoff from rainfall or snowmelt, comes into contact with sulfide-containing minerals (e.g., pyrite) in surface materials, such as waste rock, ore, and protore, bedrock, or overburden. The sulfide-containing minerals are oxidized by the oxygen in the water resulting in the production of dilute sulfuric acid. When the acidic water comes into contact with waste rock, ore, protore, or other site materials, the naturally occurring metals and radionuclides in the materials are leached and dissolved. The dissolved contaminants are then transported across the site and into local groundwater and surface waters primarily through

1) infiltration of contaminated water in the open pits (Pits 3 and 4) into underlying deposits and/or bedrock fractures
2) infiltration of contaminated rainfall and runoff (resulting from percolation through ore, protore, or waste rock piles) into groundwater
3) overland flow of contaminated runoff from the ore, protore, and mine spoils into site drainages
4) discharge of contaminated, shallow groundwater into site drainages either directly (through underflow) or indirectly (through seeps and springs).

An Expanded Site Investigation (ESI) was conducted in April 1998 by E&E on behalf of EPA. During the ESI, the following seven potential contamination sources were sampled at the site: Pit 3, Pit 4, Pollution Control Pond (PCP), Blood Pool, NPDES Outfall, 8 piles of stockpiled ore and protore, and the south spoils. The ESI sampling data showed detectable levels of metals and radionuclides in all seven of the on-site sources. These contaminants, which include arsenic, beryllium, cadmium, lead, nickel, and uranium, have been released from the sources through discharges of groundwater (via seeps) and overland transport through runoff. Elevated concentrations of site-related metals and radionuclides were detected in surface water and sediments up to approximately 3.5 miles downstream of the site. Targets impacted by site-related contaminants include critical Rainbow trout habitat and fisheries in Blue Creek. In addition, selected surface water quality benchmarks and groundwater standards were exceeded in many of the ESI samples.

In February 1999, EPA initiated Phase I of an RI/FS at the site to provide detailed information and data regarding the nature and extent of contamination in various environmental media (e.g. groundwater, surface water, sediment, soil) in areas near the mine (also referred to as Potentially Impacted Areas or PIAs) and the potential migration of contaminants from the site to the PIAs. Field activities for Phase I of the RI/FS began in August 1999. During the initial Phase I field activities, which were conducted from August - November 1999, EPA's RI/FS Contractor installed 52 monitoring wells around the mine, collected water samples from the wells, and sampled stream water and sediments near the mine. Radiological data from EPA's Final RI/FS (EPA 2005) is presented in Tables 1 – 6 in Appendix A.

In September 1999, EPA staff conducted a radiation survey of the road between the mine and Dawn's mill at Ford. A mobile scanning system mounted in a van was used to identity areas where uranium ore may have spilled from trucks transporting the ore from the mine to the Ford mill, when the mine was operating.

C. Current Site Investigations

In September 2005, EPA completed its Remedial Investigation and Feasibility Study of the Midnite Mine Superfund Site (EPA 2005). Tables 1 – 6 in Appendix A list the highest concentrations of radionuclides by media. EPA identified the following contaminants of concern in its RI/FS:

- Surface Water: Uranium, lead-210, uranium-238, and uranium-234.
- Surface and Subsurface Materials: Uranium, lead-210, radium-226, and external radiation.
- Sediment: Uranium, manganese, lead-210, uranium-238, uranium-234, and radium-226.
- Groundwater: Uranium, manganese, uranium-238, and uranium-234.
- Air: Radon.
- Plants: Uranium, lead-210, radium-226, uranium-238, and uranium-234.
- Meat: Uranium, lead-210, and radium-226.

ATSDR Site Visit

On August 18, 1999, ATSDR representatives toured the Midnite Mine site with a representative of the Spokane Tribal Natural Resources Department.

The following observations were made during the site visit:

- The site is located in a mountainous area and is accessible at two points by a haul road off the Ford-Wellpinit road.
- The mine is currently inactive.
- The only people observed on the site were a couple of workers at the water treatment plant and a worker at the seep pump-back building.
- Evidence of past mining activities was widespread throughout the site, including mine roads, two surface mining pits, large piles of waste rock including the west and south spoils, piles of unprocessed ore and protore, old mine buildings and equipment, and numerous stacks and boxes of old soil corings from the uranium mine.
- No homes were observed on or adjacent to the site; however, a small trailer was noted between Pit 3 and the water treatment plant and it appeared that someone (possibly a worker at the water treatment plant) might have been living in it.
- Seeps from the south spoils pile were observed in the west drainage; these seeps were being pumped back to the Pollution Control Pond (PCP).
- Pits 3 and 4 were partially filled with water and the water was being pumped out (presumably to the site's water treatment plant).
- The wastewater treatment plant was operating to treat contaminated water.
- Deer and coyote tracks were observed in a muddy area near the water's edge in Pit 3.
- Evidence of recent EPA RI field activities were observed including new monitoring wells and flagged surveyor stakes.
- A family was camping at the tribal campground located on Lake Roosevelt near the confluence of Blue Creek.

D. Demographics, Land Use, and Natural Resource Use

Demographics

The Midnite Mine site is located on the Spokane Indian Reservation which in 2000 had a population of 2004, as reported in the 2000 U.S. Census (USCB 2001). The population on the reservation is 83% American Indian; the remaining 17% is mostly Caucasian with less than 1% representing other ethnic and racial categories.

The nearest town to the site is Wellpinit, approximately 8 miles to the southeast, with a population of nearly 500.

According to ATSDR's analysis of the 2000 U.S. Census data, no one lives within a mile of the site boundary (See Figure 4).

Land Use

Land use in the vicinity of Midnite Mine includes recreation (camping, fishing, and hiking), agriculture, forestry, livestock grazing, housing, commercial development, and utilities. Another uranium mine, the inactive Sherwood Mine, is located about 3.5 miles south of Midnite Mine. The closest occupied residence to Midnite Mine is reportedly located approximately 1 mile east of the site.

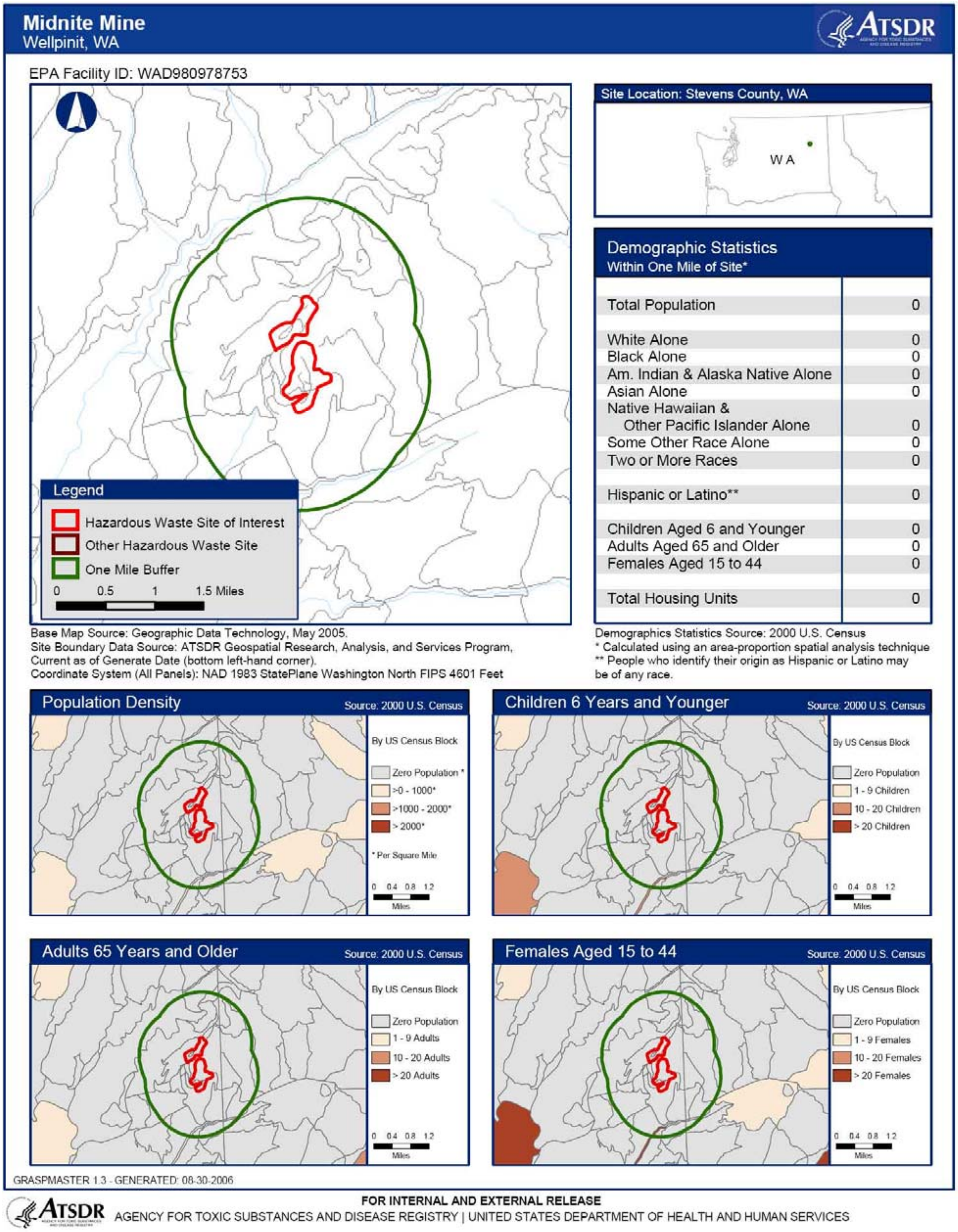

Figure 4 Demographic Map of the area around the Midnite Mine

Natural Resource Use

Surface Water

The Midnite Mine is situated on a south facing hillside at elevations ranging from about 2,400 to 3,400 feet above sea level. The hillside where the mine is located is drained by three small unnamed streams. These streams referred to as the West, Central, and East Drainages, collect surface runoff from the mine. The upper portions of the West and Central Drainages have been extensively recontoured by mining activities. The drainages converge south of the mine site and form a common drainage that empties into Blue Creek which flows for 4.5 miles to Roosevelt Lake, the reservoir created by the Grand Coulee Dam. Lake Roosevelt and Blue Creek near its mouth at Roosevelt Lake are used for sport fishing for several species including rainbow trout. Roosevelt Lake is also used for other recreational activities including boating and swimming.

Groundwater

Several studies have been conducted in the past to characterize the hydrogeology at the Midnite Mine. These studies (SMI 1996, SMI 1999, STI 2000) indicate that groundwater beneath the site flows in two aquifers, a shallow alluvial aquifer and a deeper bedrock aquifer.

The shallow alluvial aquifer is comprised of relatively permeable material, primarily waste rock, alluvium, fluvial deposits, and piles of ore and protore. The thickness of this material varies throughout the area. In some locations, the aquifer is essentially nonexistent; in other locations, primarily on site, the alluvial and waste rock material is over 100 feet thick. Although the specific direction and characteristics of groundwater flow vary across the site, the general groundwater flows laterally from north-northwest to south-southeast. However, the extent of downward vertical flow in this shallow aquifer is less certain. One study has reported that most of the precipitation that infiltrates the shallow, alluvial material flows laterally through the aquifer and eventually discharges to surface water through seeps. This study also indicates that a minor portion of groundwater in the shallow aquifer flows downward into the bedrock aquifer (SMI 1996). A more recent study, however, has acknowledged that the extent to which groundwater flows between the aquifers has not been fully characterized (SMI 1999).

Beneath the shallow alluvial aquifer lies the weathered, quartz bedrock aquifer. Due to the bedrock's low permeability, the movement of groundwater in the bedrock is believed to be dominated by fracture flow, which is believed to be oriented roughly parallel to the north-south geologic structural features (SMI 1999). In addition, groundwater reportedly flows from the bedrock into Pit-3. Citing earlier studies conducted by the former U.S. Bureau of Mines, a recent study has reported that mining activities have affected groundwater quality in only isolated locations of the uppermost portions of the bedrock aquifer (SMI 1996). Groundwater elevations in bedrock underlying the mine range from 3171 feet above sea level (near the Hillside Spoils) to 2600 feet above sea level (near the South Mine Spoils). Groundwater flow in the bedrock aquifer at the site roughly follows surface topography, i.e., groundwater flows from north-northwest to south-southeast.

Most residents of the Spokane Reservation rely on groundwater as a drinking water source; 50% of the residences use private wells, while 38% obtain their drinking water from a public water system or a private water company (STI 2000). However, there are no reported drinking water wells at the site or in the immediate site vicinity.

Environmental Contamination and Other Hazards

A. Nature and Extent of Contamination

Uranium and its radioactive decay products are abundant, due to the large uranium ore vein running through the site. Mining operations have moved this naturally occurring radioactive material to the surface and near surface and aided its leaching into surface and groundwater. The groundwater and surface water on-site is heavily contaminated with heavy metals including naturally occurring radionuclides, due to acid rock leaching (as mentioned in the Background Section). Also, surface soils have been impacted by the mining operation and use of mine tailings to construct roadbeds around the site (EPA 2005). There has also been considerable uptake of uranium by biota (see Table 1 in Appendix A).

On-site and immediately off-site groundwater have extremely high concentrations of all the naturally occurring uranium isotopes and their decay products. Uranium concentrations are thousands of times above health based comparison values (see Table 2 in Appendix A). Thorium and radium isotopes are also significantly elevated in groundwater, but to a lesser extent than the uranium (EPA 2005).

B. Physical and Other Hazards

The Midnite Mine site has features typical of inactive mines in mountainous areas, including old mine equipment and structures, steep roads, sheer drops, large waste rock piles, and large open pits. These features could pose physical hazards to persons trespassing on the site property, especially children. However, due to the site's remote location and lack of nearby residences, access by children is unlikely.

Exposure Pathways Analysis

In this section of the public health assessment, ATSDR evaluates pathways by which persons may be exposed to contaminants of concern at the Midnite Mine site. Exposure pathways consist of five elements: a source of contamination; an environmental medium through which contaminants are transported; a point of exposure (i.e., a place where people come into contact with contaminated media); a route of human exposure (i.e., how contaminants enter the body); and an exposed population.

An exposure pathway is considered complete if all five elements exist. A completed exposure pathway indicates that human exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. When one or more of the five elements of an exposure pathway are missing, the pathway is considered incomplete. If at least one of the five elements is missing and will never exist, the pathway can be eliminated from further consideration.

Identification of exposure pathways related to the Midnite Mine site does not imply a public health hazard because not all exposures are significant enough to cause adverse health effects. The potential for adverse health effects as a result of human exposures at the Midnite Mine will be evaluated in the Public Health Implications section of this document.

A. Completed Exposure Pathways

Soil/Surface Deposits

Over the years, tribal members and others have accessed the site for work (e.g., mine employees, fish and game personnel, environmental investigators, water treatment plant employees), recreation, hunting/gathering, or cultural/spiritual ceremonies. During these activities, human contact with surface soil or surface materials (waste rock, ore, protore) likely resulted in exposure to radioactive contaminants. Exposure to these contaminants could have occurred through incidental ingestion, inhalation, and skin contact as well as accidental ingestion of soil on the surface of plants gathered from the site. Former mine employees probably had the highest exposure, because they spent the most time at the site and had the greatest opportunity for close contact with the contaminated soils and surface materials.

Current exposure of tribal members and visitors to site-related contaminants in surface soil and surface materials is limited. Though the potential for exposure clearly exists, the actual extent of exposure is currently limited because the site is located in a remote area with no nearby residences, therefore any contact with contaminated soil and surface materials is likely to be infrequent and intermittent.

Air

Fugitive dusts are generated when surface soils, sediments, and surface materials (waste rock, ore, protore) at the site are suspended by wind or disturbed by site activities. While the mine was operating, these activities included blasting operations during exploration or mining; drilling of wells or boreholes; excavation and earthmoving operations; truck loading; and vehicular traffic on mine roads, haul roads, and the Ford-Wellpinit Road. Employees of the mine would have been exposed routinely to metals and radionuclides from inhaling these fugitive dusts. Mine employees may also have inhaled radon or radon daughter products emitted from soils, sediments, or surface materials at the mine. Residents of the reservation who lived downwind of the mine while it was active may also have been exposed to fugitive dusts, radon, or radon daughter product carried off-site by the wind. Tribal members who visited the site for recreational, hunting/gathering, or spiritual/cultural activities may also have been exposed to airborne contaminants. The extent of these past exposures to contaminants other than radionuclides is not known because no studies to date have measured levels of these contaminants in the vicinity of the Midnite Mine site. Current exposures to airborne contaminants from the site are also not known but are likely limited since the mine is closed and its operations that generated large quantities of fugitive dust have been discontinued.

B. Potential Exposure Pathways

Surface Water

Radionuclides in waste rock, ore, and protore piles at the mine have been released into both on-site surface waters (Pits 3 and 4, Blood Pool, Pollution Control Pond, selected seeps) and off-site surface waters downstream of the mine (unnamed drainages and Blue Creek). In addition, unprocessed ore spilled from trucks along the Haul Road could have been transported by storm water runoff into nearby surface waters.

Tribal members are unlikely to come into contact with on-site surface waters so the potential for exposure to surface water contaminants is remote. However, deer and other wildlife have been reported to drink from on-site surface waters, such as the open pits, so it is possible that persons eating deer could be exposed to on-site surface water contaminants indirectly via this pathway.

The Ford-Wellpinit Road, which lies south of the mine, passes directly over the Mine Drainage Stream and runs parallel to Blue Creek. In addition, several trails exist between this road and the mine site, including one that runs parallel to the Central Mine Drainage and East Drainage. Therefore, it is possible that a tribal member or visitor to the area could access the drainages south of the mine and be exposed to contaminants by ingesting or having dermal contact with water from mine seeps or drainage streams. However, it is questionable whether someone would drink water from these streams because of unpleasant tastes and odors resulting from the streams' high sulfate levels. Deer and other wildlife may also drink from these seeps or streams. Area visitors may also be exposed to contaminants in Blue Creek by drinking water from the creek, by dermal contact with the creek water and sediments, or by direct irradiation from surface water or sediments.

Tribal members could also be exposed to contaminants in surface water used for conducting cultural/spiritual ceremonies in sweat lodges. Sweat lodges are confined spaces constructed of natural materials (i.e., branches, moss, leaves) near a source of groundwater or surface water. During the sweat lodge ceremonies, tribal members pour water over hot rocks to generate steam. Because there are no groundwater wells in the area, sweat lodge ceremonies performed in the site vicinity might use water from Blue Creek. Contaminants in the water from Blue Creek could become airborne and be inhaled inside the sweat lodges during these ceremonies. Inhalation exposures can potentially occur not only to the gases that tend to accumulate in ground-level confined spaces (e.g., radon), but also to contaminants in the water that evaporate when it is poured over the hot rocks. The sweat lodges are a confined space, thus potentially magnifying the exposure to released gases such as radon or airborne contaminants. However, people are not likely to be exposed to uranium, thorium or radium, because they are not volatile.

As previously discussed, area surface waters are being impacted by the presence of radioactive materials entering the seeps that ultimately enter Blue Creek or the related watershed in the vicinity of the mine via the western and central drainage systems. Of those radioactive contaminants evaluated, thorium and uranium are the least mobile based on their chemical characteristics or the ability to bind to components of the soil matrix. However, radium can form very soluble salts depending the water quality and composition. For example, if waters contain high sulfur content then the probability of radium migration is greatly reduced as radium sulfate is very insoluble in water.

Currently, surface waters at the mine as well as waste piles appear to be stable with the exception of the seeps from the retention ponds. No radioactive contaminants above a detection limit or regulatory value appear to have reached Roosevelt Lake.

Sediments

Significant human exposure to contaminants in on-site sediments is unlikely since the site is located in a remote location and there are no residences in the immediate vicinity of the site. However, tribal members and visitors to areas downstream of the site may be exposed to site-related contaminants in the sediments through dermal contact or incidental ingestion. Dermal contact could occur while wading or possibly swimming in the drainage streams or in Blue Creek Incidental ingestion could occur if someone ate aquatic plants from these waters without washing them first. However, the extent of such exposures is likely limited and periodic. This situation could change in the future depending on how the Spokane Tribe chooses to use the local lands after mine reclamation is complete.

A recreational campground and beach operated by the Spokane Tribe lies at the confluence of Blue Creek and the Spokane Arm of Lake Roosevelt. Thus, dermal contact and incidental ingestion of contaminated sediments is possible for those who frequent this area. Although statistics on the usage of this recreational facility are not readily available, human exposure to contaminants in beach and campground sediments at levels of health concern is not likely based on the reported sediment contaminant concentrations.

Fish

A 1986 study found elevated levels of metals, including aluminum, cadmium, nickel, and uranium, in trout taken from Blue Creek below the Midnite Mine site. These data indicate that fish can bioaccumulate contaminants released from the site into Blue Creek surface water and sediments. Tribal members or others who eat fish from Blue Creek below the mine or who apply fish parts to the skin for cultural, spiritual, or medicinal purposes could be exposed to heavy metals and radionuclides. However, since there are no recent studies of contaminants in site area fish, it is not known whether fish in Blue Creek downstream of the site currently contain elevated levels of contaminants. Therefore, at the present time, ATSDR cannot fully evaluate the extent of human exposure to contaminants in Blue Creek fish.

The past and present extent of fishing in the Blue Creek is unknown. It is assumed that subsistence fishing is not likely since there are no residences in the immediate area. However, when the leased land is returned to Spokane Tribe, the tribe has expressed its desire to use the land to the fullest extent possible. Since the tribe relied on fish, primarily salmon, but also trout, as a principle food source in the past, the tribe may seek to more fully utilize area creeks for fishing in the future.

Terrestrial and Aquatic Plants

Radionuclides from the Midnite Mine are found in many areas on and off the site, such as the drainages south of the mine. Terrestrial and aquatic plants that grow in these areas can uptake contaminants from soil, surface water, sediment, or groundwater. Terrestrial plants can also accumulate contaminants on their leaves or stems as a result of deposition of windblown particles (soil, sediments, and radon daughters). Previous sampling of terrestrial and aquatic plants in impacted areas around the site have, in fact, shown elevated levels of uranium, thorium and associated radionuclides.

Since a wide variety of aquatic and terrestrial plants in the site area are used by tribal members for various purposes (subsistence, cultural/spiritual, and medicinal), exposure to contaminants in plants is a distinct possibility. Exposure could result from ingestion of the plants or their parts (roots, stems, flowers, and leaves), application to the skin, application to open cuts, and from inhalation or smoking. The extent of such exposure is difficult to evaluate because a number of critical exposure factors are unknown, such as the actual concentrations of radionuclides in the plant species used by the tribe, the quantities of plants used, and the frequency of their use.

Terrestrial Wildlife

Terrestrial wildlife, such as big game (e.g. deer, elk, and bear), livestock (e.g., cows), small mammals, birds, frogs, and insects, and that frequent the site or nearby impacted areas could come into contact with site contaminants. For example, big game has easy access to the site and livestock owned by the tribe are free to graze in nearby areas. Contact with site contaminants by wildlife is possible as a result of a number of activities including drinking from contaminated surface waters (e.g., open pits, seeps, drainages, Blue Creek) and ingesting contaminated aquatic or terrestrial plants. Over time, metals, such as cadmium, and radionuclides can accumulate in wildlife and in their organs, e.g. liver, kidney. Tribal members and others who eat such wildlife, their organs, or their parts for subsistence or who use them for cultural, spiritual or medicinal purposes could be exposed to site-related contaminants. This pathway is of particular concern in light of reports from tribal members and wildlife officials regarding tumors and other deformities observed in area deer and elk and the likelihood of wildlife drinking contaminated water from the mine’s two open pits and numerous springs, seeps, and drainages.

Groundwater

Direct human exposure to site-related groundwater contamination is unlikely because no drinking water wells are present on the site or in the vicinity of the site. However, if residences are built on or near the site in the future and private wells are constructed, those living in the residences could be exposed to uranium and its decay products in their drinking water. Although these exposures are possible in theory, a recent study suggests that future use of groundwater from the shallow alluvial aquifer is unlikely because the aquifer has a limited extent and area.

Indirect exposure to groundwater contaminants is possible from contaminated seeps because seeps are actually shallow groundwater discharges. Tribal members and others who visit the site area could be exposed to contaminants by drinking water from the seeps or using the water for sweat lodge ceremonies. Potential exposures associated with contaminants in seeps are discussed in greater detail in the surface water pathways evaluation.

Ionizing Radiation

Infrequent and sporadic human exposure to onsite gamma radiation is possible. It is not necessary to have direct physical contact with contamination to be exposed, only walking above radioactive contamination. Gamma radiation emitted from uranium and its decay chain products, especially radium, is significantly elevated onsite. Radiation exposure rates onsite have been measured as high as 398 µR/hr (mean value = 198 µR/hr) on the stockpiles, 143 µR/hr in disturbed areas and 138 µR/hr on the Pit 3 Road, which compares to a background rate of 11 – 19 µR/hr (EPA 2005). Indirect exposure to gamma emitting contaminants is possible from walking near contaminated soils. Tribal members and others who visit the site area could be sporadically exposed to ionizing radiation.

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Evaluation

This section contains a preliminary discussion of the possible public health implications of human exposure to contaminants from the Midnite Mine site.

Surface Soil

Though the available sampling data for surface soil are somewhat limited, the measured concentrations for radionuclides appear to be at levels of concern. Specifically, isotopes of radium are orders of magnitude above those set forth in the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) .

Air

Since mining activities occurred from 1955–1981, the airborne radionuclide sampling by DMC from 1979–1980 indicates the radionuclide concentrations when mining activities were ongoing. The 1996 USBM study, on the other hand, gives an indication that there is no measurable exposure to radionuclides, other than radon progeny, since the mine closed.

Surface Water

The comparison values that were used to determine contaminants of concern for surface water are based on exposures associated with a lifetime of drinking from a specific water body. In the case of the mine drainage streams and the seeps, this scenario seems highly unlikely. Therefore, the focus of ATSDR's analysis is on the contamination of Blue Creek – the surface water that humans are most likely to come into contact with currently and in the future. Even for Blue Creek, however, an exposure scenario of lifetime chronic consumption of drinking water is not very realistic. Uranium is a hazard from chronic exposure, but not from incidental acute exposures (ATSDR 1999b).

Uranium was detected in Blue Creek at levels up to 700 times greater than the EPA MCL, and average uranium concentrations in downstream locations were between 10 and 20 times higher than the MCL. As Table 6 shows, uranium concentrations exceeded the EPA MCL at the downstream locations. Also noteworthy is the fact that the average concentrations of uranium at downstream locations were between 20 and 40 times higher than the average concentrations at upstream locations, thus providing clear evidence that discharges from Midnite Mine account for a significant proportion of the uranium loadings to Blue Creek.

Sediment

Though limited, the available sampling data clearly indicate that sediments in waters on and near Midnite Mine contain elevated levels of site-related contaminants. Of the 24 non-radionuclides considered in the sampling efforts, only arsenic, cadmium, and manganese were detected at levels higher than their corresponding health-based comparison values for the soil exposure pathway. The soil comparison values are often used as an initial, but extremely conservative, screen of sediment toxicity. Because the soil comparison values are based on reasonable estimates of soil ingestion rates, and because people are much more likely to ingest soils than to ingest sediments from surface waters, the assumptions used to derive the soil comparison values are not representative of realistic sediment exposure scenarios. Thus, the comparison of sediment concentrations to soil comparison values would tend to greatly overstate the public health implications of the sediment contamination.

Another factor to consider when evaluating the public health implications of contaminated sediments is the fact that people in the area rarely come into contact with the material, thus greatly limiting their exposure. As a possible exception, considerable exposures to sediments might occur at the campground on Lake Roosevelt. However, the sediments at this location appear to be far less contaminated than the sediments closer to the mine.

Fish

Reported contaminant levels were compared to health-based comparison, but no radionuclides were detected above naturally expected background levels. No radionuclides exceeded any health based comparison values.

Plants

Because the plant tissue data are not species-specific, it is not possible to determine whether persons who consume plants in the vicinity of the Midnite Mine are exposed to contaminants at levels of public health concern. That is, the plant tissue data for the composite samples may not be representative of plant tissue contamination for a specific species, especially because metal uptake rates are known to vary from species to species. Nevertheless, the data presented here show that plants in the impacted area of the mine tend to uptake and accumulate uranium and its isotopes. Additional sampling data for contaminants in plant species consumed by tribal members is needed for ATSDR to evaluate the public health implications of these exposures.

Groundwater

Both on-site and off-site groundwater contain site-related contaminants, many at concentrations greater than their health-based comparison values, and some at concentrations several orders of magnitude greater than their comparison values. However, because no one is currently exposed to the contaminated groundwater in the vicinity of the Midnite Mine, or has been in the past, the levels of contamination do not pose a past or present health hazard. Because it appears that off-site groundwater contamination will continue to occur in the foreseeable future, a future resident drinking from a well down-gradient of the mine could possibly be exposed to contaminant levels at levels of concern. The public health significance of such exposures is dependent upon the specific contaminants and their concentrations in the future resident's drinking water well. Again, as with surface water, uranium is a chronic exposure hazard and not an acute exposure hazard (ATSDR 1999b).

Ionizing Radiation

Gamma radiation emitted from uranium and its decay chain products, especially radium, is significantly elevated onsite. Indirect exposure to gamma emitting contaminants is possible from walking near contaminated soils. Tribal members and others who visit the site area could be sporadically exposed to ionizing radiation. Infrequent and sporadic human exposure to onsite gamma radiation is possible. It is not necessary to have direct physical contact with contamination to be exposed, only walking above radioactive contamination.

The measured gamma exposure rates are insufficient to result in adverse health effects from acute exposure. Likewise, the limited access would preclude chronic exposures to exceed EPA's 15 mrem/yr to members of the tribe or the public in general. A person would need to spend in excess of 75 hours per year on the ore stockpiles to exceed EPA's 15 millirem annual limit.

B. Health Outcome Data

ATSDR is in the process of identifying and obtaining appropriate health outcome (i.e., morbidity and mortality) data to help address concerns expressed by tribal members about elevated rates of disease among the tribe. ATSDR will evaluate any health outcome data it obtains related to the health status of the tribe in future releases of this public health assessment.

C. ATSDR Child Health Initiative

ATSDR recognizes that infants and children may be more vulnerable to environmental exposure than adults in communities faced with contamination of their water, soil, air, or food. This vulnerability is a result of the following factors: (1) children are more likely to be exposed to certain media (e.g., surface soil) because they play outdoors and have more hand-to-mouth behaviors; (2) children are more likely to come into contact with dust, soil, and vapors close to the ground; and (3) children tend to receive higher doses of chemical exposure due to their lower body weight. Children can sustain permanent damage if toxic exposures occur as a result of these factors during critical growth stages. ATSDR is committed to evaluating the special interests of at sites such as Midnite Mine as part of ATSDR's Child Health Initiative.

In this public health assessment, ATSDR considered the likelihood of children being exposed to contaminants from the Midnite Mine at level of health concern. ATSDR initial evaluation did not identify any situations in which children are especially likely to be exposed to site-related contaminants. However, ATSDR will further evaluate children's exposure to site contaminants as additional sampling data are received and reviewed.

Community Health Concerns

On August 19, 1999, ATSDR staff held two public availability sessions at the Tribal Longhouse in Wellpinit and listened to tribal members and area residents discuss their health concerns about the Midnite Mine site. Approximately 15 people attended the two sessions including several employees of the tribal government. Most of those who attended were interested in learning about ATSDR and in sharing their knowledge and concerns about the site.

The major concerns expressed by tribal members and area residents included:

1. Perceptions of high rates of disease, such as cancer, diabetes, heart attacks, and alcoholism, among the tribe;
2. Stress and negative social changes caused by loss of natural resources and loss of traditional tribal practices as a result of site contamination; and
3. Effects of radiation and other site contaminants on plants, fish, and wildlife in the site area, based on deformities observed in local deer and elk, declines in fish and wildlife populations, etc. Some tribal members have quit eating or using area plants, fish, and wildlife due to contamination concerns.

Conclusions

1. ATSDR has conducted a preliminary evaluation of the public health significance of radioactive contamination related to the Midnite Mine site. ATSDR is currently classifying current exposure to radioactive contaminants as no apparent public health hazard. This category indicates that human exposure to contaminated media might be occurring, but the exposure is not expected to cause any harmful health effects. However, if site use changes, people could be exposed to harmful levels of uranium from surface and ground water.
2. Although not a current health hazard because exposure is infrequent, ATSDR has identified the following human exposure pathways associated with the site that warrant remediation and use restrictions:
   - Exposure to radionuclides in on-site surface deposits (waste rock, ore, protore) and onsite and off-site surface soils;
   - Exposure to radionuclides in surface and groundwater and sediments in on-site and off-site drainages and Blue Creek.
3. If site use changes to residential, there is the potential for exposure to uranium and its decay products from surface and groundwater at levels of health concern.

Recommendations

1. To the extent possible, restrict access to contamination and physical hazards at the site and post warning signs at the two entrances to the site.
2. Consider implementing activities to reduce migration of site contaminants to off-site surface waters (unnamed drainages and Blue Creek).
3. ATSDR concurs with the preferred recommendations of EPA's Record of Decision dated October 2006 (EPA 2006), and agrees that recommendations would preclude future exposures and be protective of public health.
4. ATSDR will reevaluate the site for appropriate follow-up health activities if future data or information indicates that human exposure to site contaminants is occurring at levels of public health concern.

Public Health Action Plan

The Public Health Action Plan (PHAP) for the Midnite Mine site contains a description of actions that have been or will be taken by ATSDR and other government agencies at the site. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards associated with the site, but also provides a plan of action to prevent or minimize the potential for adverse human health effects from exposure to site-related hazardous substances.

A. Actions Completed

1. ATSDR has visited the site to verify site conditions and to gather pertinent information and data for the site.
2. ATSDR has met with members of the Spokane tribe to discuss their health concerns related to the site.
3. EPA has completed the initial Phase I RI field activities for the site.
4. EPA has completed the Final RI/FS for this site.
5. EPA has completed and published its Record of Decision for this site in October 2006.

B. Proposed Actions

1. Place a clean soil cover over the mine waste (which includes waste rock, proto-ore, ore, road gravel and other waste materials), to reduce risks from direct soil contact, radiation exposure, and radon. As a result, people and animals using the site and plants at the site will have reduced risk, and people who eat the plants and animals will have reduced risk from dietary pathways.
2. Backfill open mine pits with site waste, which eliminates the exposure pathway for pit water, pit sediments, and exposed pit walls.
3. Grade and cover backfilled pits, so that waste in the pits will prevent water from precipitation (e.g., rain, snow) from accumulating in the pits and becoming contaminated.
4. Isolate waste from contact with water through the use of covers, liners, and drainage layers; and removal of water that enters the pit to prevent acid rock leaching of contaminants.
5. Effective isolation of waste from contact with water should allow impacted groundwater and surface water to recover sooner than most other alternatives, leading to reduced human and ecological risks related to exposure to contaminated water. Consolidation of waste within the pits should create a smaller waste footprint than most other alternatives. This in turn reduces the amount of cover construction material needed and reduces the areas where cover maintenance, permanent institutional controls, and access restrictions are needed.
6. Excavation and containment of mine drainage sediments and cleanup of road gravel and affected soils eliminates exposure to these materials.

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Appendix A Tables

Table 1. Radionuclides in Vegetation

Substance	Sample Location	Highest Concentration	Units
URANIUM-234	MM-AQP-W2-01OCT98WD605	450	pCi/g
URANIUM-235	MM-AQP-W2-01OCT98WD605	31	pCi/g
URANIUM-238	MM-AQP-W2-01OCT98WD605	390	pCi/g

Table 2. Radionuclides in Groundwater Monitoring Wells

Substance	Well Location	Highest Concentration	Comparison Value	Units
GROSS ALPHA	GW-54MA54	180,000	15 (MCL)	pCi/L
GROSS BETA	GW-54MA54	148,000	5 (MCL)	pCi/L
LEAD-210	GW-53MA102	400	1 (PMCL)	pCi/L
POLONIUM-210	GW-54MA54	60		pCi/L
RADIUM-226	GW-53MA102	660	20	pCi/L
RADIUM-228	GW-54MA54	44	20	pCi/L
RADON-222	GW-54MA54	130,000	300	pCi/L
THORIUM-227	GW-35AWD101	13		pCi/L
THORIUM-228	GW-54MA54	269		pCi/L
THORIUM-230	GW-54MA54	2,300		pCi/L
THORIUM-232	GW-54MA54	65.2		pCi/L
URANIUM	GW-16CD16	51,000	30 (MCL)	pCi/L
URANIUM-234	GW-54MA54	130,000		pCi/L
URANIUM-235	GW-54MA54	5,500		pCi/L
URANIUM-238	GW-54MA54	140,000	30 (MCL)	pCi/L

Table 3. Radionuclides in Unspecified Groundwater

Substance	Well Location	Highest Concentration	Comparison Value	Units
GROSS ALPHA	A1832789MA117	13,600	15 (MCL)	pCi/L
GROSS BETA	A1832789MA117	28,500	5 (MCL)	pCi/L
RADIUM-226	A1832789MA117	0.151	20	pCi/L
RADIUM-228	A1832789MA117	0.3	20	pCi/L
THORIUM-227	A1832789MA117	159		pCi/L
THORIUM-228	A1832789MA117	361		pCi/L
THORIUM-230	A1832789MA117	127		pCi/L
THORIUM-232	A1832789MA117	88.3		pCi/L
URANIUM-234	A1832789MA117	19,000		pCi/L
URANIUM-234	MWBC-01BC104	14.4		pCi/L
URANIUM-235	A1832789MA117	1000		pCi/L
URANIUM-235	MWBC-01BC104	0.492		pCi/L
URANIUM-238	A1832789MA117	18,200	30 (MCL)	pCi/L

Table 4. Radionuclides in Other Biota

Substance	Sample Location	Highest Concentration	Units
URANIUM-234	MMINS-US4-24SEP98BK607	0.46	pCi/g
URANIUM-235	MMINS-US3-24SEP98MA623	0.24	pCi/g
URANIUM-238	MMINS-US4-24SEP98BK607	0.33	pCi/g

Table 5. Radionuclides in Sediment

Substance	Sample Location	Highest Concentration	Comparison Value	Units
GROSS ALPHA	CD SEEP/SDCD-01CD107	4,750		pCi/g
GROSS BETA	CD SEEP/SDCD-01CD107	1,300		pCi/g
LEAD-210	SWP4-01/SDP4-01MA220	130		pCi/g
POLONIUM-210	SWP4-01/SDP4-01MA220	160		pCi/g
PROTACTINIUM-231*	SDBC-01/SWBC-01BC206	0.02		pCi/g
RADIUM-226	CD SEEP/SDCD-01CD107	263	5/15 surface/subsurface	pCi/g
RADIUM-228	PP01SW/PP01SDMA121	16.9	5/15 surface/subsurface	pCi/g
THORIUM-227	SWP3-01/SDP3-01MA219	22		pCi/g
THORIUM-228	CD SEEP/SDCD-01CD107	65.6		pCi/g
THORIUM-230	PP01SW/PP01SDMA121	2540		pCi/g
THORIUM-232	CD SEEP/SDCD-01CD107	49.7		pCi/g
URANIUM-233/234*	SDFW-01/SWFW-01FWD201	22		pCi/g
URANIUM-234	PP01SW/PP01SDMA121	2,410		pCi/g
URANIUM-235	CD SEEP/SDCD-01CD107	137		pCi/g
URANIUM-238	PP01SW/PP01SDMA121	2,340		pCi/g

Table 6. Radionuclides in Spring Water

Substance	Sample Location	Highest Concentration	Comparison Value	Units
GROSS ALPHA	PHSMA146	42,000	15 (MCL)	pCi/L
GROSS BETA	PHSMA146	18,000	5 (MCL)	pCi/L
LEAD-210	CD SEEP/SDCD-01CD107	91	1 (PMCL)	pCi/L
POLONIUM-210	PHSMA146	18	Included in Gross Alpha	pCi/L
RADIUM-226	CD SEEP/SDCD-01CD107	170	20	pCi/L
RADIUM-228	CD SEEP/SDCD-01CD107	22	20	pCi/L
RADON-222	CD SEEP/SDCD-01CD107	20,000	300	pCi/L
THORIUM-227	EAST SEEP/SDED-05ED101	27.5		pCi/L
THORIUM-228	CD SEEP/SDCD-01CD107	34		pCi/L
THORIUM-230	PHSMA146	410		pCi/L
THORIUM-232	CD SEEP/SDCD-01CD107	9.5		pCi/L
URANIUM	CD SEEP/SDCD-01CD107	50,400	30 (MCL)	pCi/L
URANIUM-234	CD SEEP/SDCD-01CD107	29,000		pCi/L
URANIUM-235	CD SEEP/SDCD-01CD107	1,400		pCi/L
URANIUM-238	CD SEEP/SDCD-01CD107	31,000	30 (MCL)	pCi/L

Table 7. Radionuclides in Topsoil (top 3")

Substance	Sample Location	Highest Concentration	Comparison Value	Units
LEAD-210	SMMA-14MA314	260		pCi/g
POLONIUM-210	SMMA-16MA316	320		pCi/g
RADIUM-226	SMWHR-04WHR305	59		pCi/g
RADIUM-228	SMBKNON-04BK324	5.88		pCi/g
THORIUM-227	SMMA-15MA315	20.9		pCi/g
THORIUM-228	SMMA-16MA316	21	5	pCi/g
THORIUM-230	SMMA-15MA315	288	5	pCi/g
THORIUM-232	SMMA-03MA319	10.9		pCi/g
URANIUM-234	SMMA-15MA315	196		pCi/g
URANIUM-235	SMWHR-01WHR301	8.56		pCi/g
URANIUM-238	SMMA-15MA315	159		pCi/g

Table 8. Radionuclides in Subsurface Soil (3" – 12" depth)

Substance	Sample Location	Highest Concentration	Comparison Value	Units
GROSS ALPHA	PT05SSMA135	9,290		pCi/g
LEAD-210	SSEHR-01EHR401	45		pCi/g
POLONIUM-210	SSEHR-01EHR401	41.2		pCi/g
RADIUM-226	PT05SSMA135	880	15	pCi/g
RADIUM-228	SM05SSMA145	7.66	15	pCi/g
THORIUM-227	SSEHR-06EHR406	1.04		pCi/g
THORIUM-228	PT02SSMA132	5.48		pCi/g
THORIUM-230	A1844801MA543	591		pCi/g
THORIUM-232	SSEHR-06EHR406	4.71		pCi/g
URANIUM-234	A1939896MA593	412		pCi/g
URANIUM-235	A1939896MA593	18.9		pCi/g
URANIUM-238	A1939896MA593	417		pCi/g

Table 9. Radionuclides in Surface Water

Substance	Sample Location	Highest Concentration	Comparison Value	Units
GROSS ALPHA	SW-20MA113	18,600	15 (MCL)	pCi/L
GROSS BETA	SWP3-01/SDP3-01MA219	16,700	5 (MCL)	pCi/L
LEAD-210	SDNE-01/SWNE-01NE201	200	1 (PMCL)	pCi/L
POLONIUM-210	SDNE-01/SWNE-01NE201	97	Included in Gross Alpha	pCi/L
RADIUM-226	SW-20MA113	259	20	pCi/L
RADIUM-228	EAST SEEP/SDED-05ED101	9.5	20	pCi/L
RADON-222	SW-39MA114	6,500	300	pCi/L
THORIUM-227	SWP3-01/SDP3-01MA219	48		pCi/L
THORIUM-228	PP02SW/PP02SDMA122	122		pCi/L
THORIUM-230	SW-14HI248	13,600		pCi/L
THORIUM-232	PP01SW/PP01SDMA121	112		pCi/L
URANIUM	SW-20MA113	88,000	30 (MCL)	pCi/L
URANIUM-233/234*	SWBK-18BK218	1.5		pCi/L
URANIUM-234	SW-20MA113	11,000		pCi/L
URANIUM-235	P302SW/P302SDMA302	895		pCi/L
URANIUM-238	SW-20MA113	11,000	30 (MCL)	pCi/L

Appendix B ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems.

Ambient
Surrounding (for example, ambient air).

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Cancer
Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk of for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation and Liability Act of 1980]

Chronic
Occurring over a long time (more than 1 year) [compare with acute].

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Curie
A measure of radioactive activity. A curie is the amount of a radioactive substance that will have 37,000,000,000 radioactive decays in one second. One gram of radium-226 is one curie.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends) and how people can come into contact with (or get exposed to) it. An exposure pathway has five

parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching) and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs and what methods will work well.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

mg/kg
Milligram per kilogram.

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Mortality
Death. Usually the cause (a specific disease, condition, or injury) is stated.

National Priorities List for Uncontrolled Hazardous Waste Sites
(National Priorities List or NPL) EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Emission Standards for Hazardous Air Pollutants or NESHAPs
40 CFR Part 61
Subpart H - National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities Source: [54 FR 51695, Dec. 15, 1989] § 61.92 Standard. Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard and urgent public health hazard.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [See Resource Conservation and Recovery Act (1976, 1984)]

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see disease registry].

Remedial Investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

Risk
The probability that something will cause injury or harm.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called an uncertainty factor].

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds and springs [compare with groundwater].

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people.
Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves.

Toxicological profile
An ATSDR document that examines, summarizes and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds
Organic compounds evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride and methyl chloroform.

Other glossaries and dictionaries:

Environmental Protection Agency
http://www.epa.gov/OCEPAterms/

National Center for Environmental Health (CDC)
http://www.cdc.gov/nceh/dls/report/glossary.htm

National Library of Medicine
http://www.nlm.nih.gov/medlineplus/dictionaries.html

Appendix C Comparison Values

Following are definitions of the various health-based comparison values that ATSDR used in this PHA to put the measured and modeled levels of environmental contamination into perspective:

CREG: **C**ancer **R**isk **E**valuation **G**uide, a highly conservative value that would be expected to cause no more than one excess cancer in a million persons exposed over time.

EMEG: **E**nvironmental **M**edia **E**valuation **G**uide, a media-specific comparison value that is used to select contaminants of concern. Levels below the EMEG are not expected to cause adverse non-carcinogenic health effects. These comparison values have been developed for acute exposure scenarios (EMEG-a), intermediate exposure scenarios (EMEG-i) and chronic exposure scenarios (EMEG-c).

LTHA: **L**ife**t**ime **H**ealth **A**dvisory for drinking water, a contaminant concentration that EPA has reported as being protective of public health for a lifetime (70 years) of exposure assuming a daily drinking water ingestion rate of 2 liters per day. Unlike primary MCLs (see below), LTHAs are not enforceable standards.

MCL: **M**aximum **C**ontaminant **L**evel, a health-based standard that applies to drinking water supplies. Primary standards (listed in this PHA simply as MCLs) help protect the public from being exposed to contaminants that can adversely affect their health; the primary standards are legally enforceable. Secondary standards (listed in this PHA as secondary MCLs) are not health-based, but rather protect against things people value other than their health, such as the taste, odor and other aesthetic qualities of drinking water.

MRL: **M**inimal **R**isk **L**evel, an ATSDR estimate of daily human exposure to a hazardous substance below which that substance is unlikely to pose a measurable risk of harmful, non-cancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic).

NAAQS: **N**ational **A**mbient **A**ir **Q**uality **S**tandard, an ambient-air concentration that EPA has established to identify areas with potentially unhealthy levels of air pollution. The standards are health-based and were designed to be protective of many sensitive populations, such as people with asthma and children. The standards have been developed only for a small subset of pollutants and the averaging time and statistical interpretations of the standards vary among the regulated pollutants.

NRC: ATSDR used several health-based comparison values developed by the **N**uclear **R**egulatory **C**ommission (NRC) to identify contaminants of concern for drinking water exposures. The NRC comparison values come from the agency's table of annual intake levels (see 10 CFR 20, Appendix B) that would produce a total effective dose equivalent of 50 millirem if one would drink water from a single source for an entire year.

RBC: **R**isk-**b**ased **C**oncentration, a contaminant concentration that is not expected to cause adverse health effects over long-term exposure. Scientists from EPA Region 3 drew from a variety of data sources to develop these RBCs for both cancer outcomes (RBC-c) and noncancer outcomes (RBC-n).

REL: **R**ecommended **E**xposure **L**evel, an air concentration that the National Institute for Occupational Safety and Health (NIOSH) recommends should not be exceeded. RELs are designed primarily for occupational settings and exposures. The RELs used in this PHA are all based on 8-hour time weighted average exposures.

RfC: **Ref**erence **C**oncentration, an ambient-air concentration developed by EPA that people, including sensitive subpopulations, can be exposed to continuously over a lifetime without developing adverse noncancer health effects. RfCs typically have uncertainty factors built into them to account for any perceived limitations in the data on which they are based.

RMEG: **R**eference Dose **M**edia **E**valuation **G**uide, the concentration of a contaminant in soil or water that corresponds to EPA's Reference Dose for that contaminant when default values for body weight and intake rates are taken into account. These have been developed for exposure scenarios specific to adults (RMEG-a) and children (RMEG-c).