3.3 Wyoming East Uranium Milling Region

3.3.1 Land Use

As shown in Figure 3.3-1, the Wyoming East Uranium Milling Region encompasses parts of eight counties (Albany, Campbell, Carbon, Converse, Johnson, Natrona, Platte, and Weston), although it predominantly lies within Converse and Campbell Counties. This region straddles portions of the Wyoming Basin to the west and the upper part of the Missouri Plateau to the north (U.S. Geological Survey, 2004). In this region, past, current, and potential uranium milling operations are generally found in the four-corner area of Campbell, Converse, Natrona, and Johnson Counties (known as the Pumpkin Buttes District) and in the northern-central part of Converse County (known as the Monument Hill District). The Shirley Basin Uranium District located south of Casper is the past site of a conventional uranium milling facility (Figures 3.3-1 and 3.3-2). The geology and soils of these three uranium districts are detailed in Section 3.3.3.

While 53.3 percent of the land in Wyoming is federal and state public land, surface land ownership in this region is predominantly private (68 percent) (Table 3.3-1). Within the Wyoming East Uranium Milling Region there are portions of two large tracts of federal land that are managed by the USFS:

- The Thunder Basin National Grassland, which straddles Campbell, Converse, and Weston Counties in the Powder River Basin between the Big Horn Mountains to the west and the Black Hills to the east, represents 15 percent of the region.

- The Medicine Bow National Forest, which occupies the southern part of Converse County and extends farther south into Albany County, represents almost 6 percent of the region.

Although federal grasslands and forests occupy an important portion of the region (approximately 21 percent), most rangeland is privately owned (68 percent) and is primarily used for grazing cattle and sheep. Campbell County, for example, has more private land ownership than any other county in Wyoming. Other federal lands managed by BLM, the U.S. Bureau of Reclamation, and the Department of Defense (Table 3.3-1) comprise scattered tracts mixed with state and private lands and represent only approximately 10 percent of the land in the Wyoming East Uranium Milling Region (Figure 3.3-1). As described for the Wyoming West Uranium Milling Region in Section 3.1.1, there are also in this region privately owned surface rights and publicly owned subsurface mineral rights resulting in split estate situations (BLM, 2008a) (Section 3.1.2.2).

The open rangelands of this region consist of gently rolling hills covered by sagebrush and short grass prairies capable of supporting year-round cattle and sheep grazing. Compared to the productivity of the open rangeland, farmland is marginal. It consists of dry or locally irrigated grain, hay, and pasture crops for livestock grazing or for preparing livestock feed. Agriculture is limited in the region due to low precipitation and because other water resources are insufficient for irrigation.

In addition to providing forage for livestock and grazing, the Thunder Basin National Grassland provides a variety of recreational activities, such as sightseeing, hiking, camping, hunting, and fishing (USFS, 2008). The historic Bozeman, Oregon, and Bridger Trail Corridors (see

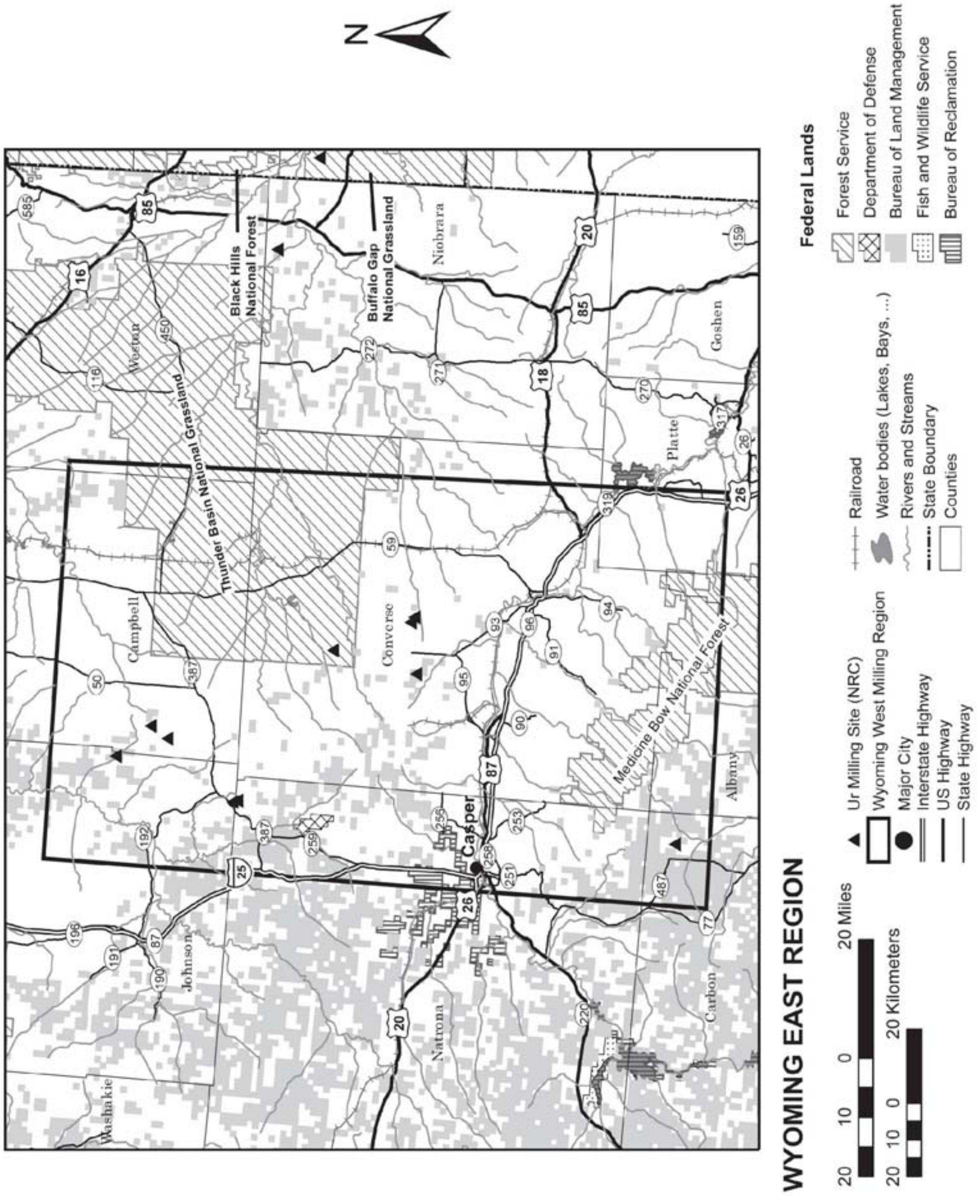


Figure 3.3-1. Wyoming East Uranium Milling Region General Map With Past, Current, and Future Uranium Milling Site Locations

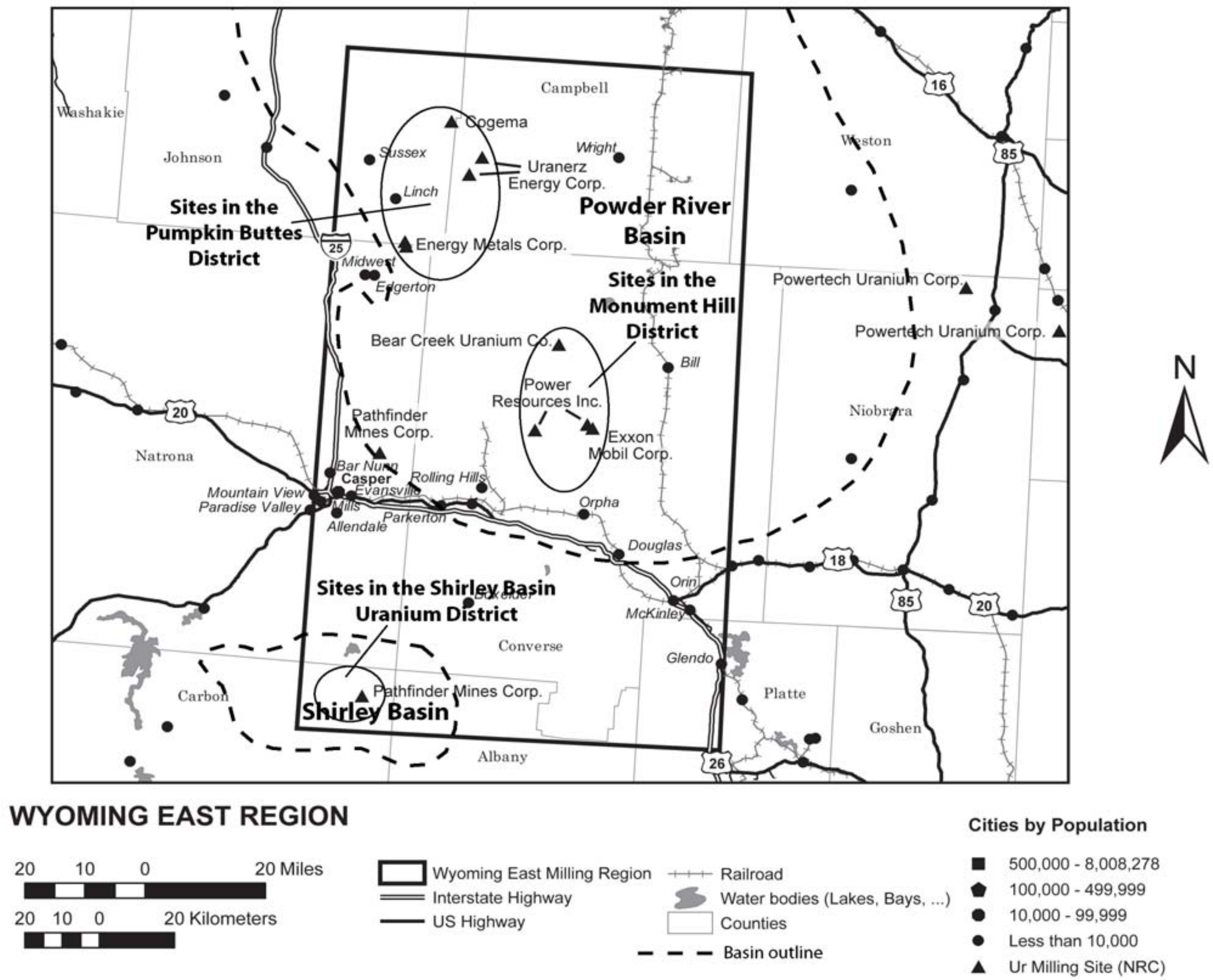


Figure 3.3-2. Map Showing Outline of the Wyoming East Region and Locations of the Pumpkin Buttes and Monument Hill Districts in the Powder River Basin and the Shirley Basin Uranium District in the Shirley Basin

Table 3.3-1. Land Surface Ownership and General Use in the Wyoming East Uranium Milling Region			
Land Surface Ownership and General Use	**Area (mi^2)**	**Area (km^2)**	**Percent**
Private Lands	5,503	14,252	68.3
U.S. Forest Service, National Grassland	1,238	3,207	15.4
U.S. Bureau of Land Management, Public Domain Land	797	2,064	9.9
U.S. Forest Service, National Forest	466	1,208	5.8
Bureau of Reclamation	36	92	0.4
U.S. Department of Defense (Navy)	14	35	0.2
Totals	8,054	20,859	100

Figure 3.1-2), extending north and north-northeast through Natrona and Johnson Counties along the western edge of the Wyoming East Uranium Milling Region, also offer a variety of recreational activities, including sightseeing, museums, historic sites, and small state parks (Fort Phil Kearny/Bozeman Trail Association, 2008).

Oil and gas production facilities, coal mines, and coal bed methane facilities have been, and continue to be, developed throughout the federal and private rangeland of the Powder River Basin. These coal, coal bed methane, and oil and gas facilities are more prevalent and concentrated in the central and northern part of the Powder River Basin in Campbell and Johnson Counties. Given the abundance and density of coal bed methane facilities in these counties, current and future permitted areas of ISL facilities of the Pumpkin Buttes District would be likely near or intermixed with such coal bed methane sites. In the southern part of the Powder River Basin in the Monument Hill District, there are only a few scattered coal bed methane sites (U.S. Geological Survey, 2001). Future ISL facilities in the Monument Hill District therefore would not interfere with land use for coal bed methane facilities.

3.3.2 Transportation

Past experience at NRC-licensed ISL facilities indicates these facilities rely on roads for transportation of goods and personnel (Section 2.8). As shown in Figure 3.3-3, the Wyoming East Uranium Milling Region is accessible from the west by Interstate 25, U.S. Highway 20, and State Route 220. From the north, the region is accessible via Gillette by State Route 59 or State Route 50. Travel from the east reaches the Wyoming East Uranium Milling Region using State Route 450 in the northern portion of the region and U.S. Highway 18 or U.S. Highway 26 farther to the south. Southern access is from U.S. Highway 26 in the southeastern corner near Glendo and State Route 487 from the southwestern corner of the region. Rail lines traverse the southern part of the region following the path of Interstate 25. A rail spur forks north of Orin and generally follows State Route 59 north in the direction of Gillette.

Areas of interest in uranium milling in the region are shown in Figure 3.3-3. For discussion purposes, these areas are located in four main subregions when considering site access by local roads. Areas of milling interest that are located in the northwestern part of the region between Edgerton and Wright are accessed from Gillette to the north or from Casper to the south. A cluster of northernmost sites is accessed by local roads leading east to State Route 50 and then south to State Route 387 and either north to Gillette or south to Casper and Interstate 25. Along State Route 387, north of Edgerton, is another subregion of uranium milling

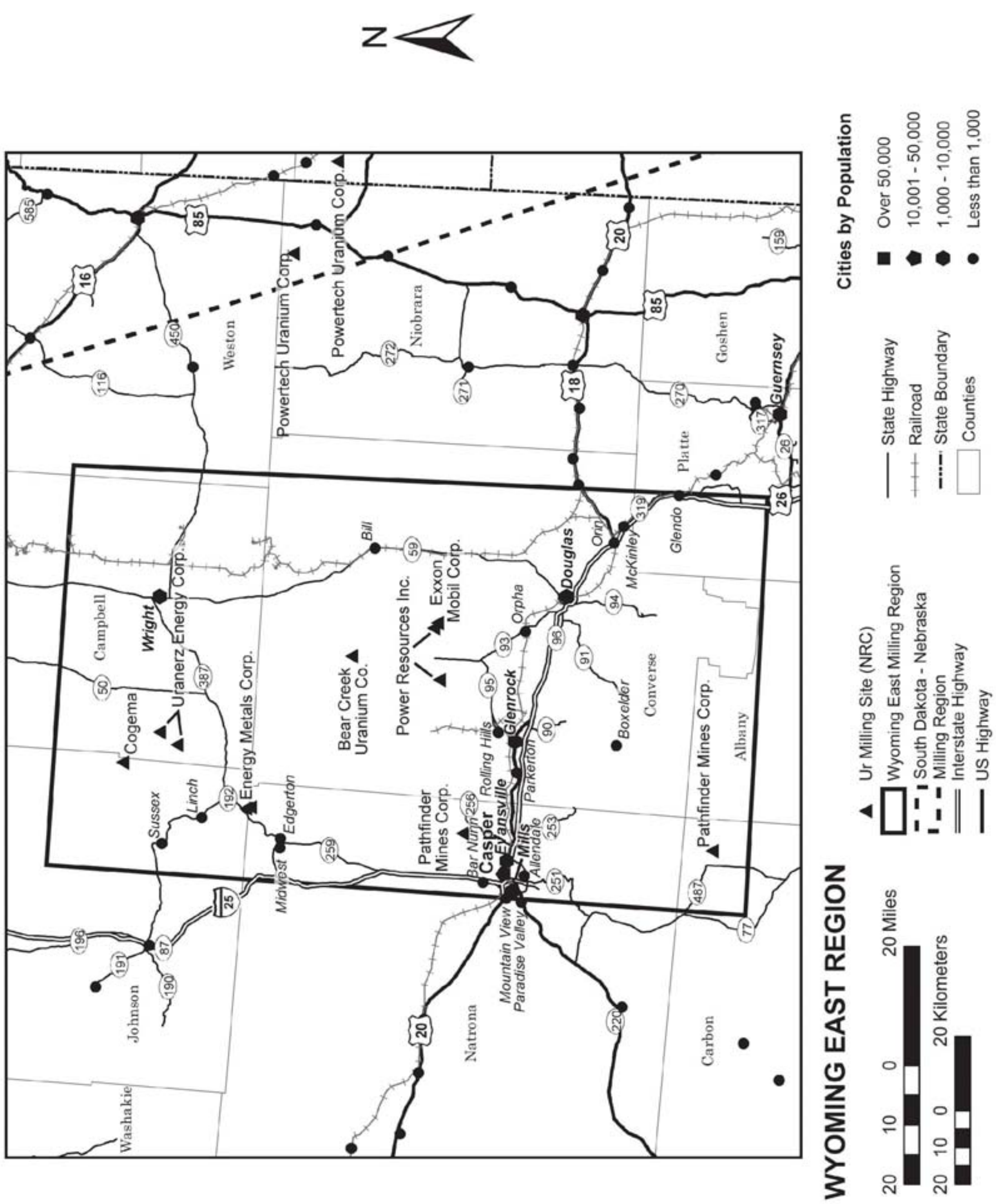


Figure 3.3-3. Wyoming East Uranium Milling Region General Map With Current and Future Uranium Milling Site Transportation Corridor

interest. The midsection of the Wyoming East Uranium Milling Region, north of Douglas, Orpha, and Rolling Hills, is the third subregion of concentrated milling interest. Local roads including Ross Road provide access to this subregion from the south using State Routes 93 and 95 that connect to Interstate 25. A rail spur runs north and dead ends into this area from the main line that follows Interstate 25. Further to the west in the direction of Casper, State Route 256 from Interstate 25 provides access for another milling site. The fourth subregion of interest is in the southwestern corner of the Wyoming East Uranium Milling Region. This is the location of the Shirley Basin conventional milling site, which is accessed using State Route 487 and 251 from Casper (and Interstate 25) to the north, or from the south on State Route 487 and U.S. Highway 30 from Laramie.

Table 3.3-2 provides available traffic count data for roads that support areas of past or future milling interest in the Wyoming East Uranium Milling Region. Counts are variable with the minimum all-vehicle count at 340 vehicles per day on State Route 93 at Orpha and the

Table 3.3-2. Average Annual Daily Traffic Counts for Roads in the Wyoming East Uranium Milling Region*

Road Segment	Distance (mi)	Trucks		All Vehicles	
		2005	2006	2005	2006
State Route 59 at Reno Junction (north of intersection with State Route 387)	—	690	750	3,630	3,930
State Route 387 at Pine Tree Junction (between State Routes 50 and 59)	20	210–410	220–410	970–3,130	970–3,130
State Route 387 at Edgerton North	—	380	440	2,110	2,140
Interstate 25 at Casper North (between Casper and State Route 259)	20	570–690	610–690	2,460–3,760	2,560–3,800
State Route 487 at Shirley Basin North (at intersection with State Route 251)	—	70	80	710	700
State Route 256 North of Interstate 25	—	140	140	2,270	2,290
U.S. Highway 20/26 at Casper East (between Evansville and Parkerton)	0.5	200	230	2,900	2,900
Interstate 25 Casper to State Route 95	21	570–1,030	610–1,030	2,610–10,220	2,710–10,220
State Route 95 at Rolling Hills	—	50	50	1,800	1,810
State Route 93 at Orpha	—	50	50	340	340
State Route 59 Douglas to Bill	35	380–450	410–440	1,940–3,690	1,940–3,690

*Wyoming Department of Transportation. "Wyoming Department of Transportation Vehicle Miles." Data for Calendar Year 2005 and 2006 Provided on Request. District 2 Office, Casper, Wyoming: Wyoming Department of Transportation. April 18, 2008.
1 mi = 1.61 km

maximum on Interstate 25 at Casper to State Route 95 at 10,220 vehicles per day. Most all-vehicle counts in the Wyoming East Uranium Milling Region are above 900 vehicles per day.

Yellowcake product shipments are expected to travel from the milling facility to a uranium hexafluoride production (conversion) facility in Metropolis, Illinois (the only facility currently licensed by NRC in the United States for this purpose). Major interstate transportation routes are expected to be used for these shipments, which are required to follow NRC packaging and transportation regulations in 10 CFR Part 71 and U.S. Department of Transportation hazardous material transportation regulations at 49 CFR Parts 171–189. Table 3.3-3 describes representative routes and distances for shipments of yellowcake from locations of uranium milling interest in the Wyoming East Uranium Milling Region. Representative routes are considered owing to the number of routing options available that could be used by a future ISL facility. Because transportation risks are dependent on shipment distance, identification of representative routes is used to generate estimates of shipment distances for evaluation of transportation impacts in Chapter 4 (Section 4.2.2). An ISL facility could use a variety of routes for actual yellowcake shipments, but the shipment distances for alternate routes are not expected to differ significantly from those estimated for the representative routes.

Table 3.3-3. Representative Transportation Routes for Yellowcake Shipments From the Wyoming East Uranium Milling Region

Origin	Destination	Major Links	Distance* (mi)
West of Savageton, Wyoming	Metropolis, Illinois	Local access road east to State Route 50 State Route 50 south to Route 387 State Route 387 south to Edgerton, Wyoming State Route 259 south to Interstate 25 Interstate 25 south to Casper, Wyoming Interstate 25 south to Denver, Colorado Interstate 70 east to St. Louis, Missouri Interstate 64 east to Interstate 57	1,420
		Interstate 57 south to Interstate 24 Interstate 24 south to U.S. Highway 45 U.S. Highway 45 west to Metropolis, Illinois	
Northwest of Douglas, Wyoming	Metropolis, Illinois	Ross Road south to State Route 93 State Route 93 south to Interstate 25 Interstate 25 south to Denver, Colorado Denver, Colorado, to Metropolis, Illinois (as above)	1,300
Shirley Basin Area, Wyoming	Metropolis, Illinois	Local access roads west to State Route 487 State Route 487 north to State Route 251 State Route 251 north to Casper, Wyoming Interstate 25 south to Denver, Colorado Denver, Colorado, to Metropolis, Illinois (as above)	1,370

*American Map Corporation. "Road Atlas of the United States, Canada, and Mexico." Long Island City, New York: American Map Corporation. p. 144. 2006.
1 mi = 1.61 km

3.3.3 Geology and Soils

As noted in Section 3.2.3, Wyoming contains the largest known reserves of uranium in the United States and has been the nation's leading producer of uranium ore since 1995 (Wyoming State Geological Survey, 2005). Sandstone-hosted uranium deposits account for the vast majority of the ore produced in Wyoming (Chenoweth, 1991). In the Wyoming East Uranium Milling Region, uranium mineralization is found in fluvial sandstones in two major areas: the Powder River Basin and the Shirley Basin (Figure 3.3-2). Uranium mineralization in sandstones in these two districts is in a geologic setting favorable for recovery by ISL milling. Since 1991, all uranium produced from sandstones in the Wyoming East Uranium Milling Region has been by the ISL method (Wyoming State Geological Survey, 2005).

The Powder River Basin encompasses an area of about 31,000 km^2 [12,000 mi^2] in Converse and Campbell Counties. Uranium was first discovered in the Powder River Basin in 1951 near Pumpkin Buttes in the central part of the basin (Davis, 1969). Other uranium deposits were found along a 97-km [60-mi] northwest-southeast trend in the southwest part of the Powder River Basin, and production began in 1953. Prior to 1968, total production from the Powder River Basin was slightly over 455,000 metric tons [500,000 tons] of U_3O_8 (Davis, 1969). The most important uranium deposits are in the Monument Hill District, which produced over 90 percent of the ore from the basin prior to 1968.

The Shirley Basin uranium area is mainly in the northeastern part of Carbon County (Figure 3.3-4). Uranium was discovered in the Shirley Basin in 1955 (Melin, 1969). Production began in 1960 from underground and open-pit mines. Milling by ISL began in 1964. Prior to 1970, approximately 1,500 metric tons [1,600 tons] of U_3O_8 was produced from mines in the Shirley Basin (Chenoweth, 1991). The dominant source of sediment in the Powder River Basin and the Shirley Basin was Precambrian (greater than 540-million-year old) granitic rock of the Sweetwater Arch and northern Laramie Range (Rackley, 1972; Harris and King, 1993). The Sweetwater Arch is also referred to as the Granite Mountains (Bailey, 1969; Anderson, 1969; Lageson and Spearing, 1988). The Sweetwater Arch and northern Laramie Range are mountain ranges composed of uraniferous granitic rock. The Powder River Basin formed during the Laramide Orogeny (mountain-building era) during the Paleocene to early Eocene (50 to 65 million years ago). Uplift of the Sweetwater Arch and Laramie Range began to affect sedimentation in the adjacent Powder River Basin and Shirley Basin in Late Cretaceous time (65 to 99 million years ago). Rapidly subsiding portions of these basins received thick clastic wedges (i.e., wedges made of fragments of other rocks) of predominantly arkosic sediments (i.e., sediments containing a significant fraction of feldspar), while larger, more slowly subsiding portions of the basins received a greater proportion of paludal (marsh) and lacustrine (lake) sediments.

Sediment in the west Shirley Basin was deposited on an alluvial fan, but in the east Shirley Basin and in the Powder River Basin, sedimentation was channel and floodplain deposits of a meandering stream (Rackley, 1972). Beginning in the middle Eocene (41 to 49 million years ago) and increasing in the Oligocene (23.8 to 33.7 million years ago), regional volcanic activity contributed a significant amount of tuffaceous materials (i.e., materials made from volcanic rock and mineral fragments in a volcanic ash matrix) to local sediments. Deposition within the basins probably continued through the Miocene (5.3 to 23.8 million years ago). With the exception of the Pumpkin Buttes in the Powder River Basin, which are capped by remnants of the Oligocene White River Formation, post-Miocene erosion has removed most Oligocene and Miocene units.

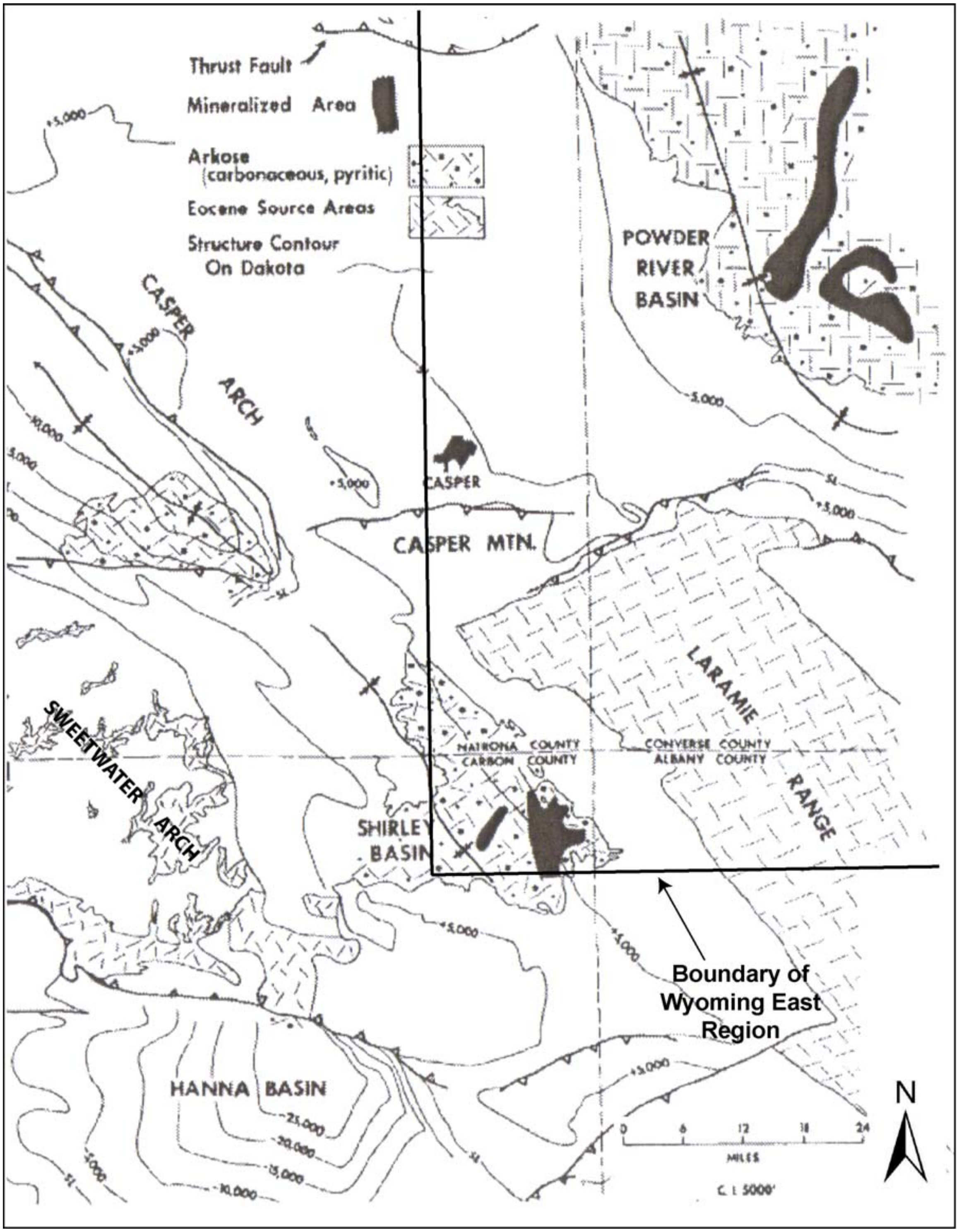


Figure 3.3-4. Index and Structure Map of East-Central Wyoming Showing Relation of the Sweetwater Arch and Laramie Range to the Powder River Basin and the Shirley Basin. The Distribution of Arkosic, Carbonaceous Sediments and Mineralized Areas in the Powder River and Shirley Basins Are Also Shown (Modified From Rackley, 1972).

A generalized stratigraphic section of Tertiary (1.8- to 65-million-year old) formations in the Shirley Basin and the Powder River Basin is shown in Figure 3.3-5. Stratigraphic descriptions presented here are limited to formations that may be involved in potential milling operations or formations that may have environmental significance, such as important aquifers and confining units above and below potential milling zones.

Formations hosting major sandstone-type uranium deposits in the Wyoming East Uranium Milling Region are the Wasatch Formation in the Powder River Basin and the Wind River Formation in the Shirley Basin. Both the Wasatch and Wind River are lower Eocene (49 to 54.8 million years old) in age (Houston, 1969) and consist of interbedded, arkosic sandstone, conglomerate, siltstone, mudstone, and carbonaceous shale, all compacted but poorly cemented (Harshman, 1968). The Wasatch Formation in the Powder River Basin also contains thick coal beds. In the Powder River Basin, recoverable ore that can be exploited by ISL milling is located in parts of the Wasatch Formation extending from depths of 120 to 300 m [400 to 1,000 ft] below the surface (Davis, 1969). Uranium deposits in the Shirley Basin lie at depths of 30 to 150 m [100 to 500 ft], almost entirely in the lower 90 m [300 ft] of the Wind River Formation (Melin, 1969; Bailey, 1969).

The Wagon Bed Formation conformably overlies the Wind River Formation in the Shirley Basin, but is absent in the Powder River Basin. The Wagon Bed comprises a series of interbedded arkosic sandstones and silicified claystones. In the central part of the Shirley Basin, the Wagon Bed Formation may not be present, having been removed by erosion. In the Shirley Basin, the White River Formation unconformably overlies the Wagon Bed Formation of the Wind River

Central Wyoming				
System	Series		Formation	
Tertiary	Pliocene		Moonstone Formation	
	Miocene		Split Rock Formation	Arikaree Formation
	Oligocene		White River Formation	
	Eocene	Upper	Wagon Bed Formation	
		Middle		
		Lower	Wind River Formation	Wasatch Formation
	Paleocene		Fort Union Formation	
Cretaceous	Upper		Lance Formation	

Figure 3.3-5. Stratigraphic Section of Tertiary Age Formations in the Powder River Basin and Shirley Basin of Wyoming. Major Sandstone-Type Uranium Deposits Are Hosted in the Wasatch Formation in the Powder River Basin and the Wind River Formation in the Shirley Basin (Modified From Harshman, 1968).

Formation where the Wagon Bed has been removed by erosion. In the Powder River Basin, the White River Formation overlies the Wasatch Formation. White River consists of tuffaceous siltstone, claystone, and conglomerate with subordinate amounts of tuff. In the Shirley Basin, the White River overlaps older Tertiary formations and wedges out against pre-Tertiary rocks on the flanks of the basin. The White River Formation has been removed by erosion throughout most of the Powder River Basin, but remnants cap the Pumpkin Buttes. The White River Formation is overlain by the Split Rock Formation in the Shirley Basin. The Split Rock consists of tuffaceous siltstone and sandstone beds that sometimes cap prominent ridges (Harshman, 1968).

The Fort Union Formation underlies the Wasatch and Wind River formations in the Powder River and Shirley Basins and, to a limited extent, is also a host to sandstone-type uranium deposits (Davis, 1969; Langden, 1973). The Fort Union is a fluvial deposit consisting of alternating and discontinuous mudstones, siltstones, carbonaceous shales, and coarser arkosic sandstone. In the Powder River Basin, the Fort Union also contains thick, continuous coal beds. The Fort Union is unconformably underlain by sediments of the Lance Formation, which is in turn underlain by a thick sequence of older sandstones, mudstones, and shales.

The uranium deposits in the Wyoming East Uranium Milling Region are stratabound and genetically related to geochemical interfaces, or roll fronts (see Section 3.1.2). The roll-front ore deposits in the Powder River Basin are usually multiple C-shaped rolls distorted by variations in gross lithology (Davis, 1969). The principal ore minerals are uraninite, coffinite, metatyuyamunite, and carnotite. Gangue minerals (i.e., low-value minerals intermixed with ore minerals) are calcite, gypsum, pyrite, iron oxide, and barite (Mrak, 1968). Although most of the uranium in the Shirley Basin is in roll-front deposits, important amounts also occur in tabular bodies near the rolls. Tabular sandstone-hosted uranium deposits are found as blanketlike, roughly parallel ore bodies along sandstone trends. The uranium mineralization in both the roll-front and tabular deposits consists of disseminations and impregnations of uraninite, calcite, pyrite, and marcasite in arkosic sandstones.

The source of uranium in sandstone-type uranium deposits in central Wyoming is a topic of conjecture. Four theories on the source of uranium in these occurrences have been suggested: (1) leached uranium from overlying ash-fall tuffs, (2) leached uranium from igneous and metamorphic rocks in the highlands surrounding the basins, (3) leached uranium from the host sandstones themselves, and (4) hydrothermal uranium from a magma source at depth (Harris and King, 1993). Combinations of these theories have been proposed as well (Boberg, 1981). The most popular theories are the (1) tuff leach and (2) highland leach. The tuff leach theory is supported by extensive geochemical studies on uranium removal from tuff (Zielinski, 1983, 1984; Trentham and Orajaka, 1986). Further, it was the tuff leach theory that led to the discovery of most of the large uranium deposits in Wyoming (Love, 1952). On the other hand, many sandstone-hosted uranium deposits in Wyoming are found adjacent to crystalline rocks, especially the uraniferous granites of the northern Laramie and Granite Mountains (Harris and King, 1993). Oxidized uranium leached from these crystalline terrains could have been transported to the sites of present mineralization.

Soils within the Wyoming East Uranium Milling Region are diverse and can vary substantially in terms of characteristics over relatively short distances. The distribution and occurrence of soils in east-central Wyoming can vary both on a regional basis (mountains, foothills, basins) and locally with changes in slope, geology, vegetation, climate, and time. In the Powder River Basin and Shirley Basin, old, tilted sedimentary rocks occur in bands along the margins of the basins, whereas younger sediments showing varying degrees of incision by erosion are found in the basin centers.

The topographic position and texture of typical soils in the Powder River Basin and Shirley Basin areas of east-central Wyoming were obtained from tMunn and Arneson (1998). This map was designed primarily for statewide study of ground water vulnerability to contamination and would not be expected to be used for site-specific soil interpretations at proposed ISL milling facilities. For site-specific evaluations, detailed soils information would be expected to be obtained from published county soil surveys or the NRCS.

In the Powder River and Shirley Basins, shallow loamy-skeletal (stony) soils with little or no subsoil development occupy ridge crests along the margins of the basins. These soils contain hard clasts (i.e., rock fragments) and tend to be much coarser than soils on the adjacent lower slopes. Loamy-skeletal soils with little subsoil development are also found in the foothills along the margins of the basin and along eroded drainageways. Fine to fine-loamy soils with moderate- to well-developed soil horizons are found on gently sloping to moderately steep slopes associated with alluvial fans and alluvial terraces. These soils are generally light colored and depleted in moisture. Moderately deep soils with well-developed soil horizons occur on low relief surfaces, such as stream terraces and floodplains, across broad expanses of the basins. Fine loamy over sandy and coarse loamy soils occurs on stream terraces. Soils found on floodplains include fine loamy and fine-sand loams. Dark-colored, base-rich soils formed under grass are generally associated with floodplains along streams with permanent high water.

3.3.4 Water Resources

3.3.4.1 Surface Waters

The Wyoming East Uranium Milling Region (Figure 3.3-6) includes portions of Albany, Campbell, Carbon, Converse, Johnson, Natrona, Platte, and Weston Counties in east-central Wyoming. Surface runoff to streams, in terms of average annual flow per unit area of a watershed, in the Wyoming East Uranium Milling Region varies from more than 13 cm/yr [5 in/yr] to less than 1 cm/yr [0.5 in/yr] in the mountains to less than 1.3 cm/yr [0.5 in/yr] in the intermontane valleys and on the plains (Gebert, et al., 1987). The potential uranium milling sites are located in the intermontane areas and on the plains. The watersheds within the Wyoming East Uranium Milling Region are listed in Table 3.3-4 along with the range of designated uses of surface water bodies assigned by the State of Wyoming (WDEQ, 2001). Because surface water uses are designated for specific water bodies (such as stream segments and lakes) within a watershed and the specific locations of future uranium milling activities are not known at this time, the range of designated uses is provided rather than a listing of designated uses for each water body within a watershed. Not all water bodies within a watershed may have all of the designated uses listed in Table 3.3-4. For example, a watershed may contain perennial streams, intermittent streams that flow only during portions of the year, and ephemeral streams that flow only because of surface runoff from local precipitation events. The perennial streams and possibly portions of intermittent streams may be designated as “fisheries” whereas ephemeral streams are unlikely to be designated as fisheries. The descriptions of the water bodies and their classifications in this section focus on perennial streams that generally have higher designated uses than the intermittent and ephemeral streams. For information regarding specific water bodies, refer to the Wyoming Department of Environmental Quality Surface Water Standards webpage (deq.state.wy.us/wqd/watershed/surfacestandards).

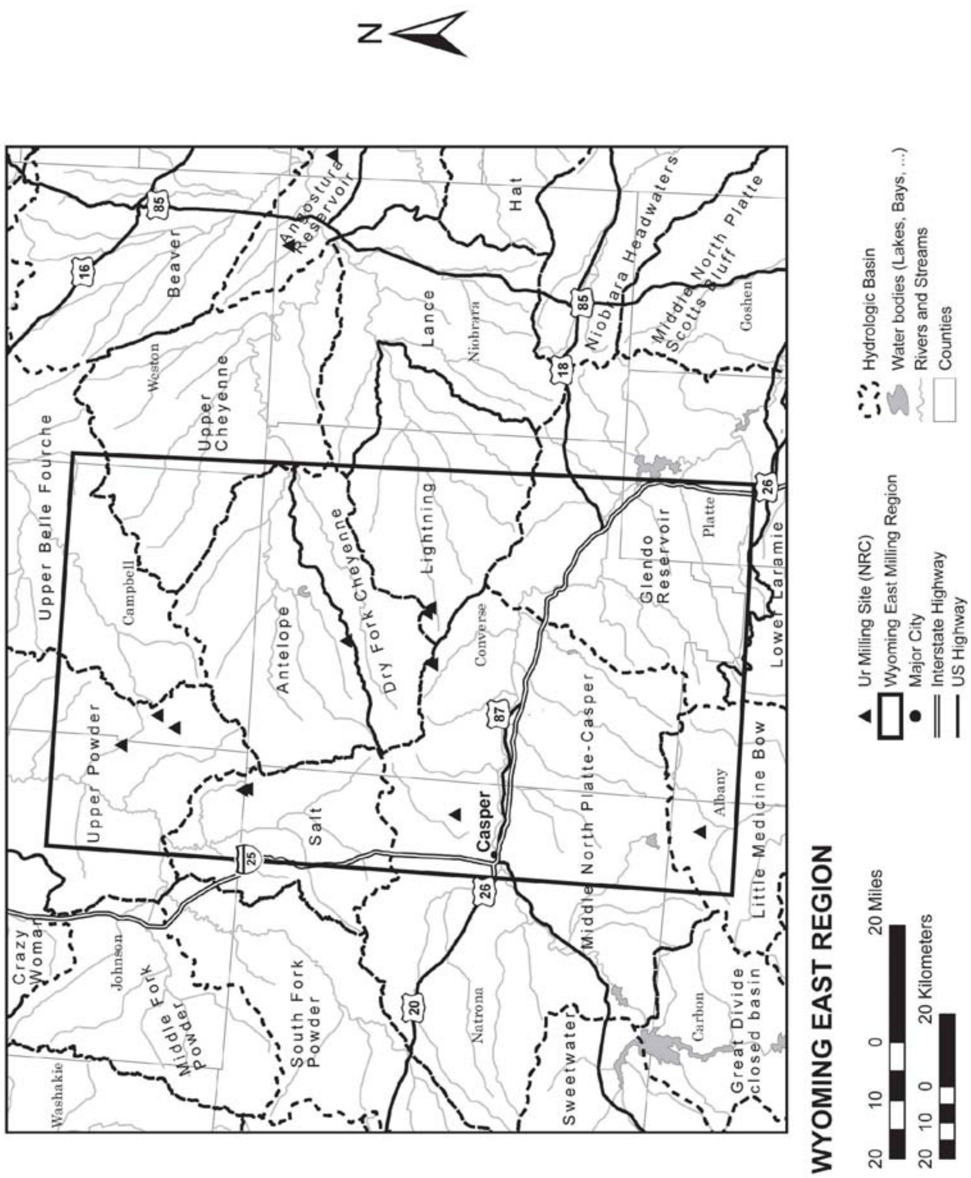


Figure 3.3-6. Watersheds Within the Wyoming East Uranium Milling Region

Table 3.3-4. Primary Watersheds in the Wyoming East Uranium Milling Region Range of Designated Uses of Water Bodies Within Each Watershed	
Watershed	**Range of State Classification of Designated Uses***
Little Medicine Bow River and Tributaries	Generally 2AB with some tributaries 2B and 3C
Glendo Reservoir and Tributaries	2AB and 3B
Middle North Platte River	2AB with some tributaries 3B
Salt Creek	2C with some tributaries 3B
Lightning Creek	3B
Dry Fork Cheyenne River	3B
Antelope Creek	3B
Upper Cheyenne River	3B
Upper Powder River	2ABww with some tributaries 3B
Upper Belle Fourche River and Tributaries	2ABww and 3B

*Class 2AB waters have designated uses including Drinking Water, Game Fish, Non-Game Fish, Fish Consumption, Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Class 2A waters have designated uses including Drinking Water, Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Class 2B waters exclude Drinking Water from the Class 2AB uses. Class 2C waters exclude drinking water and game fish from the Class 2AB uses.
Class 3A, 3B and 3C waters have designated uses including Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Classes 4A, 4B and 4C waters have designated uses including Recreation, Wildlife Agriculture, Industry, Scenic Value.
Classes 2ABww and 2Bww are warm water fisheries.
Official definitions of surface water classes and uses are in Wyoming Department of Environmental Quality Water Quality Rules and Regulations, <http://soswy.state.wy.us/Rules/RULES/6547.pdf> (29 January 2009).

The historical uranium milling districts included in the Wyoming East Uranium Milling Region are the Shirley Basin within the Little Medicine Bow River Watershed in the southwest and uranium deposits in the area known as the Powder River Basin that actually includes watersheds in addition to those contributing to the Powder River. Watersheds containing historical or potential uranium milling sites are Middle North Platte-Casper, Lightning Creek, Dry Fork Cheyenne River, Antelope Creek, Salt Creek, and Upper Powder River.

The Shirley Basin uranium district is located within the Little Medicine Bow River Watershed (Figure 3.3-6) in Carbon and Albany counties. In addition to the Little Medicine Bow River, other significant surface water features associated with the Shirley Basin are Sand Creek and Muddy Creek. Several small reservoirs are located on these streams. Several unnamed springs are also shown on the topographic maps covering the Shirley Basin. The Little Medicine Bow River and most of its tributaries are generally Class 2AB waters with some classified as 2C and 3B (Table 3.3-4). The difference between Class 2AB and Class 2C waters is that Class 2C waters do not have drinking water supply or game fish as designated uses. Class 3B also excludes nongame fish and fish consumption as designated uses. Although the Little Medicine Bow River flows directly through an area of historic uranium mining and milling, it is not listed as an impacted or threatened water body (WDEQ, 2008). The average flow of the Little Medicine Bow River at Boles Spring, Wyoming, is 1.1 m^3/s [38 ft^3/s] (U.S. Geological Survey, 2008).

The Powder River Basin contains the most extensive uranium deposits in Wyoming, covering a large portion of east-central Wyoming in Converse, Campbell, and Johnson Counties. Principal watersheds within the Powder River Basin uranium district are (from south to north), Glendo Reservoir (on the North Platte River), Middle North Platte-Casper, Lightning Creek, Dry Fork of the Cheyenne River, Antelope Creek, Salt Creek, Upper Cheyenne River, Upper Belle Fourche, and Upper Powder River. The Lightning Creek, Antelope Creek, Dry Fork of the Cheyenne River, and Upper Cheyenne River watersheds contain ephemeral and intermittent streams that flow to the Cheyenne River east of the uranium districts in the Powder River Basin. Other surface water features in these watersheds include stock ponds. The ephemeral and intermittent water bodies are generally Class 3B. These watersheds include areas of oil and natural gas as well as coal bed methane development.

The Middle North Platte-Casper watershed is drained by the North Platte River, which is fed by numerous small tributaries. The North Platte River and most of its tributaries are classed as 2AB (Table 3.3-4). Portions of the North Platte River and some tributaries are impacted by elevated selenium concentrations (WDEQ, 2008). The flow of the North Platte River is not measured in this watershed. The Middle North Platte-Casper watershed is located within the area covered by the Platte River Recovery Implementation Program. The purpose of this program is to manage the land and water resources within the Platte River Basin to support the U.S. Fish and Wildlife Service recovery plan for four target species (interior least tern, whooping crane, piping plover, and pallid sturgeon) listed as threatened or endangered species (Platte River Recovery Implementation Program, 2006). The cooperative agreement between the federal agencies and the states of Colorado, Nebraska, and Wyoming requires that federal agencies consult with the U.S. Fish and Wildlife Service on federally licensed or permitted water projects within the Platte River Recovery Implementation Program area.

The Salt Creek watershed is located north of Casper, Wyoming, in Natrona County, upstream from the Upper Powder River watershed. Salt Creek is a Class 2C water body (Table 3.3-4). The water quality of Salt Creek is impaired due to elevated chloride and threatened by oil and grease attributed to oil and natural gas production in the watershed. Flow in Salt Creek is not measured.

The Upper Belle Fourche River watershed is located in the northeastern portion of the Wyoming East Uranium Milling Region in Campbell County (Figure 3.3-6). The Upper Belle Fourche River in Wyoming is classed as 2ABww where “ww” indicates “warm water fishery” (Table 3.3-4). Water quality in some portions of the Upper Belle Fourche River is listed as impaired due to fecal coliform from livestock grazing east of the Wyoming East Uranium Milling Region (WDEQ, 2008). Average flow in the Upper Belle Fourche River at Moorcroft, Wyoming (just east of the Wyoming East Uranium Milling Region), for water years 1991 through 2008 is 0.62 m^3/s [22 ft^3/min] (U.S. Geological Survey, 2008).

The Upper Powder River watershed is located downstream of the Salt Creek watershed in Johnson and Campbell Counties. The Upper Powder River is classified as 2ABww with its smaller tributaries classified as 3B (Table 3.3-4). The Upper Powder River is listed as impacted by high chloride (WDEQ, 2008). Annual average flow in the Upper Powder River at Sussex, Wyoming, varied between 2.4 and 14 m^3/s [86 and 487 ft^3/s] between 1939 and 2007 (U.S. Geological Survey, 2008).

3.3.4.2 Wetlands and Waters of the United States

The majority of waterways in this region are composed of ephemeral and intermittent streams. Some perennial slow moving rivers are also present in the region. Regulatory guidance and jurisdictional determination are the same as those found in Section 3.2.4.2 for the Wyoming West Uranium Milling Region.

Freshwater emergent marshes are found in depressions, as fringes around lakes, and sloughs along slow-moving streams. These wetlands maybe temporarily to permanently inundated and are typically dominated by floating-leaved plants in deeper areas (e.g., *Lemna*, *Potamogeton*, *Brasenia*, *Nuphar*) and sedges (*Carex, Cyperus, Rhynchospora*), bulrushes (*Scirpus*, *Schoenoplectus*), spikerushes (*Eleocharis*), cattails (*Typha*), rushes, (*Juncus*), and grasses (e.g., *Phalaris*, *Spartina*) in seasonal wetlands (USACE, 2006).

Floodplain and riparian systems occur along rivers and streams across the Wyoming East Uranium Milling Region. Common woody species in riparian and floodplain wetlands in the region include plains cottonwood (*Populus deltoides* ssp. *monilifera*), narrowleaf cottonwood (*P. angustifolia*), various willows, green ash (*Fraxinus pennsylvanica*), cedar elm, eastern swampprivet (*Forestiera acuminata*), and the introduced saltcedar (*Tamarix ramosissima*) (USACE, 2006).

Waters of the United States and special aquatic sites that include wetlands would need to be identified and the impact delineated upon individual site selection. Based on impacts and consultation with each area, appropriate permits would be obtained from the local USACE district. Section 401 state water quality certification is required for work in Waters of the United States. Within this region, the State of Wyoming regulates isolated wetlands and waters. Cumulative total project impacts greater than .4 ha [1 acre] would require a general permit for wetland mitigation by the WDEQ.

3.3.4.3 Groundwater

Groundwater resources in the Wyoming East Uranium Milling Region are part of regional aquifer systems that extend well beyond the areas of uranium milling interest in this part of Wyoming. Uranium-bearing aquifers exist within these regional aquifer systems in the Wyoming East Uranium Milling Region. This section provides a general overview of the regional aquifer systems to provide context for a more focused discussion of the uranium-bearing aquifers in the Wyoming East Uranium Milling Region, including hydrologic characteristics, level of confinement, groundwater quality, water uses, and important surrounding aquifers.

3.3.4.3.1 Regional Aquifer Systems

The location of the Wyoming East Uranium Milling Region is shown in Figures 3.3-1 and 3.3-2. The Northern Great Plains aquifer system is the major regional aquifer system in the Wyoming East Uranium Milling Region. The Northern Great Plains aquifer system extends over one-third of Wyoming (Whitehead, 1996).

Whitehead (1996) grouped the Northern Great Plains aquifer system into five major aquifers. These aquifers, from shallowest to deepest, are the Lower Tertiary, Upper Cretaceous, Lower Cretaceous, Upper Paleozoic, and Lower Paleozoic aquifers. The Lower Tertiary aquifers consist of sandstone beds within the Wasatch Formation and the Fort Union Formation. Both formations consist of alternating beds of sandstone, siltstone, and claystone and beds containing lignite and subbituminous coal, but most water is stored in and flows through the more permeable sandstone beds. In the Powder River Basin, the Fort Union Formation and the Wasatch Formation are as thick as 1,095 and 305 m [3,600 and 1,000 ft], respectively. In the Lower Tertiary aquifers, the regional groundwater flow direction is northward and northeastward from recharge areas in northeastern Wyoming. Recharge to the aquifer is by precipitation in outcrop areas, water seeps from streambeds, and local irrigation. Discharge from the aquifer system is mainly by upward leakage of water into the shallower aquifers. The clinker layers that consist of fractured rocks along the coal outcrop appear to be a recharge area to the coal beds.

The Upper Cretaceous aquifers consist of sandstone beds interbedded with siltstone and claystone in the Lance and the Hell Creek Formations and the Fox Hills Sandstone, which are 105 to 1,035 m [350 to 3,400 ft] and 90 to 135 m [300 to 450 ft thick]. The Fox Hills Sandstone is one of the most continuous water-yielding formations in the Northern Great Plains aquifer system. Groundwater in the Upper Cretaceous aquifers moves from aquifer recharge areas at higher altitudes toward discharge areas along major rivers. The general groundwater flow direction is northward in the Powder River Basin. In Wyoming, the potentiometric surface of the Lower Tertiary aquifers is locally 122 m [400 ft] higher than that of the underlying upper Cretaceous aquifers. Hence, groundwater moves locally vertically downward from the lower Tertiary aquifers into the Upper Cretaceous aquifers through the confining layer separating these two aquifers.

The Lower Cretaceous aquifers are separated from the overlying Upper Cretaceous aquifers by several thick confining units. The Pierre Shale, the Lewis Shale, and the Steele Shale are the regionally thickest and most extensive confining units. Water across the Pierre Shale can leak into the underlying Lower Cretaceous aquifers where the Pierre Shale is fractured.

The Lower Cretaceous aquifers are the most widespread aquifers in the Northern Great Plains aquifer system and contain several sandstones. The principal water-yielding units are the Muddy Sandstone and the Inyan Kara Group in the Powder River Basin. The Lower Cretaceous aquifers contain little freshwater. The water becomes saline in the deep parts of the Powder River Basin. Locally, the Sundance, Swift, Rierdon, and Piper Formations yield small to moderate quantities of water.

The Paleozoic aquifers cover a larger area, but they are deeply buried in most places and contain little freshwater. They are divided into Upper Paleozoic aquifers and Lower Paleozoic aquifers. In much of the Powder River Basin, the Upper and Lower Paleozoic aquifers are hydraulically connected and locally are called the Madison Aquifer System.

The Upper Paleozoic aquifers are confined everywhere except in recharge areas. They consist primarily of the Madison Limestone, the Tensleep Sandstone in the western parts of the Powder River Basin, and sandstone beds of the Minnelusa Formation in the eastern part of the Powder River Basin. The Pennsylvanian sandstones yield less water than the Madison Limestone and contain freshwater locally at the outcrop areas. Pennsylvanian rocks are not usually considered to be a principal aquifer. In the Upper Paleozoic aquifers, the regional groundwater flow direction is northeastward from recharge areas where the aquifers crop out adjacent to structural uplifts near the southern and western limits of the aquifer system.

Lower Paleozoic aquifers consist of sandstone and carbonate rocks. The principal geologic units that compose the Lower Paleozoic aquifers are the Flathead Sandstone, sandstone beds of the Winnipeg Formation, limestones of the Red River and the Stonewall Formations, and the

Bighorn and the Whitehead Dolomites. The groundwater flow direction is generally northeastward. Lower Paleozoic aquifers contain freshwater only in a small area in north-central Wyoming. These aquifers contain slightly saline to moderately saline water throughout the southern half of their extent.

The Madison Limestone exhibits karst features (features formed by the dissolution of a layer or layers of soluble bedrock, usually carbonate rock such as limestone or dolomite) at the outcrop areas in north-central Wyoming (Wyoming East Uranium Milling Region). Several large springs formed from some of the solution conduits in the Madison Limestone, including the Thermopolis hot springs system in central Wyoming with a discharge rate of about 11,355 L/min [3,000 gal/min] of geothermal water.

Recharge to the aquifers in most of the area is likely small, due to low annual precipitation and high evaporation. The mean annual precipitation in the Wyoming East Uranium Milling Region is typically in the range of 28–38 cm/yr [11–15 in/yr], but at high elevations, it locally exceeds 50 cm/year [20 in/year] based on precipitation data from 1971 to 2000. The evaporation rate was estimated to be 105.9±7.1 cm/year [41.7±2.8 in/year] using the Kohler-Nordenson-Fox equation with data from the station in Lander, Wyoming (Curtis and Grimes, 2004).

3.3.4.3.2 Aquifer Systems in the Vicinity of Uranium Milling Sites

The hydrogeological system in areas of uranium milling interest in the Wyoming East Uranium Milling Region consists of a thick sequence of primarily sandstone aquifers and shale aquitards. Uranium-bearing sandstone aquifers in the Fort Union Formation at the active uranium milling sites are also important for water supplies in the milling region.

Areas of uranium milling interest at the Reynolds and Smith Ranch areas are underlain, from shallowest to deepest, by the alluvium, the Wasatch Formation, the Fort Union Formation, the Lance Formation, and the Fox Hills Formation. The alluvium has a thickness of 0–9 m [0–30 ft] and has small yields in stream valleys. The Wasatch Formation and the Fort Union Formation contain important sandstone aquifers for water supplies. Groundwater production from the Lance and the Fox Hills Formations is largely unknown at the ISL facilities in the Reynolds and Smith Ranch areas in Converse County (Power Resources, Inc., 2004).

As discussed in Section 3.3.4.3.1, this aquifer system is separated from the underlying aquifers including, from shallowest to deepest where they are continuous, the Muddy Sandstone, the Inyan Kara Group, and the Paleozoic aquifers by shale layers. The Paleozoic aquifers are deeply buried in most places and contain little freshwater (Whitehead, 1996).

3.3.4.3.3 Uranium-Bearing Aquifers

Uranium mineralization at locations of milling interest is typically hosted by Paleocene-age confined sandstone aquifers (at the Smith Ranch and Reynolds Ranch ISL sites) or Eocene-age confined sandstone aquifers (at the Irigaray and Christensen Ranch ISL sites) in the Wyoming East Uranium Milling Region.

Confined sandstone beds in the Fort Union Formation are the uranium-bearing aquifers at the Smith Ranch and Reynolds Ranch ISL sites in Converse County. The Fort Union Formation contains multiple confined sandstone aquifers in the eastern and northeastern parts of the permit area at the Smith Ranch and Reynolds Ranch ISL sites, but it is unconfined in the southwestern and western parts. Among the confined sandstone aquifers, the U- and

S-Sandstones are the primary uranium mineralization zone, and they are referred to as the U/S sand. O-Sandstone aquifers also contain economic uranium mineralization in the Fort Union Formation (NRC, 2006). Confined sandstone units in the Wasatch Formation are the uranium-bearing units at the Irigaray and Christensen Ranch ISL sites. These units are L, K, and J fluvial units in an ascending order at the Christensen Ranch ISL site and these fluvial units correspond to the Lower Irigaray sandstone, the Upper Irigaray sandstone, and the Unit 1 sandstone at the Irigaray Ranch ISL site. The K unit is the primary uranium mineralization zone (Cogema Mining, Inc., 1998).

For ISL operations to begin, portions of the uranium-bearing sandstone aquifers in the Fort Union Formation in the Wyoming East Uranium Milling Region would need to be exempted by the UIC program administered by WDEQ (Section 1.7.2.1).

Hydrogeological characteristics: In the Wyoming East Uranium Milling Region, the production aquifer system typically consists of confined sandstone aquifers. Aquifer properties (e.g., transmissivity, thickness, storage coefficient) vary spatially in the region.

At the Smith Ranch and Reynolds Ranch areas, the mean effective transmissivity of the U/S sandstone aquifer and O-sandstone aquifer is 6,700 L/day/m {8.2 m^2/day [540 gal/day/ft} and 7,900 L/day/m {9.7 m^2/day} [640 gal/day/ft]}, respectively. The storage coefficient for the U/S sandstone aquifer and O-sandstone aquifer ranges between 1.5×10^{-5} and 1.7×10^{-5} and 6.3×10^{-5} and 7.8×10^{-5}, respectively, indicating the confined nature of the production aquifer (typical storage coefficients for confined aquifers range from 10^{-5} to 10^{-3} (Driscoll, 1986, p. 68). The average groundwater velocities through the U/S-sandstone aquifer and O-sandstone aquifer were reported to be 2.4 and 0.17 m/yr [8 and 0.56 ft/yr] (NRC, 2006). The approximate thickness of the Fort Union Formation is 910–1,100 m [3,000–3,600 ft] in the Powder River Basin (PRI, 2004; Whitehead, 1996). Groundwater production from the Fort Union Formation is generally good with water yields as high as 2,080 L/min [550 gal/min] (PRI, 2004; NRC, 2006).

The average thickness of the K unit is 54 m [180 ft]. The K unit has a mean hydraulic conductivity of 0.13 m/day [0.42 ft/day] (Cogema Mining, Inc., 1998).

Level of confinement: The production aquifer is typically confined in the Wyoming East Uranium Milling Region. The thickness of the confinement varies spatially.

At the Smith Ranch and Reynolds Ranch ISL sites, the U/S sandstone is confined above by a 6- to 20-m [20- to 70-ft]-thick shale aquitard (V Shale). It is confined below by a 45-m [150-ft]-thick shale aquitard (R Shale) (NRC, 2006). Aquifer tests revealed that the confining shale members would be effective aquitards to the vertical movement of leaching solution (Power Resources Inc., 2006, 2005).

At the Irigaray and Christensen Ranch ISL sites, the K unit is confined above by a 23-m [76-ft]-thick aquitard. It is confined below by a 27-m [90-ft]-thick aquitard. The vertical hydraulic conductivity of the upper confining layer ranges from 8.2×10^{-6} to 1.1×10^{-4} m/day [27×10^{-6} to 3.6×10^{-4} ft/day]. The vertical hydraulic conductivity of the lower confining layer ranges from 7.4×10^{-6} to 1.2×10^{-3} m/day [24×10^{-6} to 3.9×10^{-3} ft/day]. The confining strata are continuous over the commercial area of the Irigaray and Christensen Ranch ISL sites (Cogema Mining, Inc., 1998).

As discussed in Section 3.3.4.3.1, the aquifer sequence that includes, from the shallowest to deepest, the Wasatch Formation, the Fort Union Formation, the Lance Formation, and the Fox Hills Formation are confined below by regionally extensive and thick low permeability layers that include the Pierre Shale, the Lewis Shale, and the Steele Shale. The vertical hydraulic conductivity of the Pierre Shale is reported to be 1.5×10^{-8} to 1.5×10^{-4} m/day [5×10^{-8} to 5×10^{-4} ft/day] outside the Wyoming East Uranium Milling Region (Kansas Geological Survey, 1991). The Pierre Shale is fractured in some parts of the region and may leak water to the underlying lower Cretaceous aquifers (Whitehead, 1996). Hence, where the Pierre Shale is fractured, the aquifer sequence may not be effectively confined below.

Groundwater quality: In some parts of the Wyoming East Uranium Milling Region, the total dissolved solids (TDS) levels in the uranium-bearing aquifers exceed the EPA’s drinking water standards. The uranium and radium-226 concentrations in the uranium-bearing aquifers typically exceed their respective EPA Maximum Contaminant Levels.

At the Smith Ranch and Reynolds Ranch ISL area, the water quality is usually good in the U/S-sandstone and O-sandstone aquifers and meets the EPA’s drinking water standards except for radium-226. Radium-226 naturally exists in the U/S sandstone and O-sandstone aquifers at a level of 296 pCi/L and 86 pCi/L, respectively, which exceeds the EPA’s primary drinking water standard of 5 pCi/L. Both aquifers have TDS ranging from 234–952 mg/L [234–952 ppm] {the limit of dissolved solids recommended by the EPA for drinking water is 500 mg/L [500 ppm]} (NRC, 2006).

At the Irigaray and Christensen Ranch ISL sites, the TDS concentrations are usually below the drinking water standard, but groundwater is not considered as potable in the ore production zone due to elevated concentrations of radium-226 in excess of the EPA primary drinking standards of 5 pCi/L.

Current groundwater uses: In the vicinity of the Smith Ranch and Reynolds Ranch ISL area permit area, groundwater is largely pumped for livestock watering, and to a lesser extent, for domestic water supply (NRC, 2006).

3.3.4.3.4 Other Important Surrounding Aquifers for Water Supply

At the regional scale, the Wasatch Formation and the Fort Union Formation are important aquifers for water supplies. The Fox Hills Sandstone is one of the most continuous water-yielding formations in the Northern Great Plains aquifer system. Except at outcrop areas, the Paleozoic aquifers are not usually used for water production, because they are either deeply buried or contain saline water (Whitehead, 1996).

At the ISL facilities in the Reynolds and Smith Ranches, the Wasatch Formation and the Fort Union Formation contain important sandstone aquifers for water supplies. The thickness of the Wasatch Formation ranges from 0–150 m [0–500 ft] and yields as high as 530 L/min [140 ga/min]. Water yields from the Lance Formation and the Fox Hills Formation are largely unknown at the Reynolds and Smith Ranch areas. The thickness of the Lance Formation is about 915 m [3,000 ft], and its water yield is estimated to not exceed 75 L/min [20 gal/min]. The thickness of the underlying Fox Hills Formation is about 150–210 m [500–700 ft], and its water yield is estimated to not exceed 380 L/min [100 gal/min] (PRI, 2004 and the references therein).

3.3.5 Ecology

3.3.5.1 Terrestrial

Wyoming East Uranium Milling Flora

According to the EPA, the identified ecoregions in the Wyoming East Uranium Milling Region primarily consist of Wyoming Basin, Northern Great Plains, Southern Rockies, and the Western High Plains ecoregions (Figure 3.3-7). Uranium milling districts in this region are generally found in the Rolling Sagebrush Steppe and the Powder River Basin of the Wyoming Basin. Habitat types and species found in these areas are based on the Wyoming Gap Analysis project (Wyoming Geographic Information Science Center, 2007) as described in Section 3.2.5.

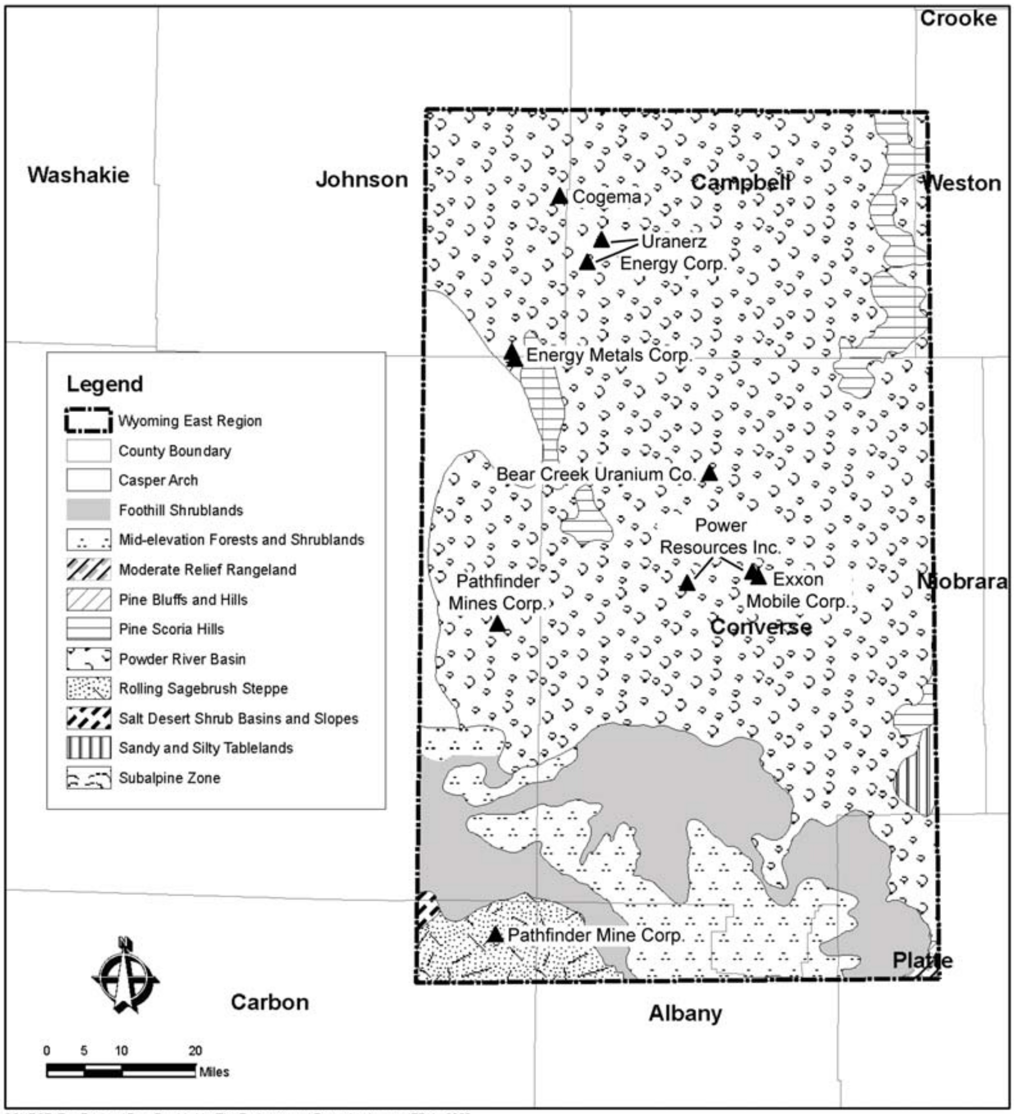
The Rolling Sagebrush Steppe and the Salt Desert Shrub Basin ecoregions of the Wyoming Basin have been described in the Wyoming West Uranium Milling Region (Section 3.2.5). An excellent description of the Wyoming East Uranium Milling Region Fauna is provided by Chapman, et al. (2004) and is summarized next.

The Southern Rockies are characterized by rugged, steep mountains, intermontane depressions and open meadows, and high-elevation plateaus. Ponderosa pines are found at lower elevations with pinyon-juniper woodlands below that grasslands are located in the lowest areas. Lodgepole pine is more common in the Middle Rockies region; white pine (*Pinus* spp.), grand fir (*Abies grandis)*, and cedar, prevalent in the Northern Rockies region, are absent from the alpine zone. A greater portion of the Middle Rockies is used for summer grazing of livestock (Chapman, et al., 2004).

The Subalpine Forests ecoregion of the Southern Rockies is a forested area found on the steep forested slopes of the Medicine Bow and Sierra Madre Mountains with a greater extent on the north slopes. The dense forests are dominated by lodgepole pine, Englemann spruce and subalpine fir; some areas are locally dominated by aspen (*Populus tremula*). Whortleberry dominates the forest understory. Subalpine meadows also occur in some areas (Chapman, et al., 2004).

The Mid-Elevation Forests and Shrublands ecoregion of the Southern Rockies is found in the 2,300 to 2,750 m [7,500 to 9,000 ft] elevation range within the Laramie, Medicine Bow, and Sierra Madre mountains. Vegetation located in the region from the southwest to northeast are composed of aspen, Douglas fir, lodgepole pine, limber pine (*Pinus flexilis*), and ponderosa pine. Due to the increased availability of moisture ponderosa pine grows mainly on the eastern slopes of the Laramie Mountains, as it does on the eastern Bighorn Mountains. The understory is composed of grasses and shrubs. Perennial streams are diverted for irrigation in lower elevations and are often dry in their lower reaches in the summer (Chapman, et al., 2004).

The Foothill Shrublands ecoregion of the Southern Rockies is a transition between the higher elevation forests of the Laramie, Medicine Bow, and Sierra Madre Mountains and the more arid grassland and sagebrush regions in the Wyoming Basin and the High Plains. On the east side of the Laramie Mountains, this ecoregion is a continuation of high plains prairie grasslands of blue grama, prairie junegrass, and western wheatgrass interspersed with mountain big sagebrush and mountain mahogany shrubland. Pockets of aspen, limber pine, and Douglas fir are often found on north-facing slopes. Riparian vegetation along the water courses originating in higher mountains include willow species and narrowleaf cottonwood, with boxelder (*Acer*



SOURCE: Eco Regional Data Provided by The Environmental Protection Agency (EPA) - 2005

Figure 3.3-7. Ecoregions of the Wyoming East Uranium Milling Region

negundo) and wild plum in the north. Land use is mainly livestock grazing and some irrigated hayland adjacent to perennial streams (Chapman, et al., 2004).

The High Plains ecoregion consists of rolling plains and tablelands formed by uplift and the erosion of the Rocky Mountains. Due to the rainshadow of the Rocky Mountains drought resistant shortgrass and mixed-grass prairie dominate the plains vegetation. Seasonal precipitation in this region generally falls during the growing season. This region occupies the southeastern corner of Wyoming where the Southern Rockies, Wyoming Basin, and the Northwestern Great Plains ecoregions meet. The boundaries of these regions fade into one another and some characteristics of each region can be found near the borders, making the boundary of the High Plains in Wyoming a transitional area.

The Moderate Relief Rangeland ecoregion of the High Plains consists of mixed-prairie vegetation dominated by grass species such as blue grama, western winter wheatgrass, junegrass, Sandberg blue grass needle-and-thread grass, prairie junegrass, and winter fat (*Ceratoides lanata*). Other species found in the prairie include rabbitbrush, fringed sage, scattered yucca, and other various forbs. Patches of mountain mahogany (*Cercocarpus* spp.) and skunkbush sumac (*Rhus trilobata*) grow on bluffs and hilltops. The plains surface steadily increases in elevation as it rises to a subtle boundary transition with the Laramie Mountains (Chapman, et al., 2004).

The Pine Bluffs and Hills ecoregion of the High Plains is composed of escarpments, bluffs, and badlands. Ponderosa pine woodland and open grasslands alternate along the rocky outcrops. Common species found in this region include little bluestem, common juniper, and bearberry (*Arctostaphylos uva-ursi*). Areas of limber pine and silver sagebrush may also be present (Chapman, et al., 2004).

The Sandy and Silty Tablelands ecoregion of the High Plains is characterized by tablelands with areas of moderate relief. This region consists of mixed-grass prairies dominated by blue grama, western wheatgrass, june grass, needle-and-thread grass, rabbit brush, fringed sage, and various forbs. Since the 1880s the ecoregion has been mainly used for livestock grazing (Chapman, et al., 2004).

The Northwestern Great Plains encompass the Missouri Plateau section of the Great Plains. This area includes semiarid rolling plains of shale and sandstone derived soils punctuated by occasional buttes and badlands. For the most part, it has not been influenced by continental glaciation. Cattle grazing and agriculture with spring wheat and alfalfa farming are common land uses. Agriculture is affected by erratic precipitation and limited opportunities for irrigation. In Wyoming, mining for coal and coal-bed methane production is prevalent, with a large increase in the number of coal-bed methane wells drilled in recent years. Native grasslands and some woodlands persist, especially in areas of steep or broken topography (Chapman, et al., 2004).

The Pine Scoria Hills ecoregion is composed of rugged broken land and stony rough hills covered by open ponderosa pine-Rocky Mountain juniper forest or ponderosa pine savannas. Coal, sandstone, and shale bedrock underlie the region. Savannas and extensive open grassland are found in areas with less available moisture. Species found in this region include little bluestem (*Schizachyrium scoparium*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), western wheatgrass, blue grama, and Sandberg bluegrass. Skunkbush sumac and western snowberry (*Symphoricarpos occidentalis*) are common shrubs.

Land use includes woodland grazing and areas of historical small-scale coal mining (Chapman, et al., 2004).

The Casper Arch ecoregion of the Northwestern Great Plains is a transitional region between the Northern Great Plains and the Wyoming Basin. Soils are weathered from sodic Cody shale; they are generally well drained to slowly permeable, and are moderately to very shallow. Shrubland dominated by sagebrush steppe, which may include Wyoming big sagebrush, Gardner saltbush (*Atriplex gardneri*), Indian ricegrass (*Oryzopsis hymenoides*), birdfoot sagebrush (*Artemisia pedatifida*), western wheatgrass, bluebunch wheatgrass, needle-and-thread grass, blue grama, Sandberg bluegrass, junegrass, rabbitbrush, fringed sage, and other grasses, forbs, and shrubs (Chapman, et al., 2004).

The Powder River Basin ecoregion of the Northwestern Great Plains covers rolling prairie and dissected river breaks surrounding the Powder, Cheyenne, and Upper North Platte Rivers. The Powder River Basin has less precipitation and less available water than the neighboring regions. Vegetation within this region is composed of mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (Chapman, et al., 2004).

Wyoming East Uranium Milling Region Fauna

The animal species that may occur in the Wyoming Basin and the Middle/Southern Rockies have been discussed previously in the Wyoming West Uranium Milling Region (see Section 3.2.5.1)

The Northwest Great Plains/Northern short grasslands region of Wyoming is home to approximately 337 different species. Many of these species are found in the adjacent Wyoming Basin Shrub Steppe (World Wildlife Fund, 2007d,e). Many of the animals in this region are associated with prairie potholes. Birds include the Ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsoni*), golden eagle, sharp tailed grouse (*Tympahuchus phasinellus*), sage-grouse, the greater prairie chicken (*Tympanuchus cupido*), numerous migratory birds such as ducks and song birds, and one of the largest breed populations of the endangered piping plover (*Charadrius melodus*). Blacktail and white tailed deer, pronghorns, bighorn sheep, American bison (*Bison bison*), bobcat (*Lynx rufus*), and cougars (*Felis concolor*) are typical large animals. This region is also known for its abundance of white-tailed prairie dog towns, which the black-footed ferret uses as a habitat (World Wildlife Fund, 2007a–e).

The Western High Plains/Western Short Grasslands is home to approximately 431 different species. Many of these spices can be found in the adjacent Northwest Great Plains region to the north. Rodents are the most numerous type of mammals of this region. These include Desert and Eastern cotton tail rabbits, gophers (*Thomonys* sp.), shrews (*Sorex* sp.), voles (*Microtus* sp.), kangaroo rats (*Dipodomys* sp.), black-tailed prairie dogs, and numerous rat and mouse species. Larger mammals include the pronghorns, elk, big horn sheep, coyote, beaver, porcupine, bobcats, and foxes. The largest diversity of animals of the region is birds. Birds include the Ferruginous hawk, Swainson's hawk, golden eagle, sharp tailed grouse, prairie chickens, wrens, kingbirds, vireos sparrows, flycatchers (*Tyrannidae* spp.), and ducks. This region contains numerous reptile and amphibians. Amphibian species include the northern cricket frog (*Acris crepitans*), leopard frog (*Rana* spp.), bull frog (*Rana catesbeiana*), Rio Grande frog (*Rana berlandieri*), narrowmouth toad (*Gastrophryne* spp.), great plains toad (*Bufo cognatus*), green toad (*Bufo debilis* spp.), tiger salamander, and Woodhouse toad. Western rattle snake ringneck snake (*Diadophis punctatus* ssp.), king snake (*Lampropeltis* spp.), hog-nose snake (*Heterodon platirhinos*), and garter snake can be found in the region. Numerous lizards and turtles are also found within the region (World Wildlife Fund, 2007 a–e).

According to the Wyoming Game and Fish Department, crucial wintering habitats are found within this region for large game mammals and nesting leks for the sage-grouse. Figures 3.3-8 to 3.3-14 show the crucial winters and yearlong ranges for large mammal found in this region. Most of the crucial areas are located either in the Thunder Basin National Grassland in the northeast portion of the region, the Medicine Bow National Forest in the Laramie Mountains, or along the North Platte River and its tributaries that traverse west-east across the lower half of the region. Within this region, the area of milling interest nearest to Casper is situated in close proximity to a crucial wintering area for antelopes. Numerous sage-grouse leks are clustered near the Pumpkin Buttes Uranium District in the northwestern part of the study region. In addition, a large concentration of leks is found in the southwestern corner of the study region in the vicinity of the Shirley Basin Uranium District.

3.3.5.2 Aquatic

Within the Wyoming East Uranium Milling Region, watersheds identified as aquatic habitat areas include the Lower Salt Creek Basin; the middle North Platte River Corridor, the La Bonte Creek and Horseshoe Creek Watersheds; and the North Platte River, Bolton Creek; and Bates Creek Watersheds. Additional information on watersheds in the region is provided in Section 3.3.4.1. The three uranium districts within the Wyoming West Uranium Milling Region are located in the following regional watersheds: Salt Creek, Middle North Platte-Casper, Lightning Creek, Dry Fork Cheyenne River, Antelope Creek, and Upper Powder River.

The Lower Salt Creek Basin located in the northeastern portion of the Wyoming West Uranium Milling Region (near theh Pumpkin Buttes Uranium District) is a relatively dry basin with little vegetation. This basin includes intermittent streams with few perennial streams. Many of the stream channels are degraded or actively degrading. Small reservoirs in the basin are dewatered for live stock and have diminished water storage capacity from sedimentation due to erosion. Native species like the fathead minnow, flathead chub, longnose dace, plains minnow, sand shiner, and white sucker are found in this watershed (Wyoming Game and Fish Department, 2007a,b).

The La Bonte Creek and Horseshoe Creek watersheds are located in the southeastern portion of the Wyoming West Uranium Milling Region. These watersheds are subject to short periods of high water flow that contribute to the scouring of stream channels leaving wide channels that decrease during low flow periods during the summer, winter and fall seasons thus limiting habitat. Native species found in the watersheds include the brassy minnow, fathead minnow, longnose dace, sand shiner, longnose sucker, stonecat and plains killifish. Sport fish that can be found in the systems include rainbow and brown trout (Wyoming Game and Fish Department, 2007a,b).

The middle North Platte River Corridor (near the Monument Hill Uranium District) is discussed for the Wyoming West Uranium Milling Region (Section 3.2.5.2).

The North Platte River, Bolton Creek, and Bates Creek watersheds are located in the southwestern portion of the Wyoming East Uranium Milling Region (in the vicinity of the Shirley Basin Uranium District). Soil erosion and sediment loading to these waterways have diminished the potential for fish to naturally reproduce. Sedimentation is further increased by erosive soils,

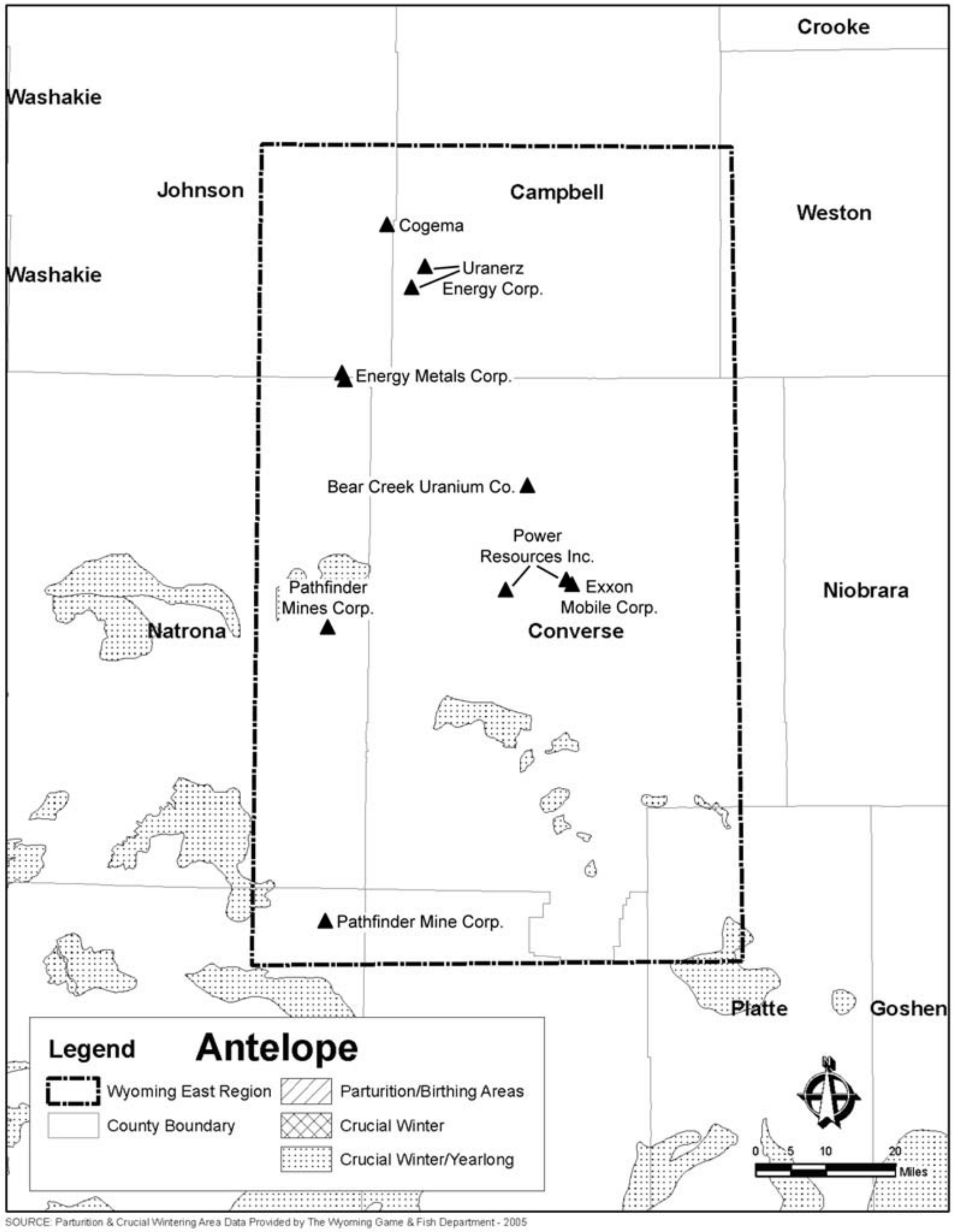


Figure 3.3-8. Antelope Wintering Area for the Wyoming East Uranium Milling Region

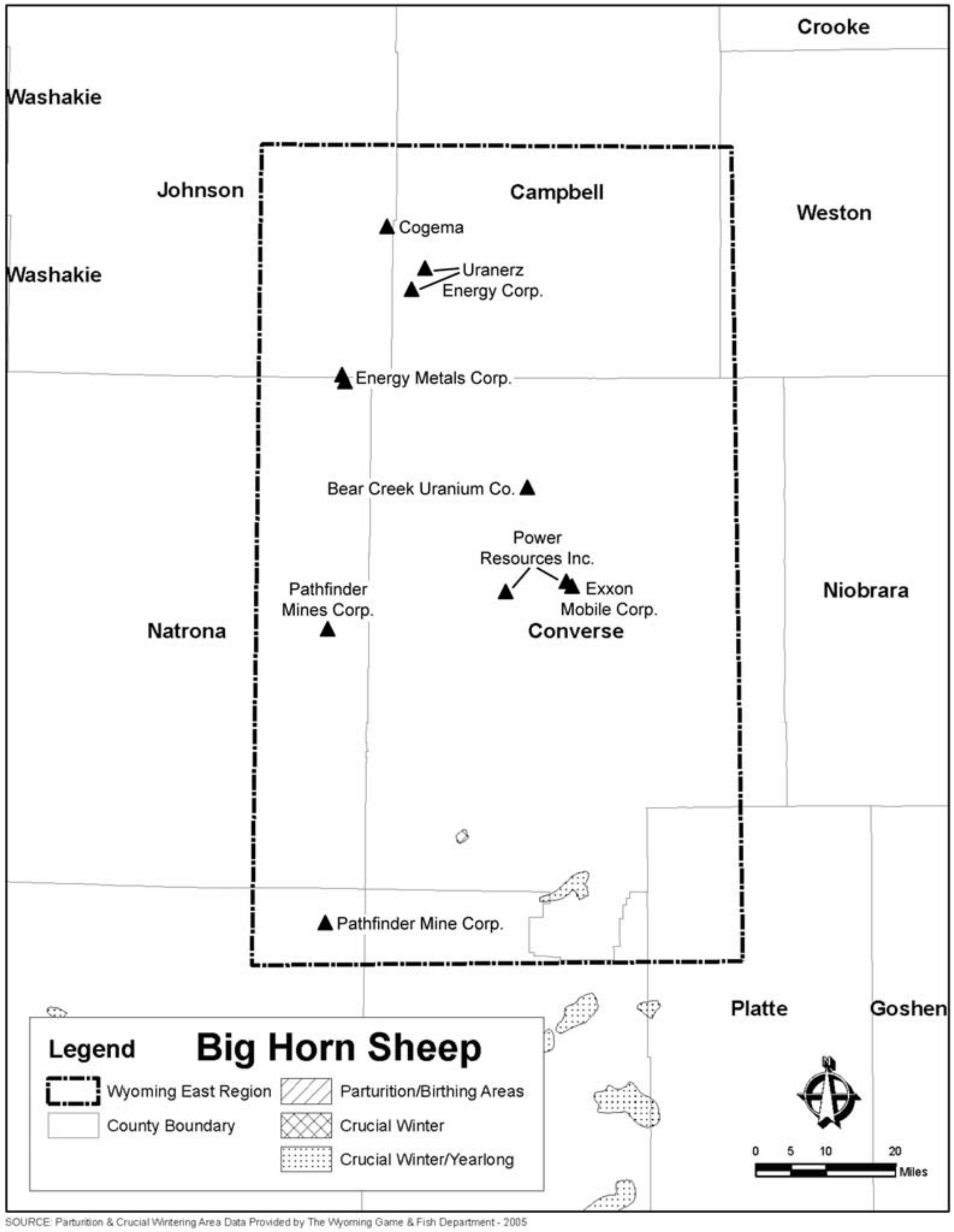


Figure 3.3-9. Big Horn Wintering Area for the Wyoming East Uranium Milling Region

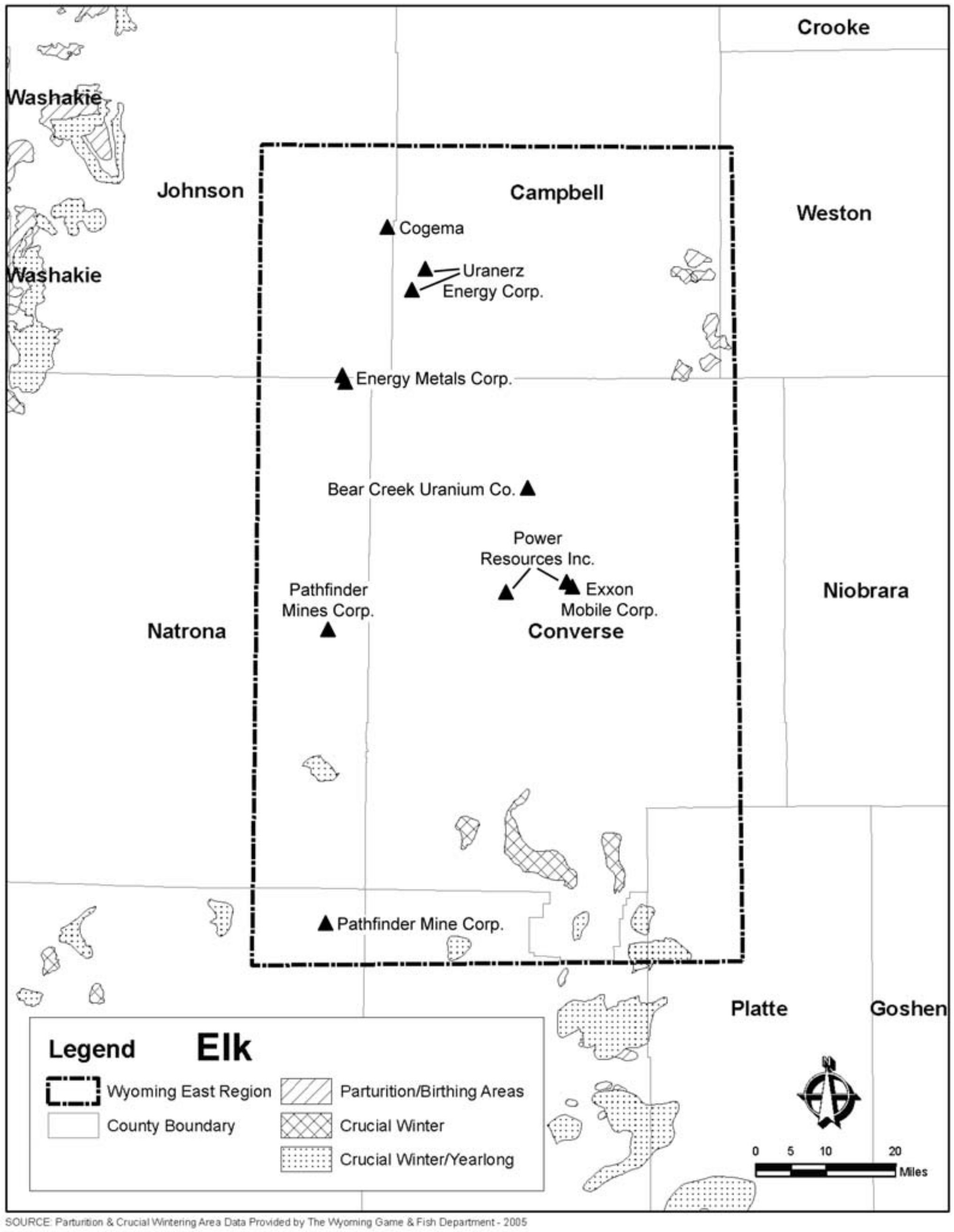


Figure 3.3-10. Elk Wintering Area for the Wyoming East Uranium Milling Region

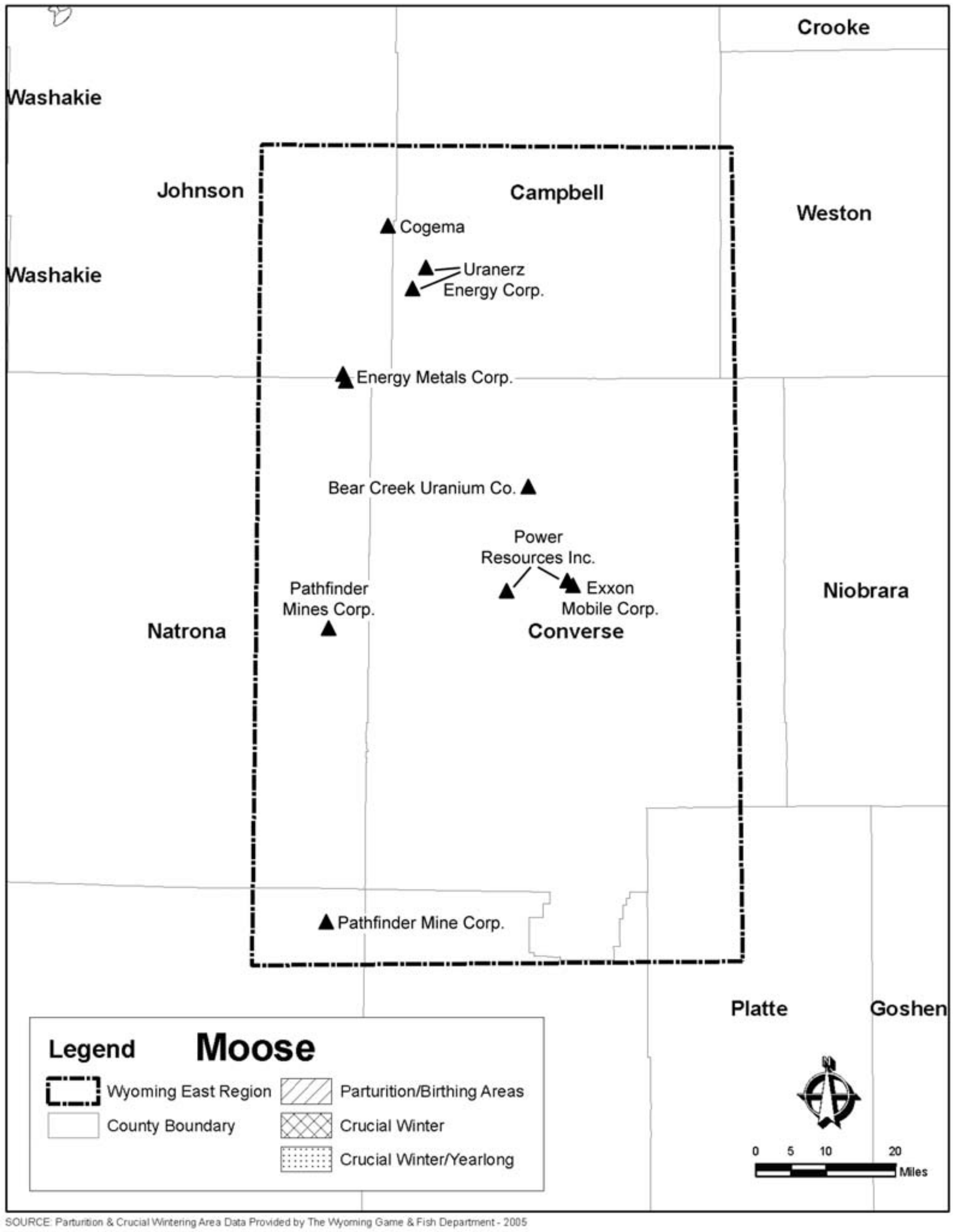


Figure 3.3-11. Moose Wintering Area for the Wyoming East Uranium Milling Region

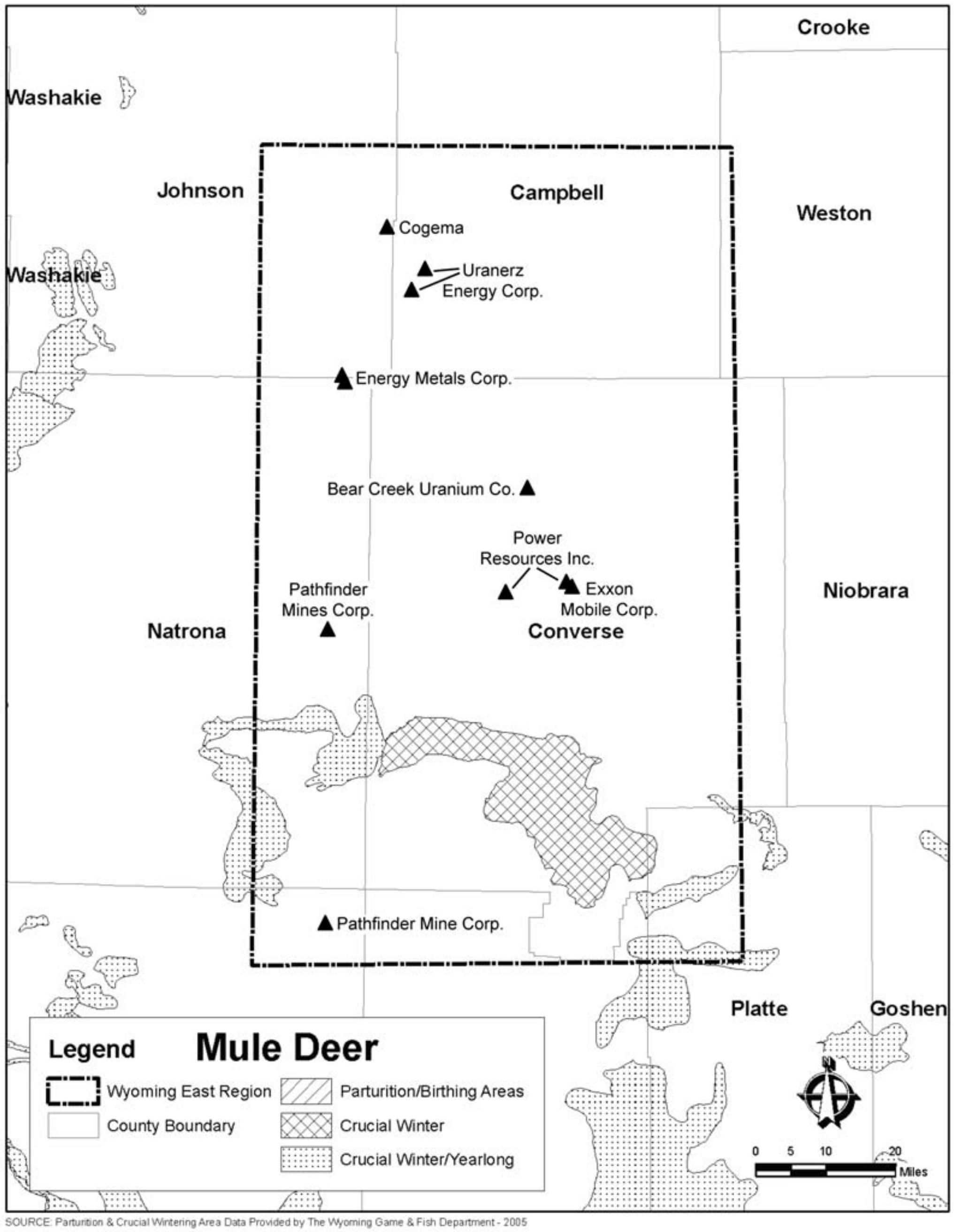


Figure 3.3-12. Mule Deer Wintering Area for the Wyoming East Uranium Milling Region

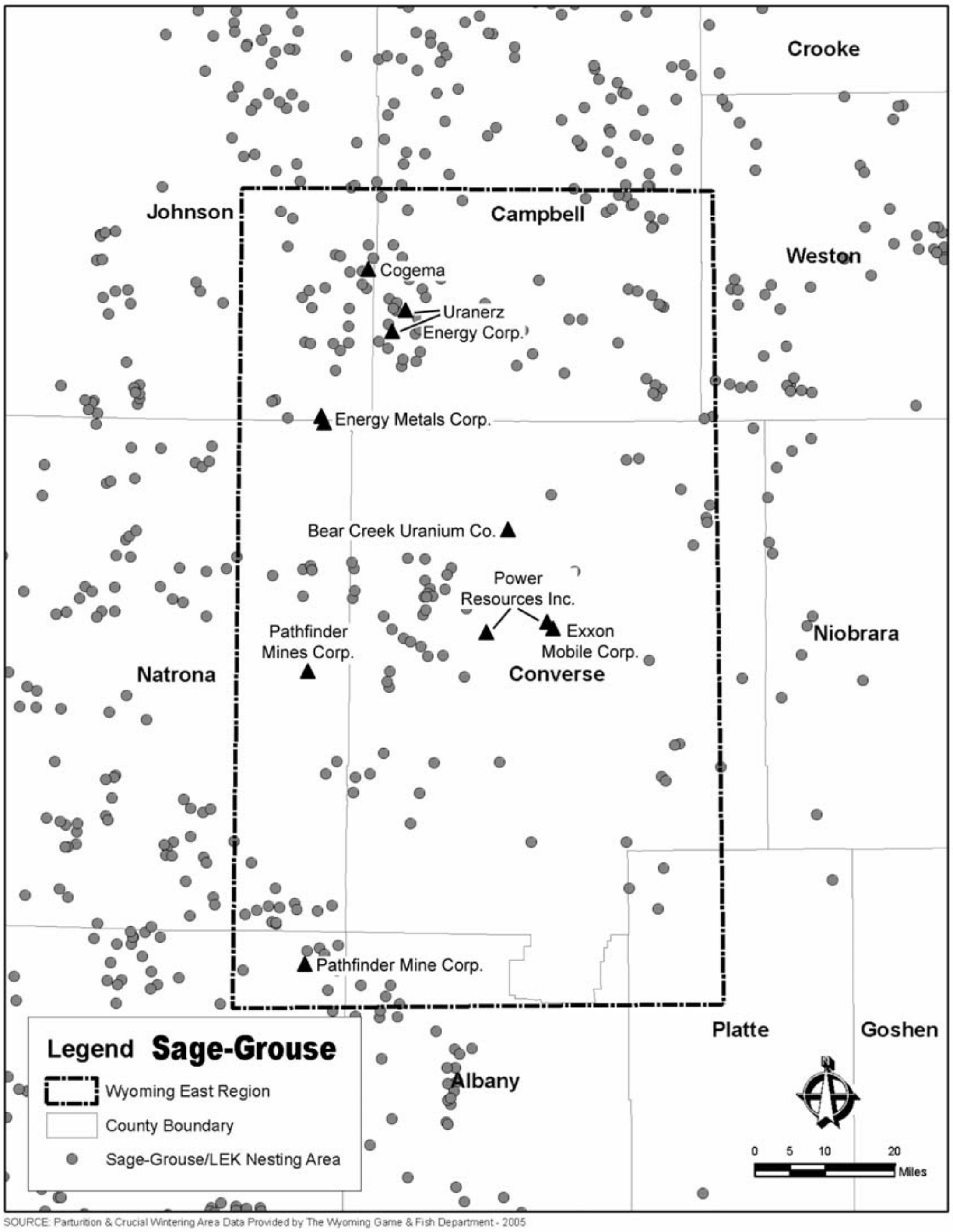
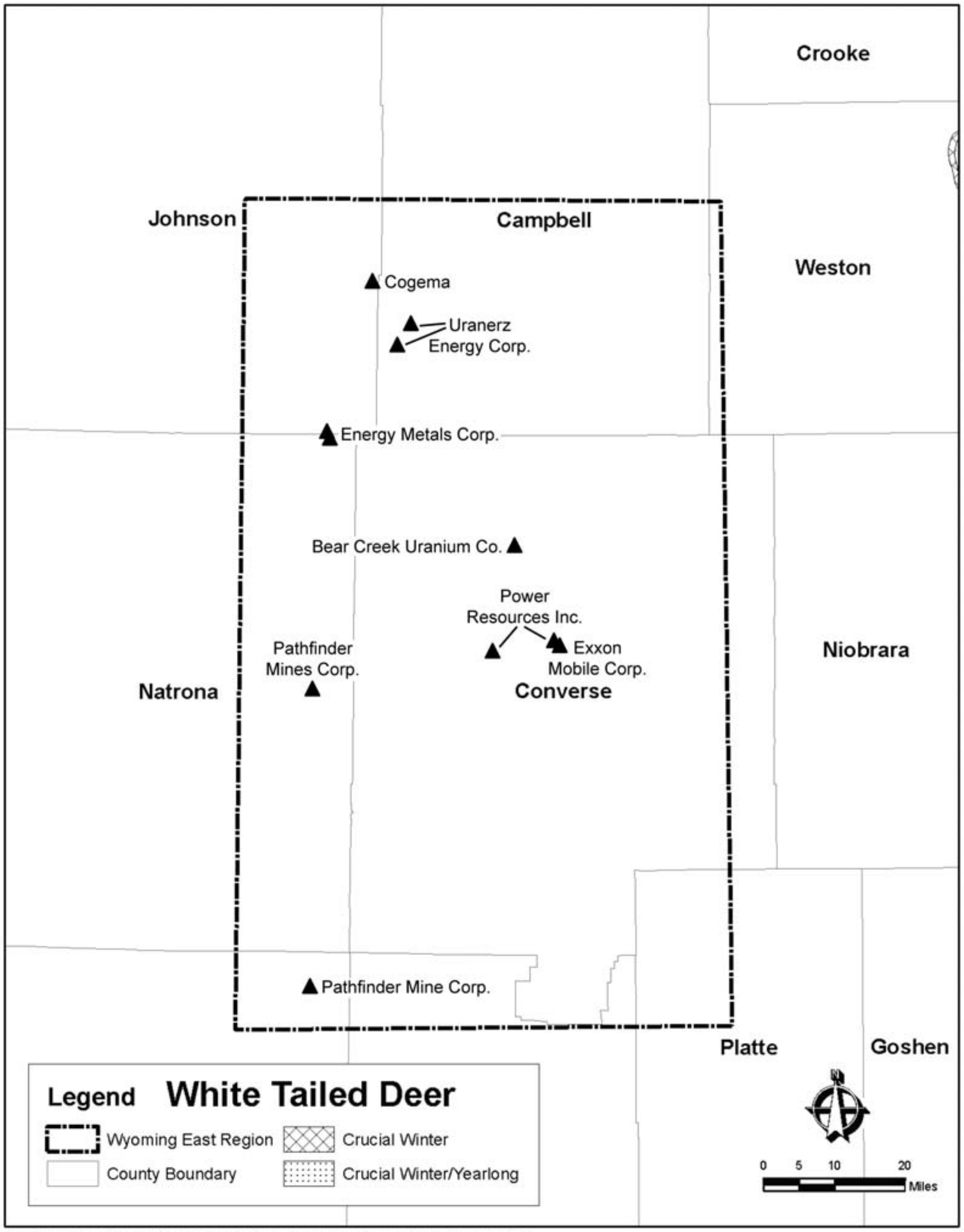


Figure 3.3-13. Sage-Grouse/Leks Nesting Areas for the Wyoming East Uranium Milling Region



SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

Figure 3.3-14. White Tailed Deer Wintering Area for the Wyoming East Uranium Milling Region

intense grazing, road density, and poorly engineered stream crossings. Native fish within these watersheds include the big mouth shiner, brassy minnow (*Hybognathus hankinsoni*), common shiner (*Notropis cornutus)*, creek chub, fathead minnow, longnose dace, sand shiner, stoneroller, longnose sucker, white sucker, and the plains killifish. Sports fish in the watershed include rainbow trout, cutthroat trout, brook trout, and green sunfish (*Lepomis cyanellus)* (Wyoming Game and Fish Department, 2007a,b).

3.3.5.3 Threatened and Endangered Species

A number of federally listed threatened and endangered species that are known to exist within habitats found with in the region have been discussed previously for the Wyoming West Uranium Milling Region in Section 3.2.5.3.

- Black Footed Ferret—discussed in Section 3.2.5.3
- Blowout Penstemon—discussed in Section 3.2.5.3
- Bonytail Chub—discussed in Section 3.2.5.3
- Canada Lynx—discussed in Section 3.2.5.3
- Colorado Butterfly Plant (*Gaura neomexicana* ssp*. Coloradensis*)—The Colorado butterfly plant typically occurs on subirrigated, stream deposited soils on level floodplains and drainage bottoms. Subpopulations are often found in low depressions or along bends in wide, active, meandering stream channels just a short distance upslope of the active channel. The plant occurs on soils derived from conglomerates, sandstones and tufaceous mudstones and siltstones of the Tertiary White River, Arikaree, and Ogalalla Formations. Average annual precipitation within its range is 33–41 cm [13–16 in] primarily in the form of rainfall. The Colorado butterfly plant requires early- to mid-succession riparian habitat experiencing periodic disturbance. It commonly occurs in communities including redtop and Kentucky bluegrass (*Poa pratensis*) on wetter sites, or wild licorice (*Aralia nudicaulis*), Flodmans's thistle (*Cirsium flodmanii*), curlytop gumweed (*Grindelia squarrosa*), and smooth scouring rush (*Equisetum laevigatum*) on drier sites (U.S. Fish and Wildlife Service, 2008).
- Colorado Pikeminnow—discussed in Section 3.2.5.3.
- Humpback Chub—discussed in Section 3.2.5.3.
- Interior Least Tern—discussed in Section 3.2.5.3.
- Pallid Sturgeon—discussed in Section 3.2.5.3.
- Piping Plover—discussed in Section 3.2.5.3.
- Preble's Meadow Jumping Mouse—discussed in Section 3.2.5.3.
- Razor Sucker—discussed in Section 3.2.5.3.
- Ute Ladies's Tresses—discussed in Section 3.2.5.3.

- Western Prairie Fringed Orchid—discussed in Section 3.2.5.3.

- Whooping Crane—discussed in Section 3.2.5.3.

- Wyoming Toad (*Bufo baxteri*)—This toad is a glacial relict found only in Albany County, Wyoming. It formerly inhabited flood plains, ponds, and small seepage lakes in the shortgrass communities of the Laramie Basin. The diet of this species includes ants, beetles, and a variety of other arthropods. Adults emerge from hibernation in May or June, after daytime maximum temperatures reach 21 °C [70 °F] (U.S. Fish and Wildlife Service, 2008).

- Yellow Billed Cuckoo—(candidate) discussed in Wyoming West Uranium Milling Region

Wyoming Species of Concern are described as Wyoming Native Species Status Matrix 1 (populations are greatly restricted or declining—extirpation appears possible) and 2 (populations are declining or restricted in numbers and/or distribution–extirpation is not imminent). Wyoming state species of concern may be found in the Wyoming East Uranium Milling Region include the following:

- Kendall Warm Spring Dace (*Rhinichthys osculus thermalis*), Native Species Status 1—It resides solely in a warm spring tributary to the Green River within the Bridger-Teton National Forest. Kendall warm springs dace are found well distributed throughout all but the upper portion of the 300-m [984-ft]-long spring creek. Kendall Warm Springs has a near constant temperature of 29 °C [85 °F]. Habitat consists of moderate to fast riffles, several man-made pools less than 1 m [3 ft] deep and shallower boggy areas. Adults are seen in the main current and pools while juveniles are seen in vegetated lateral habitats (Wyoming Game and Fish Department, 2008).

- Bluehead Sucker (*Catostomus discobolus*) Native Species Status 1—Bluehead suckers are usually found in the main current of streams, although their streamlined bodies form a narrow caudal peduncle, which indicates adaptation to living in the strong currents of larger rivers. Bluehead suckers prefer turbid to muddy streams with often high alkalinity and are rarely found in clear water (Wyoming Game and Fish Department, 2008).

- Black Footed Ferret (*Mustela nigripes*), Native Species Status 1—The black-footed ferret is found almost exclusively in prairie dog colonies in basin-prairie shrublands, sagebrush-grasslands, and grasslands. It is dependent on prairiedogs for food and all essential aspects of its habitat, especially prairie dog burrows where it spends most of its life underground (Wyoming Game and Fish Department, 2008).

- Bonneville Cutthroat (*Oncorhynchus clarki utah*), Native Species Status 2—Cutthroat trout prefer gravel-bottomed creeks and small rivers as well as lakes. The Bonneville cutthroat trout is well known for its ability to survive in harsh and often degraded (by man) habitats. In Wyoming, the Bonneville cutthroat is found in the Smith Fork and Thomas Fork drainages of the Bear River system. It is also native to some drainages in Idaho, Utah and Nevada with the bulk of its historic range within Utah (Wyoming Game and Fish Department, 2008).

- Western Silvery Minnow (*Hybognathus argyritis*), Native Species Status 2—This minnow prefers large to medium sized rivers with sluggish flow and silted bottoms. It is typically found in shallow backwaters and slow pools with sand or gravel substrates. It is more abundant in clear water and show intolerance for turbidity and pollution. Western silvery minnows occur in the Belle Fourche, Little Powder, and Little Missouri Rivers. It is believed to persist in the Powder River but recent surveys did not find them. They are believed extirpated from the Big Horn River. The western silvery minnow is associated with the more common plains minnow (Wyoming Game and Fish Department, 2008).

- Swift Fox (*Vulpes velox*), Native Species Status 4—The Swift fox historically inhabited Montana and the Dakotas through the Great Plains states to northwestern Texas and eastern New Mexico. In Wyoming, it occurs primarily east of the Continental Divide and is considered common in Wyoming. Its habitat consists of shortgrass and mixed grass prairies, although it often uses highway and railroad right-of-ways, agricultural areas, and sagebrush-grasslands. Closely associated with prairie dog colonies, the swift fox uses underground dens year round. It selects habitat with low growing vegetation, relatively flat terrain, friable soils, and high den availability. Although expected to be stable, Wyoming classifies it as Native Species Status 4 because habitat is vulnerable though there is no ongoing significant loss of habitat (Wyoming Game and Fish Department, 2008).

- Plains Topminnow (*Fundulus sciadicus*), Native Species Status 2—The plains topminnow is considered to be of special concern in Minnesota, Missouri, Kansas, Nebraska, and Colorado. In Wyoming plains topminnows are considered rare and their distribution appears to be declining. The plains topminnow occupies habitats that are impacted by natural and anthropogenic dewatering. Introductions of western mosquito fish have been implicated in the current restricted distribution of plains topminnow in Nebraska (Wyoming Game and Fish Department, 2008).

- Great Basin Gopher Snake—discussed in Section 3.2.5.3.

- Canada Lynx—discussed in Section 3.2.5.3.

- Pale Milk Snake Native Species Status 2—discussed in Section 3.2.5.3.

- Smooth Green Snake—discussed in Section 3.2.5.3.

- Yellow-Billed Cuckoo—discussed in Section 3.2.5.3.

- Greater Sage-Grouse—discussed in Section 3.2.5.3.

- Bald Eagle—discussed in Section 3.2.5.3.

- Trumpeter Swan—discussed in Section 3.2.5.3.

- Fringed Myotis—discussed in Section 3.2.5.3.

- Long-Legged Myotis—discussed in Section 3.2.5.3.

- Pallid Bat—discussed in Section 3.2.5.3.
- Spotted Bat—discussed in Section 3.2.5.3.

3.3.6 Meteorology, Climatology, and Air Quality

3.3.6.1 Meteorology and Climatology

Wyoming's elevation results in relatively cool temperatures. Much of the temperature variations within the state can be attributed to elevation with average values dropping 1 to 2 °C [1.8 to 3.6 °F] per 300 m [1,000 ft] (National Climatic Data Center, 2005]. Summer nights are normally cool although daytime temperatures may be quite high. The fall, winter, and spring can experience rapid changes with frequent variations from cold to mild periods. Freezes in early fall and late spring are typical and result in long winters and a short growing season. In the mountains and high valleys, freezes can occur any time in the summer. During winter warm spells, nighttime temperatures can remain above freezing. Valleys protected from the wind by mountain ranges can provide ideal pockets for cold air to settle and temperatures in the valley can be considerably lower that on nearby mountainsides. Tables 3.3-5 and 3.3-6 provide information on two climate stations located in the Wyoming East Uranium Milling Region.

Precipitation within Wyoming varies, with spring and early summer being the wettest time for much of the state. Mountain ranges are generally oriented in a north-south direction. This is perpendicular to the prevailing westerlies. Therefore, these mountains often act as moisture barriers. Air currents for the Pacific Ocean rise and drop much of their moisture along the

Table 3.3-5. Information on Two Climate Stations in the Wyoming East Uranium Milling Region*

Station (Map Number)	County	State	Longitude	Latitude
Glenrock 5 ESE (044)	Converse	Wyoming	105°47W	42º50N
Midwest (062)	Natrona	Wyoming	106°17W	43º25N

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

Table 3.3-6. Climate Data for Stations in the Wyoming East Uranium Milling Region*

		Glenrock 5 ESE	Midwest
Temperature (°C)†	Mean—Annual	8.8	7.5
	Low—Monthly Mean	−3.1	−5.7
	High—Monthly Mean	22.4	21.5
Precipitation (cm)‡	Mean—Annual	31.0	35.0
	Low—Monthly Mean	0.90	1.4
		Glenrock 5 ESE	**Midwest**
	High—Monthly Mean	6.1	6.5
Snowfall (cm)	Mean—Annual	58.4	135
	Low—Monthly Mean	0	0
	High—Monthly Mean	13.5	22.6

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.
†To convert Celsius (ºC) to Fahrenheit (ºF), multiply by 1.8 and add 32.
‡To convert centimeters (cm) to inches (in), multiply by 0.3937.

western slopes of the mountains. Summer showers are frequent, but typically result in rainfall amounts of a few hundredths of an inch. Usually several times a year in the state, local thunderstorms will result in 2.5 to 5 cm [1 to 2 in] of rain in a 24-hour period. On rare occasions, rainfall in a 24-hour period can reach 7.5 to 12.5 cm [3 to 5 in] (National Climatic Data Center, 2005). Heavy rains can create flash flooding in headwater streams, and this flooding intensifies if these storms coincide with snowpack melting. Table 3.3-6 contains precipitation data for two stations in the Wyoming East Uranium Milling Region. The wettest month for both stations identified in Table 3.3-6 is May, which based on the snow depth data, coincides with snowpack melting (National Climatic Data Center, 2004). One of the stations is in Converse County and the other is in Natrona County. Data from the National Climatic Data Center's Storm Events Database from 1950 to 2007 indicate that the vast majority of thunderstorms in Converse and Natrona Counties occurs between June and August with the most occurring in June (National Climatic Data Center, 2007).

Hailstorms are the most destructive storm event for Wyoming. Most hailstorms pass over open rangeland with minimal impact. When a hailstorm passes over a city or farmland, the property and crop damage can be severe. Most of the severe hailstorms occur in the southeast corner of the state.

Low elevations typically experience light to moderate snowfall from November to May. Snowfall within Wyoming varies by location with the mountain ranges typically receiving the most. Significant storms of 25 to 40 cm [10 to 16 in] of snowfall are infrequent outside of the mountains. Wind often coincides or follows snowstorms and can form snow drifts several meters [feet] deep. Snow can accumulate to considerable depths in the high mountains. Blizzards that last more than 2 days are uncommon. Table 3.3-6 contains snowfall data for two stations in the Wyoming East Uranium Milling Region.

Wyoming is windy and ranks first in the United States with an annual average speed of 6 m/s [12.9 mph]. During winter, Wyoming frequently experiences periods where wind speed reaches 13 to 18 m/s [30 to 40 mph] with gusts to 22 to 27 m/s [50 or 60 mph] (National Climatic Data Center, 2005). Prevailing wind direction varies by location but usually ranges from west-southwest through west to northwest. Because the wind is normally strong and constant from those directions, trees often lean to the east or southeast.

The pan evaporation rates for the Wyoming East Uranium Milling Region range from about 102 to 127 cm [40 to 50 in] (National Weather Service, 1982). Pan evaporation is a technique that measures the evaporation from a metal pan typically 121 cm [48 in] in diameter and 25 cm [10 in] tall. Pan evaporation rates can be used to estimate the evaporation rates of other bodies of water such as lakes or ponds. Pan evaporation rate data is typically available only from May to October. Freezing conditions often prevent collection of quality data during the other part of the year.

3.3.6.2 Air Quality

The air quality general description for the Wyoming East Uranium Milling Region is similar to the description in Section 3.2.6 for the Wyoming West Uranium Milling Region.

As described in Section 1.7.2.2, the permitting process is the mechanism used to address air quality. If warranted, permits may set facility air pollutant emission levels, require mitigation measures, or require additional air quality analyses. Except for Indian Country, New Source

Review permits in Wyoming are regulated under the EPA-approved State Implementation Plan. For Indian Country in Wyoming, the New Source Review permits are regulated under 40 CFR 52.21 (EPA, 2007a).

State implementation plans and permit conditions are based in part on federal regulations developed by the EPA. The NAAQS are federal standards that define acceptable ambient air concentrations for six common nonradiological air pollutants: nitrogen oxides, ozone, sulfur oxides, carbon monoxide, lead, and particulates. In June 2005, EPA revoked the 1-hour ozone standard nationwide in all locations except certain Early Action Compact Areas. None of the 1-hour ozone Early Action Compact Areas are in Wyoming. States may develop standards that are stricter or supplement the NAAQS. Wyoming has a more restrictive annual average standard for sulfur dioxide at 60 $\mu g/m^3$ [1.6×10^{-6} oz/yd^3] and a supplemental 50 $\mu g/m^3$ [1.3×10^{-6} oz/yd^3] PM_{10} standard with an annual averaging time (WDEQ, 2006).

Prevention of Significant Deterioration requirements identify maximum allowable increases in concentrations for particulate matter, sulfur dioxide, and nitrogen dioxide for areas designated as attainment. Different increment levels are identified for different classes of areas, and Class I areas have the most stringent requirements.

The Wyoming East Uranium Milling Region air quality description focuses on two topics: NAAQS attainment status and PSD classifications in the region.

All of the area within the Wyoming East Uranium Milling Region is classified as attainment for NAAQS. Figure 3.3-15 identifies counties in Wyoming and surrounding areas that are partially or entirely designated as nonattainment or maintenance for NAAQS at the time this GEIS was prepared (EPA, 2007b). All of the area within the Wyoming East Uranium Milling Region is classified as attainment. In fact, Wyoming only has one area that is not in attainment. The city of Sheridan in Sheridan County is designated as nonattainment for PM_{10}. Portions of several Colorado counties along the southern Wyoming border are classified as not in attainment. However, the southern boundary of the Wyoming East Uranium Milling Region is north of the Wyoming/Colorado border.

Table 3.3-7 identifies the Prevention of Significant Deterioration Class I areas in Wyoming. These areas are shown in Figure 3.3-16. There are no Class I areas in the Wyoming East Uranium Milling Region (40 CFR Part 81).

3.3.7 Noise

The existing ambient noise levels in the undeveloped rural and more urban areas of the Wyoming East Uranium Milling Region would be 22 to 38 dB, similar to those described in Section 3.2.7 for the Wyoming West Uranium Milling Region. The largest community is Casper, the second largest city in Wyoming, with a population near 50,000. Smaller communities include Glenrock and Douglas, with populations between 2,000 and about 6,000 (see Section 3.3.10). Ambient noise levels in these communities would be expected to be similar to other urban areas (up to 78 dB) (Washington State Department of Transportation, 2006).

As described in Section 3.3.2, major highways in the region include Interstate 25 and U.S. Highways 20, 26, 18, and 87. Sections of these highways are multilane, limited access freeways, and traffic is highest to the east (about 7,200 vehicles per day) and north (about 5,300 vehicles per day) of Casper on Interstate 25 (Wyoming Department of Transportation,

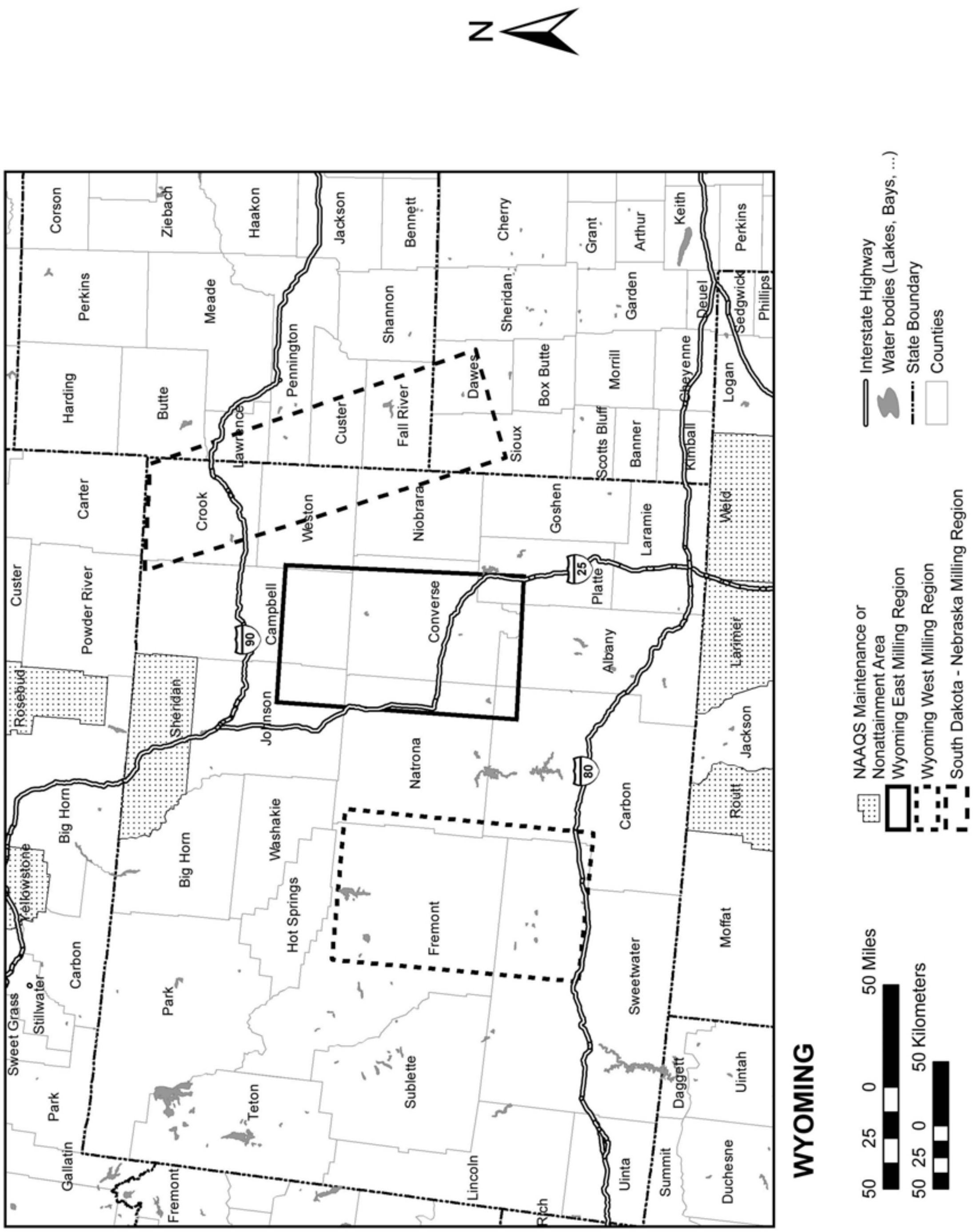


Figure 3.3-15. Air Quality Attainment Status for Wyoming and Surrounding Areas (EPA, 2007a)

Table 3.3-7. U.S. Environmental Protection Agency Class I Prevention of Significant Deterioration Areas in Wyoming*
Bridger Wilderness
Fitzpatrick Wilderness
Grand Teton National Park
North Absaroka Wilderness
Teton Wilderness
Washakie Wilderness
Yellowstone National Park
*Modified from Code of Federal Regulations. "Prevention of Significant Air Deterioration of Air Quality." Title 40, Protection of the Environment, Part 81. Washington, DC: U.S. Government Printing Office. 2005.

2005). Passenger cars make up about 75 percent of the traffic count on Interstate 25, indicating that ambient noise levels would likely be less than those measured at up to 70 dBA along Interstate 80 where traffic count and heavy truck traffic is higher (Federal Highway Administration, 2004; see also Section 3.2.7).

The current ISL uranium facilities (Smith Ranch-Highland and Reynolds Ranch) and those that are anticipated for the Wyoming East Uranium Milling Region are located at least 16 km [10 mi] from the larger communities in the region. For the three uranium districts in the Wyoming East Uranium Milling Region, most of the ambient noise levels would therefore be anticipated to be similar to rural, undeveloped areas. As in the Wyoming West Uranium Milling Region, a number of small communities are located along the highways and roads that run through the region. For example, Linch, Savageton, and Sussex are located in the Pumpkin Buttes Uranium District in the northwest corner of the region. In the central uranium district, the closest small communities include Orpha and Bill, and Shirley Basin is located in the uranium district in the southeast corner of the region. Noise levels in these areas would be anticipated to be higher than the undeveloped areas (22 to 38 dB), but less than the larger urban areas like Casper and Douglas.

3.3.8 Historical and Cultural Resources

3.3.8.1 Cultural Resources Overview

A general overview of historical and cultural resources for the Wyoming East Uranium Milling Region is provided in Section 3.2.8.1. As described in Section 3.2.8.1, the Wyoming SHPO administers and is responsible for oversight and compliance with the NRHP, compliance and review for Section 106 of the NHPA traditional cultural properties review, enforcement of NAGPRA, and compliance with other federal and state historic preservation laws, regulations, and statutes.

3.3.8.2 National Register of Historic Properties and State Registers

Table 3.3-8 includes a summary of the historic properties in the Wyoming East Uranium Milling Region that are listed on the Wyoming state and/or the NRHP. Many of the sites are located in Casper, Glenrock, and Douglas, at least 16 km [10 mi] from potential and existing uranium ISL facilities. Several sites near Sussex in Johnson County are located near the uranium district in the northwest corner of the Wyoming East Uranium Milling Region.

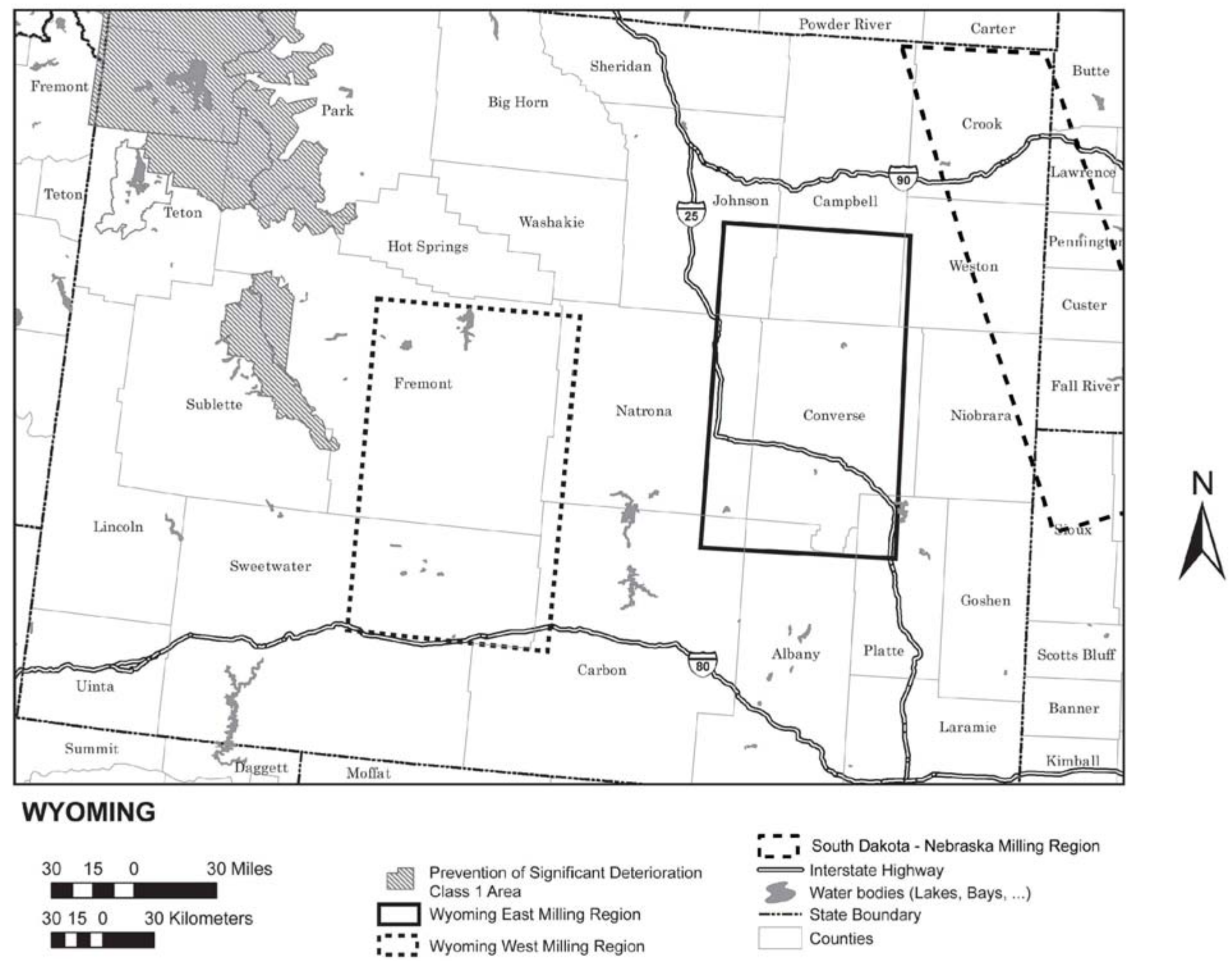


Figure 3.3-16. Prevention of Significant Deterioration Class I Areas in the Wyoming East Uranium Milling Region and Surrounding Areas (40 CFR Part 81)

Table 3.3-8. National Register Listed Properties in Counties Included in the Wyoming East Uranium Milling Region

County	Resource Name	City	Date Listed YYYY-MM-DD
Campbell	Basin Oil Field Tipi Rings (48CA1667)	Piney	1985-12-13
Campbell	Bishop Road Site (48CA1612)	Piney	1985-12-13
Campbell	Nine Mile Segment, Bozeman Trail (48CA264)	Pine Tree Junction	1989-07-23
Converse	Antelope Creek Crossing (48CO171 and 48CO165)	City Unavailable	1989-07-23
Converse	Braehead Ranch	Douglas	1995-09-07
Converse	Christ Episcopal Church and Rectory	Douglas	1980-11-17
Converse	College Inn Bar	Douglas	1979-07-10
Converse	Commerce Block	Glenrock	2005-01-21
Converse	Douglas City Hall	Douglas	1994-03-17
Converse	Fort Fetterman	Orpha	1969-04-16
Converse	Fremont, Elkhorn & Missouri Valley Railroad Passenger Depot	Douglas	1994-08-03
Converse	Glenrock Buffalo Jump	Glenrock	1969-04-16
Converse	Holdup Hollow Segment, Bozeman Trail (48CO165)	City Unavailable	1989-07-23
Converse	Hotel Higgins	Glenrock	1983-11-25
Converse	Jenne Block	Douglas	1998-01-06
Converse	La Prele Work Center	Douglas	1994-04-11
Converse	Morton Mansion	Douglas	2001-01-11
Converse	North Douglas Historic District	Douglas	2002-11-25
Converse	Officer’s Club, Douglas Prisoner of War	Douglas	2001-09-08
Converse	Ross Flat Segment, Bozeman Trail (48C0165)	City Unavailable	1989-07-23
Converse	Sage Creek Station (48CO104)	Glenrock	1989-07-23
Converse	Stinking Water Gulch Segment, Bozeman Trail (48CO165)	City Unavailable	1989-07-23
Converse	U.S. Post Office—Douglas Main	Douglas	1987-05-19
Johnson	AJX Bridge over South Fork and Powder Rivers	Kaycee	1985-02-22
Johnson	Cantonment Reno	Sussex	1977-07-29
Johnson	Dull Knife Battlefield	Barnum	1979-08-15
Johnson	EDZ Irigaray Bridge	Sussex	1985-02-22
Johnson	Fort Reno	Sussex	1970-04-28
Johnson	Lake Desmet Segment, Bozeman Trail	City Unavailable	1989-07-23
Johnson	Powder River Station—Powder River Crossing (48JO134 and 48JO801)	Sussex	1989-07-23
Johnson	Sussex Post Office and Store	Kaycee	1998-11-12
Natrona	Archaeological Site No. 48NA83	Arminto	1994-05-13
Natrona	Big Horn Hotel	Arminto	1978-12-18
Natrona	Bishop House	Casper	2001-03-12
Natrona	Bridger Immigrant Road—Waltman Crossing	Casper	1975-01-17
Natrona	Casper Army Air Base	Casper	2001-08-03
Natrona	Casper Buffalo Trap	Casper	1974-06-25
Natrona	Casper Federal Building	Casper	1998-12-21
Natrona	Casper Fire Department Station No. 1	Casper	1993-11-04
Natrona	Casper Motor Company—Natrona Motor Company	Casper	1994-02-23
Natrona	Church of Saint Anthony	Casper	1997-01-30
Natrona	Consolidated Royalty Building	Casper	1993-11-04
Natrona	DUX Bessemer Bend Bridge	Bessemer Bend	1985-02-22
Natrona	Elks Lodge No. 1353	Casper	1997-01-30

Table 3.3-8. National Register Listed Properties in Counties Included in the Wyoming East Uranium Milling Region (continued)

County	Resource Name	City	Date Listed YYYY-MM-DD
Natrona	Fort Casper	Casper	1971-08-12
Natrona	Fort Casper (Boundary Increase)	Casper	1976-07-19
Natrona	Independence Rock	Casper	1966-10-15
Natrona	Martin's Cove	Casper	1977-03-08
Natrona	Masonic Temple	Casper	2005-08-24
Natrona	Midwest Oil Company Hotel	Casper	1983-11-17
Natrona	Natrona County High School	Casper	1994-01-07
Natrona	North Casper Clubhouse	Casper	1994-02-18
Natrona	Ohio Oil Company Building	Casper	2001-07-25
Natrona	Pathfinder Dam	Casper	1971-08-12
Natrona	Rialto Theater	Casper	1993-02-11
Natrona	Roosevelt School	Casper	1997-01-30
Natrona	South Wolcott Street Historic District	Casper	1988-11-23
Natrona	Split Rock, Twin Peaks	Muddy Gap	1976-12-22
Natrona	Stone Ranch Stage Station	Casper	1982-11-01
Natrona	Teapot Rock	Midwest	1974-12-30
Natrona	Townsend Hotel	Casper	1983-11-25
Natrona	Tribune Building	Casper	1994-02-18

3.3.8.3 Tribal Consultation

Section 3.2.8.3 includes a discussion on Native American tribes located within or immediately adjacent to the state of Wyoming that have interests in the state, including

- Arapaho Tribe of the Wind River Reservation
- Shoshone Tribe of the Wind River Reservation
- Northern Cheyenne Tribe of Montana
- Cheyenne River Sioux
- Flandreau Santee Sioux
- Lower Brulé Sioux
- Oglala Sioux
- Rosebud Sioux
- Sisseton-Whapeton Oyate
- Standing Rock Sioux
- Yankton Sioux
- Crow Tribe of Montana

The Siouan tribes are located throughout South and North Dakota, and the Crow and Northern Cheyenne are located in Montana and have interests in Wyoming. Other Siouan-speaking tribes, as well as other tribes in North Dakota, Wyoming, Montana, and Nebraska may have traditional land use claims in the Wyoming East Uranium Milling Region.

3.3.8.4 Places of Cultural Significance

Section 3.2.8.4 includes a more detailed discussion of culturally significant places and traditional cultural properties in Central and Eastern Wyoming. As described in Section 3.2.8, there are no culturally significant places listed in either the NRHP or state registers in the Wyoming East

Uranium Milling Region. However, the Lakota Sioux or other Sioux bands (Cheyenne River Sioux, Lower Brulé Sioux, Oglala Sioux, Rosebud Sioux) along with the Northern Cheyenne, Crow Tribe, the Arapaho, the Kiowa, and Wind River Shoshone who once occupied or may have utilized portions of the Wyoming East Uranium Milling Region consider the Black Hills in Wyoming and South Dakota, Devil's Tower in northeastern Wyoming, Pumpkin Buttes in eastern Wyoming, and Bear Butte in southwestern South Dakota to be culturally significant. These were once used for personal rituals and the Sun Dance and are the source of origin legends among many of these tribes.

Areas of central and eastern Wyoming once used by these tribes may contain additional, hitherto undocumented or undisclosed culturally significant sites and traditional cultural properties. Mountains, peaks, buttes, prominences, and other elements of the natural and cultural environment are often considered important elements of a traditional, culturally significant landscape.

Traditional cultural properties are those that refer to beliefs, customs, and practices of a living community that have been passed down over the generations. Native American traditional cultural properties are often not found on the state or national registers of historic properties or described in the extant literature or in SHPO files. There are, however, a range of cultural property types of religious or traditional use that might be identified during the tribal consultation process. These might include

- Sites of ritual and ceremonial activities and related features
- Shrines
- Marked and unmarked burial grounds
- Traditional use areas
- Plant and mineral gathering areas
- Traditional hunting areas
- Caves and rock shelters
- Springs
- Trails
- Prehistoric archaeological sites

3.3.9 Visual/Scenic Resources

Based on the BLM Visual Resource Handbook (BLM, 2007a–c), the uranium districts in the Wyoming East Uranium Milling Region are located at the junction of the Northern and Southern Rocky Mountain, Wyoming Basin, and Great Basin physiographic provinces (Bennett, 2003). The BLM resource management plans covering this region include the Casper (BLM, 2007d), Buffalo (BLM, 2001), Rawlins (BLM, 2008b), and Newcastle (BLM, 2000) field offices (see the BLM Wyoming website at http://www.blm.gov/wy/st/en.html). The VRM classifications assigned within these resource plans are presented in Figure 3.3-17.

The bulk of the Wyoming East Uranium Milling Region is categorized as VRM Class III (along highways) and Class IV (open grassland, oil and natural gas, urban areas). The landscape has been extensively modified in urban areas and in several areas of oil, natural gas, and coal production, such as Natrona and Converse Counties near Casper and Douglas (Bennett, 2003; BLM, 2007d) and Johnson and Campbell Counties near Gillette (BLM, 2001). As a result, these areas are predominantly classified as VRM Class IV or as Class V/Rehabilitation. The BLM resource management plans do not identify any VRM Class I resources that fall within the

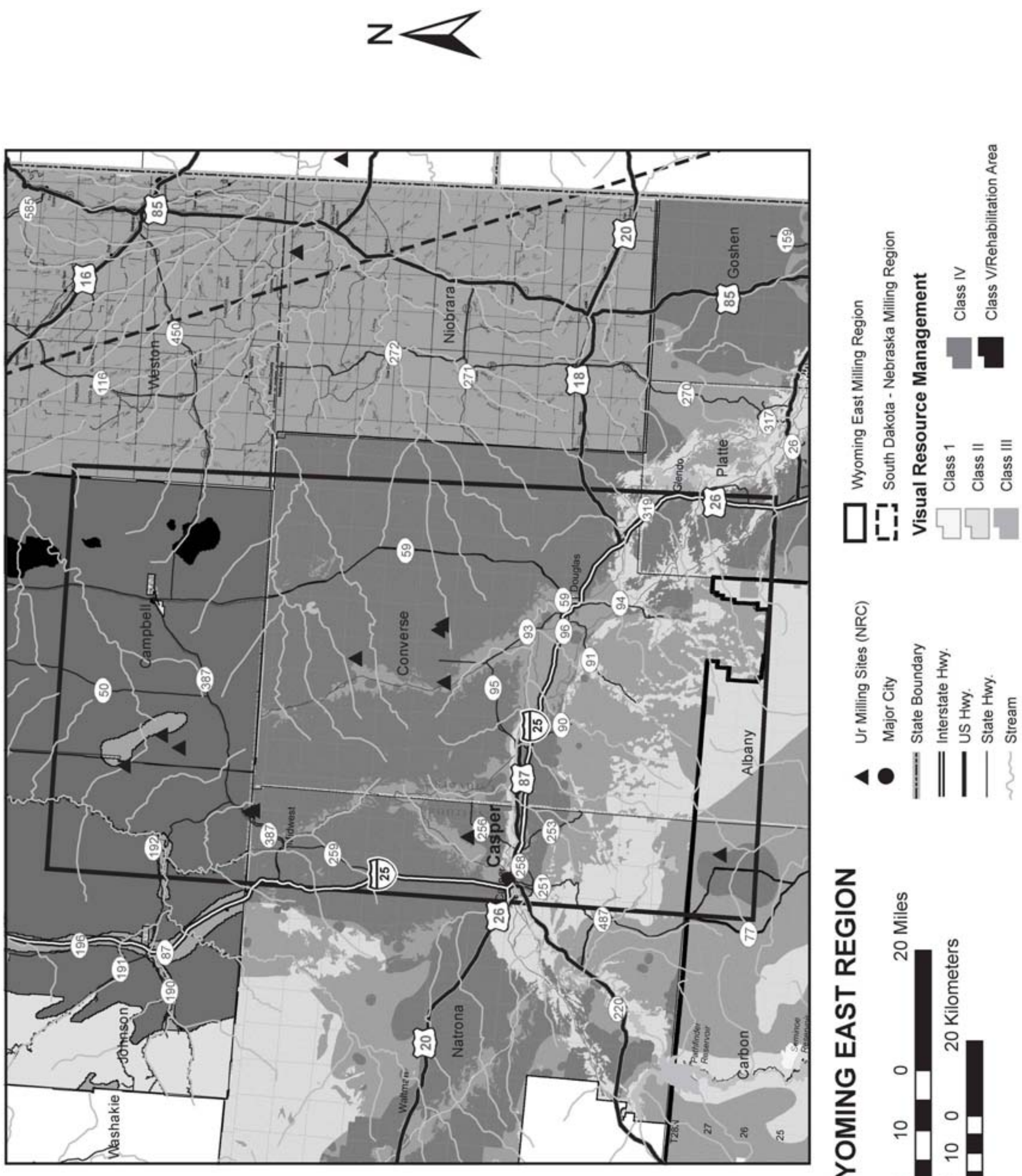


Figure 3.3-17. BLM Visual Resource Classifications for the Wyoming East Uranium Milling Region (BLM, 2008b, 2007d, 2001, 2000)

Wyoming East Uranium Milling Region. VRM Class II areas are generally identified south of Interstate 25 in the region, ranging from the Laramie Mountains in the southwestern portion of the region to the North Platte River and its tributaries across the southern part of the region (BLM, 2007d, 1992). Additional areas of potentially sensitive visual resources include the Bozeman, Oregon, and Bridger Historic Trails that cross the southern part of the region, traveling east to west roughly parallel to the North Platte River (Bennett, 2003; BLM, 2007d, 1992) on the north side of the Laramie Mountains. All of the current and potential ISL facilities identified in the three uranium districts in the Wyoming East Uranium Milling Region are located within Class III through Class V/Rehabilitation VRM areas (Figure 3.3-17). There are no Prevention of Significant Deterioration Class I or Wyoming Unique/Irreplaceable or Rare/Uncommon designated areas within the Wyoming East Uranium Milling Region (Girardin, 2006).

3.3.10 Socioeconomics

For the purpose of this GEIS, the socioeconomic description for the Wyoming East Uranium Milling Region includes communities within the region of influence for potential ISL facilities in the three uranium districts in the region. These include communities that have the highest potential for socioeconomic impacts and are considered the affected environment. Communities that have the highest potential for socioeconomic impacts are defined in the GEIS by (1) proximity to an ISL facility {generally within 48 km [30 mi]}; (2) economic profile, such as potential for income growth or destabilization; (3) employment structure, such as potential for job placement or displacement; and (4) community profile, such as potential for growth or destabilization to local emergency services, schools, or public housing. The affected environment within the Wyoming East Uranium Milling Region consists of counties and CBSAs. A CBSAs, according to the U.S. Census Bureau, is a collective term for both metro and micro areas ranging from a population of 10,000 to 50,000 (U.S. Census Bureau, 2008). The major political divisions of the affected environment are listed in Table 3.3-9. The following subsections describe areas most likely to have implications to socioeconomics and are listed below. In some subsections Metropolitan Areas are also discussed. A Metropolitan Area is greater than 50,000 and a town is considered less than 10,000 in population (U.S. Census

Table 3.3-9. Summary of Affected Environment Within the Wyoming East Uranium Milling Region

Counties Within Wyoming East	Core-Based Statistical Areas Within Wyoming East
Albany	Casper
Campbell	
Carbon	
Converse	
Johnson	
Natrona	
Niobrara	
Platte	
Weston	

Bureau, 2008). Smaller communities such as Bill and Linch are considered as part of the county demographics.

3.3.10.1 Demographics

Demographics are based on 2000 U.S. Census data population and racial characteristics of the affected environment (Table 3.3-10). (Figure 3.3-18 illustrates the populations of communities within the Wyoming East Uranium Milling Region.) Most 2006 data compiled by the U.S. Census Bureau is not yet available for the geographic area of interest.

The most populated county in the Wyoming East Uranium Milling Region is Natrona County, and the most sparsely populated county is Niobrara County. The county with the largest percentage of nonminorities is Niobrara County with a white population of 98.0 percent. The largest minority based county is Carbon County with a white population of 90.1 percent or a minority-based population of 9.9 percent. The CBSAs of Casper is demographically similar to the counties within the Wyoming East Uranium Milling Region.

3.3.10.2 Income

Income information from the 2000 U.S. Census including labor force, income, and poverty levels for the affected environment is based on data collected from state and county levels. Data collected at the state level also include information on towns, CBSA, or Metropolitan Areas and considers an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [30 mi]} for income opportunities or may be a workforce needed to fulfill specialized positions (if local workforce is unavailable or unspecialized). In Wyoming, the workforce frequently commutes long distances to work. For example, in the Wyoming East Uranium Milling Region, most of the affected counties experienced net inflows of workers during the fourth quarter of 2005. Net inflows ranged from about 160 for Johnson County to about 7,500 for Campbell County. These inflows were predominately for jobs related to the energy industry in the Powder River Basin (Wyoming Workforce Development Council, 2007). Converse (−1,063) and Platte (−228) Counties experienced net outflows during the same period. Data collected at the county level are generally the same as for the affected environment presented in Table 3.3-9. State-level information for the surrounding region is provided in Table 3.3-11, and county data are listed in Table 3.3-12.

For the surrounding region, the state with both the largest labor force population and families and individuals living below poverty level is Colorado. The largest labor force population is Billings, Montana {128 km [80 mi] from the nearest potential ISL facility in the region}, and the smallest labor force population is Laramie, Wyoming {96 km [60 mi] from the nearest potential ISL facility}. The population with the highest per capita income is Fort Collins, Colorado {240 km [150 mi] from the nearest potential ISL facility}, and the lowest per capita income population is Laramie, Wyoming. The population with the highest percentage of individuals and families below poverty levels is Laramie, Wyoming (Table 3.3-11).

The county with the largest labor force is Natrona County, and the smallest labor force is located in Niobrara County. The county with the highest per capita income is Campbell County, and the smallest per capita income at the county level is Niobrara County. The county with the highest percentage of individuals and families living below the poverty level is Albany County (Table 3.3-12).

Table 3.3-10. 2000 U.S. Bureau of Census Population and Race Categories of the Wyoming East Uranium Milling Region*

Affected Environment	Total Population	White	African American	Native American	Some Other Race	Two or More Races	Asian	Hispanic Origin†	Native Hawaiian and Other Pacific Islander
Wyoming	493,782	454,670	3,722	11,133	12,301	8,883	2,771	31,669	302
Percent of total		92.1%	0.8%	2.3%	2.5%	1.8%	0.6%	6.4%	0.1%
Albany County	32,014	29,235	354	18	847	710	545	2,397	18
Percent of total		91.3%	1.1%	0.1%	2.6%	2.2%	1.7%	7.5%	0.1%
Campbell County	33,698	32,369	51	313	378	450	108	1,191	29
Percent of total		96.1%	0.2%	0.9%	1.1%	1.3%	0.3%	3.5%	0.1%
Carbon County	15,639	14,092	105	9	808	321	105	2,163	9
Percent of total		90.1%	0.7%	0.1%	5.2%	2.1%	0.7%	13.8%	0.1%
Converse County	12,052	11,416	18	110	296	177	32	660	3
Percent of total		94.7%	0.1%	0.9%	2.5%	1.5%	0.3%	5.5%	0.0%
Johnson County	7,075	6,865	6	45	39	112	8	148	0
Percent of total		97.0%	0.1%	0.6%	0.6%	1.6%	0.1%	2.1%	0.0%
Natrona County	66,533	62,644	505	686	1,275	1,121	277	3,257	25
Percent of total		94.2%	0.8%	1.0%	1.9%	1.7%	0.4%	4.9%	0.0%
Niobrara County	2,407	2,360	3	12	12	17	3	36	0
Percent of total		98.0%	0.1%	0.5%	0.5%	0.7%	0.1%	1.5%	0.0%
Platte County	8,807	8,471	14	44	149	112	15	465	2
Percent of total		96.2%	0.2%	0.5%	1.7%	1.3%	0.2%	5.3%	0.0%
Weston County	6,644	6,374	8	84	62	102	13	137	1
Percent of total		95.9%	0.1%	1.3%	0.9%	1.5%	0.2%	2.1%	0.0%
Casper	49,644	46,680	428	495	1,011	775	245	2,656	10
Percent of total		94.0%	0.9%	1.0%	2.0%	1.6%	0.5%	5.4%	0.0%

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100 percent).

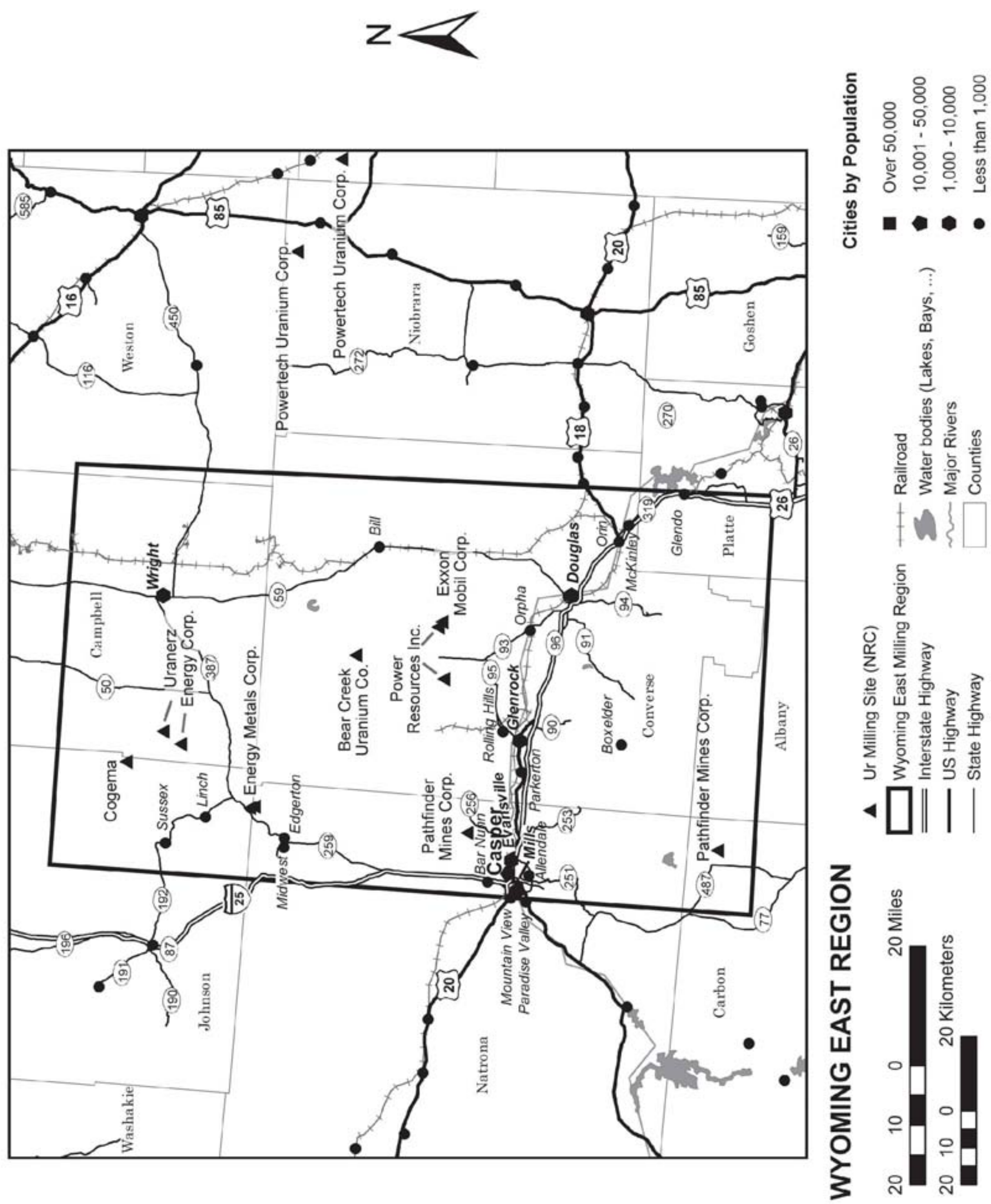


Figure 3.3-18. Wyoming East Uranium Milling Region With Population

Table 3.3-11. U.S. Bureau of Census State Income Information for Wyoming East Uranium Milling Region*

Affected Environment	2000 Labor Force Population (16 years and over)	Median Household Income in 1999	Median Family Income in 1999	Per Capita Income in 1999	Families Below Poverty Level in 2000	Individuals Below Poverty Level in 2000
Colorado	2,331,898	$47,203	$55,883	$24,049	67,614	388,952
South Dakota	394,945	$35,282	$42,237	$17,562	18,172	95,900
Wyoming	257,808	$37,892	$45,685	$19,134	10,585	54,777
Casper	26,343	$36,567	$46,267	$19,409	1,122	5,546
Percent of total†	68.4%	NA‡	NA‡	NA‡	8.5%	11.4%
Cheyenne, Wyoming	27,647	$38,856	$46,771	$19,809	891	4,541
Percent of total†	66.7%	NA‡	NA‡	NA‡	6.3%	8.8%
Ft. Collins, Colorado	69,424	$44,459	$59,332	$22,133	1,417	15,835
Percent of total†	72.4%	NA‡	NA‡	NA‡	5.5%	14.0%
Laramie, Wyoming	15,504	$27,319	$43,395	$16,036	633	5,618
Percent of total†	67.2%	NA‡	NA‡	NA‡	11.1%	22.6%
Rapid City, South Dakota	31,948	$35,978	$44,818	$19,445	1,441	7,328
Percent of total†	68.8%	NA‡	NA‡	NA‡	9.4%	12.7%

* U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 15 April 2008).
†Percent of total based on a population of 16 years and over.
‡NA—Not applicable.

3.3.10.3 Housing

Housing information based on 2000 U.S. Census data is provided in Table 3.3-13.

The availability of housing within the immediate vicinity of potential ISL facilities in the Wyoming East Uranium Milling Region is limited. The majority of housing is available in larger populated areas such as the towns of Casper {48 km [30 mil] to the nearest potential ISL facility} and

Table 3.3-12. U.S. Bureau of Census County Income Information for Wyoming East Uranium Milling Region*						
Affected Environment	**2000 Labor Force Population (16 years and over)**	**Median Household Income in 1999**	**Median Family Income in 1999**	**Per Capita Income in 1999**	**Families Below Poverty Level in 2000**	**Individuals Below Poverty Level in 2000**
Albany County, Wyoming	18,182	$28,790	$44,334	$16,706	763	6,228
Percent of total†	67.7%	NA‡	NA‡	NA‡	10.8%	21.0%
Campbell County, Wyoming	18,805	$49,536	$53,92	$20,063	507	2,544
Percent of total†	76.6%	NA‡	NA‡	NA‡	5.6%	7.6%
Carbon County, Wyoming	7,744	$36,060	$41,991	$18,375	411	1,879
Percent of total†	62.5%	NA‡	NA‡	NA‡	9.8%	12.9%
Converse County, Wyoming	6,244	$39,603	$45,905	$18,744	319	1,379
Percent of total†	68.6%	NA‡	NA‡	NA‡	9.2%	11.6%
Johnson County, Wyoming	3,472	$34,012	$42,299	$19,030	147	712
Percent of total†	61.7%	NA‡	NA‡	NA‡	7.2%	10.1%
Natrona County, Wyoming	35,081	$36,619	$45,575	$18,913	1,548	7,695
Percent of total†	68.3%	NA‡	NA‡	NA‡	8.7%	11.8%
Niobrara County, Wyoming	1,193	$29,701	$33,714	$15,757	74	309
Percent of total†	61.5%	NA‡	NA‡	NA‡	10.7%	13.4%
Platte County, Wyoming	4,540	$33,866	$41,449	$17,530	216	1,021
Percent of total†	66.1%	NA‡	NA‡	NA‡	8.5%	11.7%
Weston County	3,183	$32,348	$40,472	$17,366	119	628
Percent of total†	60.0%	NA‡	NA‡	NA‡	6.3%	9.9%

* U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Percent of total based on a population of 16 years and over.
‡NA—Not applicable.

Table 3.3-13. U.S. Bureau of Census Housing Information for the Wyoming East Uranium Milling Region*

Affected Environment	Single Family Owner-Occupied Homes	Median Value in Dollars	Median Monthly Costs With a Mortgage	Median Monthly Costs Without a Mortgage	Occupied Housing Units	Renter-Occupied Units
Wyoming	95,591	$96,600	$825	$229	193,608	55,793
Albany County	4,987	$118,600	$916	$225	13,269	6,345
Campbell County	5,344	$102,900	$879	$247	12,207	3,174
Carbon County	7,744	$76,500	$685	$196	6,129	1,708
Converse County	2,290	$84,900	$714	$206	4,694	1,142
Johnson County	1,414	$115,500	$849	$227	2,959	677
Natrona County	15,250	$84,600	$746	$218	26,819	7,993
Niobrara County	480	$60,300	$562	$200	1,011	222
Platte County	1,659	$84,100	$698	$205	3,625	800
Weston County	1,174	$66,700	$664	$199	2,624	549
Casper	12,642	$84,500	$744	$220	20,437	6,645

*U.S. Census Bureau. “American FactFinder.” <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).

Riverton {193 km [120 mi] to the nearest potential ISL facility}. Temporary housing such as apartments, lodging, and trailer camps within the immediate vicinity of the proposed ISL facilities is not as limited. There are 17 apartment complexes available in larger populated areas such as the CBSAs or towns of Casper, Douglas, Lusk, and Orpha (MapQuest, 2008). There are also 15 hotels/motels along major highways or towns near the uranium districts located within the Wyoming East Uranium Milling Regions. In addition to apartments and lodging, there are more than 25 trailer camps situated along major roads or near towns (MapQuest, 2008).

3.3.10.4 Employment Structure

Employment structure from the 2000 U.S. Census, including employment rate and type, is based on data collected at the state and county levels. Data collected from the state level also includes information on towns, CBSAs, or Metropolitan Areas and considers an outside workforce. An outside workforce may include workers willing to commute long distances {greater than 48 km [30 mi]} for employment opportunities or external labor necessary to fulfill specialized positions (if local workforce is unavailable or unspecialized). Data collected at the county level are generally the same as the affected environment presented in Table 3.3-9.

Based on review of regional state-level information, Colorado has the highest percentage of employment.

At the county level, the county in the Wyoming East Uranium Milling Region with the highest percentage of employment is Campbell County and the county with the highest unemployment rate is Albany County.

3.3.10.4.1 State Data

3.3.10.4.1.1 Colorado

The State of Colorado has an employment rate of 66.3 percent and unemployment rate of 3.0 percent. The largest sector of employment is management, professional, and related occupations at 37.4 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Ft. Collins

Ft. Collins has an employment rate of 68.5 percent and unemployment higher than the state at 3.8 percent. The largest sector of employment is management, professional, and related occupations at 42.9 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.3.10.4.1.2 South Dakota

The state of South Dakota has an employment rate of 64.9 percent and unemployment rate of 3.0 percent. The largest sector of employment is management, professional, and related occupations at 32.6 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Rapid City

Laramie has an employment rate of 63.7 percent and unemployment higher than the state at 3.2 percent. The largest sector of employment is management, professional, and related occupations at 32.8 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.3.10.4.1.3 Wyoming

The State of Wyoming has an employment rate of 63.1 percent and unemployment rate of 3.5 percent. The largest sector of employment is sales and office occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Casper

Casper has an employment rate of 64.9 percent and an unemployment rate lower than that of the state at 3.4 percent. The largest sector of employment is sales and office occupations at 30.6 percent followed by management, professional, and related occupations at 29.7 percent. The largest type of industry is educational, health, and social services at 22.1 percent. The largest class of worker is private wage and salary workers at 76.6 percent (U.S. Census Bureau, 2008).

Cheyenne

Cheyenne has an employment rate of 59.2 percent and unemployment less than the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 33.0 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Laramie

Laramie has an employment rate of 63.4 percent and unemployment less than the state at 3.7 percent. The largest sector of employment is management, professional, and related occupations at 40.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.3.10.4.2 County Data

Albany County, Wyoming

Albany County has an employment rate of 63.9 percent and an unemployment rate higher than that of the state at 3.7 percent. The largest sector of employment is management, professional, and related occupations at 40.4 percent. The largest type of industry is educational, health, and social services at 37.1 percent. The largest class of worker is private wage and salary workers at 61.9 percent (U.S. Census Bureau, 2008).

Campbell County, Wyoming

Campbell County has an employment rate of 73.2 percent and an unemployment rate lower than that of the state at 3.4 percent. The largest sector of employment is management, professional, and related occupations at 23.9 percent followed by construction, extraction, and maintenance occupations at 23.7 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 23.3 percent followed by educational, health, and social services at 16.7 percent. The largest class of worker is private wage and salary workers at 78.4 percent (U.S. Census Bureau, 2008).

Carbon County, Wyoming

Carbon County has an employment rate of 59.2 percent and an unemployment rate lower than that of the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 23.4 percent followed by sales and office occupations at 21.9 percent. The largest type of industry is educational, health, and social services at 17.1 percent. The largest class of worker is private wage and salary workers at 65.6 percent (U.S. Census Bureau, 2008).

Converse County, Wyoming

Converse County has an employment rate of 65.4 percent and an unemployment rate lower than that of the state at 3.2 percent. The largest sector of employment is management, professional, and related occupations at 23.2 percent followed by sales and office occupations at 21.4 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 20.1 percent followed by educational, health, and social services at 18.5 percent. The largest class of worker is private wage and salary workers at 71.1 percent (U.S. Census Bureau, 2008).

Johnson County, Wyoming

Johnson County has an employment rate of 57.6 percent and an unemployment rate slightly higher than that of the state at 3.7 percent. The largest sector of employment is management, professional, and related occupations at 37.5 percent followed by sales and office occupations at 20.3 percent. The largest type of industry is educational, health, and social services at 20.5 percent followed by agriculture, forestry, fishing and hunting, and mining at 19.5 percent. The largest class of worker is private wage and salary workers at 61.1 percent (U.S. Census Bureau, 2008).

Natrona County, Wyoming

Natrona County has an employment rate of 64.6 percent and an unemployment rate similar to that of the state at 3.5 percent. The largest sector of employment is sales and office occupations at 29.9 percent followed by management, professional, and related occupations at 28.5 percent. The largest type of industry is educational, health, and social services at 21.2 percent. The largest class of worker is private wage and salary workers at 76.2 percent (U.S. Census Bureau, 2008).

Niobrara County, Wyoming

Niobrara County has an employment rate of 59.4 percent and an unemployment rate lower than that of the state at 2.1 percent. The largest sector of employment is management, professional, and related occupations at 34.4 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 24.7 percent. The largest class of worker is private wage and salary workers at 62.6 percent (U.S. Census Bureau, 2008).

Platte County, Wyoming

Platte County has an employment rate of 63.1 percent and an unemployment rate lower than that of the state at 2.9 percent. The largest sector of employment is management, professional, and related occupations at 30.3 percent. The largest type of industry is educational, health, and social services at 21.4 percent. The largest class of worker is private wage and salary workers at 64.4 percent (U.S. Census Bureau, 2008).

Weston County, Wyoming

Weston County has an employment rate of 56.6 percent and an unemployment rate lower than that of the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 24.3 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 22.4 percent. The largest class of worker is private wage and salary workers at 68.9 percent (U.S. Census Bureau, 2008).

3.3.10.5 Local Finance

Local finance such as revenue and tax distribution information for the affected counties is presented in Table 3.3-14.

Wyoming

The State of Wyoming does not have an income tax nor does it assess tax on retirement income received from another state. Wyoming has a 4 percent state sales tax, 2 percent to 4 percent county lodging tax, and 4 percent use tax. Counties have the option of collecting an additional 1 percent tax for general revenue and 2 percent tax for specific purposes. Wyoming also imposes “ad valorem taxes” on mineral extraction properties. Taxes levied for uranium production were 10.0 percent in 2007 (6.0 percent “ad valorem” and 4 percent severance) totaling $1.7 million dollars (Wyoming Department of Revenue, 2007). For 2007, in the Wyoming East Uranium Milling Region all of this uranium tax revenue was generated in Converse County. Annual sales and use tax distribution information for the affected counties (including cities and towns) in the Wyoming East Uranium Milling Region are presented in Table 3.3-14.

Casper

Sources of revenue for Casper, the largest city in the Wyoming East Uranium Milling Region, include sales, use, lodging, and property taxes as well as mill levies. The sales and use tax rate is 5 percent and lodging is 3 percent. The largest distribution of property tax is school district tax at a rate of 32.5 percent (Casper Chamber of Commerce, 2007).

Campbell County

Campbell County has 1 school district with 24 schools consisting of 15 elementary schools, 2 junior high schools, 1 junior/senior high school, 1 high school, 1 alternative school, and 1 aquatic center. There are a total of approximately 7,441 students. The majority of schools provides bus services (Campbell County School District No. 1, 2007).

Carbon County

Carbon County has two school districts, Carbon County School District No. 1 and No. 2, with a combined total of approximately 2,647 students. There are a total of nine elementary schools, two middle schools, two high schools, and two private schools. The majority of schools within each school district provides bus services (Carbon County School District No.1, 2008; Carbon County District No. 2, 2008).

Table 3.3-14. 2007 State and Local Annual Sales and Use Tax Distribution of Affected Counties Within the Wyoming East Uranium Milling Region*					
Affected Counties	**Use Tax**		**Sales Tax**		**Gross Revenue**
	State	**Local**	**State**	**Local**	
Albany County	$2,712,413	$3,152,059	$12,083,171	$14,042,820	$32,812,196
Campbell County	$9,104,434	$8,130,984	$72,443,855	$64,724,530	$155,316,435
Carbon County	$3,778,037	$4,328,728	$15,087,797	$16,953,793	$40,812,784
Converse County	$1,042,601	$837,455	$8,316,835	$6,682,328	$17,225,640
Johnson County	$795,512	$639,174	$8,502,430	$6,831,523	$17,012,155
Natrona County	$4,135,490	$3,322,747	$51,551,636	$41,420,622	$102,046,519
Niobrara County	$156,916	$182,363	$1,091,293	$1,268,288	$2,745,320
Platte County	$1,100,272	$884,041	$3,040,039	$2,442,613	$7,523,115
Weston County	$630,016	$506,201	$2,572,484	$2,066,940	$5,886,521

* Wyoming Department of Revenue. "State of Wyoming Department of Revenue 2007 Annual Report." 2007. <http://revenue.state.wy.us/PortalVBVS/uploads/2007%20DOR%20Annual%20Report.pdf> (7 April 2009).

Converse County

Converse County has two school districts, Converse County School Districts No. 1 and No. 2, with a total of approximately 2,455 students. There are a total of nine elementary schools, four middle/intermediate schools, and two high schools. The majority of schools within each school district provides bus services (Schoolbug.org, 2007b).

Johnson County

Johnson County has one school district with two elementary schools, one middle school, two high schools, and one learning center. There are a total of approximately 1,257 students. The majority of schools provides bus services (Johnson County School District No. 1, 2007).

Natrona County

Natrona County has one school district, Natrona County School District No. 1, with a total of approximately 11,500 students. There are more than 30 public and private elementary and secondary schools. The majority of schools provides bus services (Natrona County School District No. 1, 2007).

Niobrara County

Niobrara County has one school district, Niobrara County School District No. 1, with a total of approximately 422 students. There is one elementary and middle school, one high school, and one private school. Information as to whether these schools provide bus services is not available (Niobrara County School District No. 1, 2008).

Platte County

Platte County has the Platte County School District No. 1, with a total of approximately 1,571 students. There are two elementary schools, one middle school, one high school, and two private or parochial schools. Information as to whether these schools provide bus services is not available (Platte County School District No.1, 2008).

Weston County

Weston County has one school district, Weston County School District No. 1, with a total of approximately 1,134 students. There are two elementary schools, one middle school, and one high school. Information as to whether these schools provide bus services is not available (Weston County School District No. 1, 2008).

3.3.10.6 Education

Information on education for the affected communities within the region of influence is presented next.

Based on review of the affected environment, the county with the largest number of schools is Natrona County and the county with the smallest number of schools is Niobrara County. The CBSA of Casper was average to the county level when compared to the aforementioned schools.

Casper

Casper has one school district, Natrona County School District No. 1, with a total of approximately 11,500 students. There are more than 25 public and private elementary, middle, and high schools. The majority of schools provides bus services (Schoolbug.org, 2007a).

Albany County

Albany County has one school district, Albany County School District No. 1, with a total of approximately 3,790 students. There are 13 elementary schools, 6 middle schools, and 3 high schools. The majority of schools provides bus services (Greatschools.com, 2008).

Campbell County

Campbell County has 1 school district with 24 schools consisting of 15 elementary schools, 2 junior high schools, 1 junior/senior high school, 1 high school, 1 alternative school, and 1 aquatic center. There are a total of approximately 7,441 students. The majority of schools provides bus services (Campbell County School District No. 1, 2007).

Carbon County

Carbon County has two school districts, Carbon County School Districts No. 1 and No. 2, with a combined total of approximately 2,647 students. There are a total of nine elementary schools, two middle schools, two high schools, and two private schools. The majority of schools within each school district provide bus services (Carbon County School District No.1, 2008; Carbon County School District No. 2, 2008).

Converse County

Converse County has two school districts, Converse County School Districts No. 1 and No. 2, with a total of approximately 2,455 students. There are a total of nine elementary schools, four middle/intermediate schools, and two high schools. The majority of schools within each school district provides bus services (Schoolbug.org, 2007b).

Johnson County

Johnson County has one school district with two elementary schools, one middle school, two high schools, and one learning center. There are a total of approximately 1,257 students. The majority of schools provides bus services (Johnson County School District No. 1, 2007).

Natrona County

Natrona County has one school district, Natrona County School District No. 1, with a total of approximately 11,500 students. There are more than 30 public and private elementary and secondary schools. The majority of schools provides bus services (Natrona County School District No. 1, 2007).

Niobrara County

Niobrara County has one school district, Niobrara County School District No. 1, with a total of approximately 422 students. There is one elementary and middle school, one high school, and one private school. Information as to whether these schools provide bus services is not available (Niobrara County School District No. 1, 2008).

Platte County

Platte County has the Platte County School District No. 1, with a total of approximately 1,571 students. There are two elementary schools, one middle school, one high school, and two private or parochial schools. Information as to whether these schools provide bus services is not available (Platte County School District No.1, 2008).

Weston County

Weston County has one school district, Weston County School District No. 1, with a total of approximately 1,134 students. There are two elementary schools, one middle school, and one high school. Information as to whether these schools provide bus services is not available (Weston County School District No. 1, 2008).

3.3.10.7 Health and Social Services

Health Care

The majority of the health care facilities that provide service in the vicinity of the Wyoming East Uranium Milling Region is located within populated areas of the affected environment. The closest health care facilities within the vicinity of the ISL facilities are located in Riverton, Lander, Casper, Douglas, Wheatland, Cheyenne, and Laramie and have a total of 15 facilities

(MapQuest, 2008). These consist of hospitals, clinics, emergency centers, and medical services. The following hospitals are located proximate to the Wyoming East Milling Region: Riverton (1), Cheyenne (1), Laramie (1), and Wheatland (1).

Local Emergency

Local police within the Wyoming East Uranium Milling Region are under the jurisdiction of each county. There are 28 police, sheriff, or marshals offices within the region: Albany County (2), Campbell County (2), Carbon County (6), Converse County (3), Johnson County (3), Natrona County (4), Niobrara County (2), Platte County (3), and Weston County (3) (USACops, 2008).

Fire departments within the Wyoming East Uranium Milling Region are comprised at the county, town, CBSA, or city level. There are seven fire departments within the milling region: Campbell County (one), Casper (one), Douglas (two), Lusk (one), Natrona County (one), and Wheatland (one) (50states, 2008).

3.3.11 Public and Occupational Health

3.3.11.1 Background Radiological Conditions

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 3 mSv/yr [300 mrem/yr] but varies by location and elevation (National Council of Radiation Protection and Measurements, 1987). In addition, the average American receives 0.6 mSv/yr [60 mrem/yr] from man-made sources including medical diagnostic tests and consumer products (National Council of Radiation Protection and Measurements, 1987). Therefore, the total from natural background and man-made sources for the average U.S. resident is 3.6 mSv/yr [360 mrem/yr]. For a breakdown of the sources of this radiation, see Figure 3.2-22.

Background dose varies by location primarily because of elevation changes and variations in the dose from radon. As elevation increases so does the dose from cosmic radiation and hence the total dose. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. The amount of radon in the soil/bedrock depends on the type, porosity, and moisture content. Areas that have types of soils/bedrock like granite and limestone have higher radon levels than those with other types of soils/bedrock (EPA, 2006).

The total effective dose equivalent is the total dose from external sources and internal material released from licensed operations. Doses from sources in the general environment (such as terrestrial radiation, cosmic radiation, and naturally occurring radon) are not included in the dose calculation for compliance with 10 CFR Part 20, even if these sources are from technologically enhanced naturally occurring radioactive material, such as preexisting radioactive residues from prior mining (Atomic Safety and Licensing Board, 2006).

For the Wyoming East Uranum Milling Region, the average background radiation dose for the state of Wyoming is used, which is 3.16 mSv/yr [316 mrem/yr] (EPA, 2006). This value includes natural and man-made sources. This dose is slightly lower than the U.S. average primarily because the radon dose is lower {U.S. average of 2 mSv/yr [200 mrem/yr] versus Wyoming average of 1.33 mSv/yr [133 mrem/yr]}. The cosmic dose is slightly higher than the U.S. average: 0.515 mSv/yr [51.5 mrem/yr] versus 0.27 mSv/yr [27 mrem/yr]. The remaining contributions from terrestrial, internal, and manmade radiation combined are the same as the U.S. average of 1.318 mSv/yr [131.8 mrem/yr].

3.3.11.2 Public Health and Safety

Public health and safety standards are the same regardless of a facility's location. See Section 3.2.11.2 for further discussion of these standards.

3.3.11.3 Occupational Health and Safety

Occupational health and safety standards are the same regardless of facility's location. See Section 3.2.11.3 for further discussion of these standards.

3.3.12 References

50States. "Wyoming." <www.50states.com> (15 April 2008).

Anderson, D.C. "Uranium Deposits of the Gas Hills." *Contributions to Geology, Wyoming Uranium Issue*. Laramie, Wyoming: University of Wyoming. Vol. 8, No. 2.1. pp. 93–104. 1969.

Atomic Safety and Licensing Board. "Atomic Safety and Licensing Board Transcript in the Matter of Hydro Resources Inc." Docket No. 40–8968–ML. Washington, DC: Atomic Safety and Licensing Board. May 16, 2006.

Bailey, R.V. "Uranium Deposits in the Great Divide Basin-Crooks Gap Area, Fremont and Sweetwater Counties, Wyoming." *Contributions to Geology, Wyoming Uranium Issue*. Laramie, Wyoming: University of Wyoming. Vol. 8, No. 2.1. pp. 105–120. 1969.

Bennett, E. "The Visual Resource Inventory for the Casper Field Office." Casper, Wyoming: BLM, Casper Field Office. March 2003.

BLM. "Proposed Resource Management Plan and Final Environmental Impact Statement for Public Lands Administered by the Bureau of Land Management Rawlins Field Office." Rawlins, Wyoming: BLM, Rawlins Field Office. January 2008a. <http://www.blm.gov/rmp/wy/rawlins/> (03 March 2008).

BLM. "Split Estate." Washington, DC: BLM. 2008b. <http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/split_estate.html> (29 January 2008).

BLM. "Visual Resource Management." Manual 8400. Washington, DC: BLM. 2007a. <http://www.blm.gov/nstc/VRM/8400.html> (17 October 2007).

BLM. "Visual Resource Inventory." Manual H–8410–1. Washington, DC: BLM. 2007b. <http://www.blm.gov/nstc/VRM/8410.html> (17 October 2007).

BLM. "Visual Resource Contrast Rating." Manual 8431. Washington, DC: BLM. 2007c. <http://www.blm.gov/nstc/VRM/8431.html> (17 October 2007).

BLM. "Proposed Resource Management Plan and Final Environmental Impact Statement for the Casper Field Office Planning Area." BLM/WY/PL–07/017+1610. Casper, Wyoming: BLM, Casper Field Office. June 2007d. <http://www.blm.gov/rmp/casper/PRMP-FEIS.htm> (17 October 2007).

BLM. “Buffalo Resource Management Plan.” Buffalo, Wyoming: BLM, Buffalo Field Office. April 2001. <http://www.blm.gov/pgdata/etc/medialib/blm/wy/programs/planning/rmps.Par.94672.File.dat/2001rmp_update.pdf?bcsi_scan_B6C3A1920618BACA=0&bcsi_scan_filename=2001rmp_update.pdf> (17 October 2007).

BLM. “Newcastle Resource Management Plan.” Newcastle, Wyoming: BLM, Newcastle Field Office. 2000. <http://www.blm.gov/rmp/WY/application/rmp_browse.cfm?hlevel=1&rmpid=89&idref=28910> (17 October 2007).

BLM. “Nebraska Record of Decision and Approved Resource Management Plan.” Casper, Wyoming: BLM, Casper District Office. 1992. <http://www.blm.gov/rmp/WY/Nebraska/rmp.pdf> (17 October 2007).

Boberg, W.W. “Some Speculations on the Development of Central Wyoming as a Uranium Province.” Wyoming Geological Association 32nd Annual Field Conference Guidebook. Casper, Wyoming: Wyoming Geological Association. pp. 161–180. 1981.

Campbell County School District No. 1. “Campbell County School District No. 1, Educational Services Center.” Gillette, Wyoming. 2007. <www.esc.ccsd.k12.wy.us/> (15 October 2007).

Carbon County School District No.1. “Carbon County School District One.” Rawlins, Wyoming: Carbon County School District. 2008. <www.crb1.k12.wy.us/> (27 February 2008).

Carbon County School District No. 2. “Carbon County School District #2, Carbon County, Wyoming.” Saratoga, Wyoming: Carbon County School District No. 2. 2008. <www.crb2.k12.wy.us> (27 February 2008).

Casper Chamber of Commerce. *Community Profile*. Casper, Wyoming: Casper Chamber of Commerce. 2006.

Chapman, S.S., S.A. Bryce, J.M. Omernik, D.G. Despain, J. ZumBerge, and M. Conrad. “Ecoregions of Wyoming.” U.S. Geological Survey Map. Scale 1:1,400,000. 2004.

Chenoweth, W.L. “A Summary of Uranium Production in Wyoming.” Mineral Resources of Wyoming, Wyoming Geological Association, 42nd Annual Field Conference Guidebook. Casper, Wyoming: Wyoming Geological Association. pp. 169–179. 1991.

Cogema Mining, Inc. “Environmental Assessment for Renewal of Source Material License No. SUA–1341.” Docket No. 40-8502. Mills, Wyoming: Cogema Mining, Inc. 1998.

Collentine, M., R. Libra, K.R. Feathers, and L. Hamden. “Occurrence and Characteristics of Groundwater in the Great Divide and Washakie Basin.” Laramie, Wyoming: University of Wyoming, Water Resources Research Institute, report prepared for EPA. Vol. VI–A. p. 112. 1981.

Curtis J. and K. Grimes.. “Wyoming Climate Atlas.” 2004. <http://www.wrds.uwyo.edu/wrds/wsc/climateatlas/> (29 April 2008).

Davis, J.F. “Uranium Deposits of the Powder River Basin.” *Contributions to Geology, Wyoming Uranium Issue*. Laramie, Wyoming: University of Wyoming. Vol. 8, No. 2.1. pp. 131–142. 1969.
Driscoll, F.G. *Groundwater and Wells*. Second edition. St. Paul, Minnesota: Johnson Filtration Systems Inc.. p. 1,089. 1986.

EPA. “Counties Designate Nonattainment or Maintenance for Clean Air Act’s National Ambient Air Quality Standards (NAAQS).” 2007a. <http://www.epa.gov/oar/oaqps/greenbk/mapnmpoll.html> (29 September 2007).

EPA. “Prevention of Significant Deterioration (PSD) Permit Program Status: May 2007.” 2007b. <http://www.epa.gov/nsr/where.html> (26 September 2007).

EPA. “Assessment of Variations in Radiation Exposure in the United States (Revision 1).” Contract Number EP–D–05–02. Washington, DC: EPA. 2006.

Federal Highway Administration. “Synthesis of Noise Effects on Wildlife Populations.” FHWA–HEP–06–016. Washington, DC: Federal Highway Administration, Department of Transportation. 2004.

Fort Phil Kearny/Bozeman Trail Association. “The Bozeman Trail Corridor.” Sheridan, Wyoming: The Fort Phil Kearny/Bozeman Trail Association. 2008. <http://www.bozemantrail.org/btcorridor-map.html> (27 February 2008).

Gebert, W.A., D.J. Graczyk, and W.R. Krug. “Average Annual Runoff in the United States, 1951–1980.” U.S. Geological Survey Hydrologic Investigations Atlas HA–710. Scale 1:7,500,000. 1987.

Girardin, J. “A List of Areas Designated Unique and Irreplaceable or Designated Rate or Uncommon by the Council.” Letter (November 29) to T. Lorenzon, Director Environmental Quality Council. Cheyenne, Wyoming: Environmental Quality Council. 2006.

Greatschools.com. “Albany County.” 2008. <www.greatschools.com> (27 February 2008).

Harris, R.E. and J.K. King. “Geological Classification and Origin of Radioactive Mineralization in Wyoming.” A.W. Snoke, J.R. Steidtmann, and S.M Roberts, eds. Geology of Wyoming: Geological Survey of Wyoming Memoir No. 5. pp. 898–916. 1993.

Harshman, E.N. “Uranium Deposits of Wyoming and South Dakota.” *Ore Deposits in the United States 1933–1967*. New York City, New York: American Institute of Mining, Metallurgical, and Petroleum Engineers. pp. 815–831. 1968.

Houston, R.S. “Aspects of the Geologic History of Wyoming Related to the Formation of Uranium Deposits.” *Contributions to Geology, Wyoming Uranium Issue.* Laramie, Wyoming: University of Wyoming. Vol. 8, No. 2.1. pp. 67–79. 1969.

Johnson County School District No. 1. 2007. <www.natronaschools.org> (15 October 2007).

Kansas Geological Survey. "Open-File Report. 91-1." 1991. <http://www.kgs.ku.edu/Dakota/vol3/fy91/rep06.htm> (29 April 2008).

Lageson, D. and D. Spearing. *Roadside Geology of Wyoming*. Missoula, Montana: Mountain Press Publishing Company. 1988.

Langden, R.E. "Geology and Geochemistry of the Highland Uranium Deposit." Wyoming Geological Association Earth Science Bulletin. pp. 41–48. 1973.

Love, J.D. "Preliminary Report on Uranium Deposits in the Pumpkin Buttes Area, Powder River Basin, Wyoming." U.S. Geological Survey Circular 176. 1952.

MapQuest. "Wyoming." <www.mapquest.com> (15 April 2008).

Melin, R.E. "Uranium Deposits in Shirley Basin, Wyoming." Laramie, Wyoming: University of Wyoming. Vol. 8, No. 2.1. pp. 143–149. 1969.

Mrak, V.A. "Uranium Deposits in the Eocene Sandstones of the Powder River Basin, Wyoming." *Ore Deposits of the United States 1933–1967*. New York City, New York: American Institute of Mining Engineers. pp. 838–848. 1968.

Munn, L.C. and C.S. Arneson. "Soils of Wyoming—A Digital Statewide Map at 1:500,000-Scale." B–1069. Laramie, Wyoming: University of Wyoming Agricultural Experiment Station, College of Agriculture. 1998.

National Climatic Data Center. "NCDC U.S. Storm Events Database." 2007. <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms> (14 April 2008).

National Climatic Data Center. "Climates of the States, Climatology of the United States No. 60 (New Mexico, Nebraska, South Dakota, and Wyoming)." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2005. <http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl?directive=prod_select2&prodtype=CLIM60&subrnum=> (30 January 2005).

National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

National Council on Radiation Protection and Measurements. "Report No. 094—Exposure of the Population in the United States and Canada From Natural Background Radiation." Bethesda, Maryland: National Council on Radiation Protection & Measurements. 1987.

National Weather Service. "NOAA Technical Report NWS 33: Evaporation Atlas for the Contiguous 48 United States." Washington, DC: National Oceanic and Atmospheric Administration. 1982.

Natrona County School District No. 1. 2007. <www.natronaschools.org> (15 October 2007).

Niobrara County School District No. 1. 2008. <www.lusk.k12.wy.us/> (27 February 2008).

NRC. “Environmental Assessment for the Addition of the Reynolds Ranch Mining Area to Power Resources, Inc’s Smith Ranch/Highland Uranium Project Converse County.” Wyoming. Source Material License No. SUA–1548. Docket No. 40-8964. Washington, DC: NRC. 2006.

Platte County School District No. 1. 2008. <http://platte.schoolfusion.us/> (4 March 2008).

Platte River Recovery Implementation Program. October 24, 2006. <http://www.platteriver.org/library/program_document/land_plan_final.pdf> (26 January 2009).

Power Resources, Inc. “License Amendment Request—Reynolds Ranch Amendment Area, Responses to NRC Requests for Additional Information.” MS060940386, ML060940398, and ML060940400. Douglas, Wyoming: Power Resources, Inc. 2006

Power Resources, Inc. “License Amendment Request—Addition of Reynolds Ranch Amendment Area.” ML050390076. Douglas, Wyoming: Power Resources, Inc. 2005.

Power Resources, Inc. “Reynolds Ranch Amendment.” Permit Mine No. 1548—Smith Ranch–Highland Uranium Project. Vol. III. Douglas, Wyoming: Power Resources, Inc. 2004.

Rackley, R.I. “Environment of Wyoming Tertiary Uranium Deposits.” *American Association Petroleum Geologists Bulletin*. Vol. 56, No. 4. 1972.

Schoolbug.org. “City of Casper.” 2007a. <www.schoolbug.org> (15 October 2007).

Schoolbug.org. “Converse County, Wyoming.” 2007b. <www.schoolbug.org> (15 October 2007).

Trentham, R.C. and I.P. Orajaka. “Leaching of Uranium From Felsic Volcanic Rocks: Experimental Studies.” *Uranium*. Vol. 3. pp. 55–67. 1986.

USACE. “Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region.” Vicksburg, Mississippi: USACE, U.S. Army Engineer Research and Development Center. August 2006.

USACops. “Wyoming.” <www.usacops.com> (15 April 2008)

U.S. Census Bureau. “American FactFinder 2000 Census Data.” 2008. <http://factfinder.census.gov> (25 February 2008).

U.S. Fish and Wildlife Service. “Mountain Prairie Region.” 2008. <http://www.fws.gov/mountain%2Dprairie/> (15 February 2008).

USFS. “Medicine Bow—Routt National Forests Thunder Basin National Grassland.” 2008. Laramie, Wyoming: USFS. <http://www.fs.fed.us/r2/mbr/recreation/> (27 February 2008).

U.S. Geological Survey. “Water Watch.” 2008. <http://water.usgs.gov/waterwatch> (28 February 2008).

U.S. Geological Survey. “A Tapestry of Time and Terrain.” Denver, Colorado: U.S. Geological Survey. 2004. <http://tapestry.usgs.gov/Default.html> (25 February 2008).

U.S. Geological Survey. “A Field Conference on Impacts of Coalbed Methane Development in The Powder River Basin, Wyoming.” U.S. Geological Survey Open-File Report 01-126. Reston, Virginia: U.S. Geological Survey. 2001. <http://pubs.usgs.gov/of/2001/ofr-01-126/figures.html> (25 February 2008).

Washington State Department of Transportation. “WSDOT's Guidance for Addressing Noise Impacts in Biological Assessments—Noise Impacts.” Seattle, Washington: Washington State Department of Transportation. 2006. <http://www.wsdot.wa.gov/TA/Operations/Environmental/NoiseChapter011906.pdf> (12 October 2007).

Weston County School District No. 1. 2008. <www.weston1.k12.wy.us/> (27 February 2008).

Whitehead, R.L. “Groundwater Atlas of the United States, Montana, North Dakota, South Dakota, Wyoming.” U.S. Geological Survey Report HA 730–I. Denver, Colorado: U.S. Geological Survey. 1996. <http://pubs.usgs.gov/ha/ha730/ch_i/> (29 January 2009).

WDEQ. “Wyoming’s 2008 305(b) Integrated State Water Quality Assessment Report and 2008 303(d) List of Waters Requiring TMDLs. Cheyenne, Wyoming: WDEQ, Water Quality Divisions. 2008. <http://deq.state.wy.us/wqd/watershed/Downloads/305b/2008/2008%20Integrated%20Report.pdf> (27 January 2009).

WDEQ. “Chapter 2, Ambient Standards.” 2006. <http://deq.state.wy.us/aqd/standards.asp> (23 October 2007).

World Wildlife Fund. “Colorado Rockies Forests.” Washington, DC: World Wildlife Fund. 2007a. <http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na0511_full.html> (10 October 2007).

World Wildlife Fund. “Northern Short Grasslands.” Washington, DC: World Wildlife Fund. 2007b. <http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na0811_full.html> (13 September 2007).

World Wildlife Fund. “South Central Rockies Forests.” Washington, DC: World Wildlife Fund. 2007c. <http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na0528_full.html> (10 October 2007).

World Wildlife Fund. “Wildfinder—Mapping the World’s Species: Ecoregion NA1313 (Wyoming Basin Shrub Steppe).” Washington, DC: World Wildlife Fund. 2007d. <http://www.worldwildlife.org/wildfinder/searchByPlace.cfm?ecoregion=Na1313> (15 October 2007).

World Wildlife Fund. “Wyoming Basin Shrub Steppe.” Washington, DC: World Wildlife Fund. 2007e. <http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na1313_full.html> (13 September 2007).

Wyoming Department of Revenue. 2008. <http://revenue.state.wy.us> (25 February 2008).

Wyoming Department of Revenue. “State of Wyoming Department of Revenue 2007 Annual Report.” 2007. <http://revenue.state.wy.us/PortalVBVS/uploads/2007%20DOR%20Annual%20Report.pdf> (7 April, 2009).

Wyoming Department of Transportation. “WYDOT Traffic Analysis.” Cheyenne, Wyoming: Wyoming Department of Transportation. 2005. <http://www.dot.state.wy.us/Default.jsp?sCode=hwyta> (25 February 2008).

Wyoming Game and Fish Department. “Comprehensive Wildlife Conservation Strategy.” Cheyenne, Wyoming: Wyoming Game and Fish. 2008. <http://gf.state.wy.us/wildlife/CompConvStrategy/Species> (19 February 2008).

Wyoming Game and Fish Department. “Official State List of Birds, Mammals, Amphibians, and Reptiles in Wyoming.” Cheyenne, Wyoming: Wyoming Game and Fish. 2007a. <http://gf.state.wy.us/wildlife/nongame/SpeciesList/index.asp> (15 October 2007).

Wyoming Game and Fish Department. “Terrestrial Habitat/Aquatic Habitat/Habitat Management.” Cheyenne, Wyoming: Wyoming Game and Fish. 2007b. <http://gf.state.wy.us/habitat/aquatic/index.asp> (13 September 2007).

Wyoming Geographic Information Science Center. “Wyoming Gap Analysis.” Laramie, Wyoming: University of Wyoming, Wyoming Geographic Information Science Center. 2007. <http://www.wygisc.uwyo.edu/wbn/gap.html> (25 February 2008).

Wyoming State Geological Survey, Industrial Minerals and Uranium Section. “Uranium Page.” <http://www.wsgs.uwyo.edu/minerals/uranium.aspx> (15 July 2005).

Wyoming Workforce Development Council. “Wyoming Workers Commuting Patterns Study.” Cheyenne, Wyoming: Wyoming Workforce Development Council. 2007.

Zielinski, R.A. “Volcanic Rocks as Sources of Uranium.” *Uranium Deposits in Volcanic Rocks*. Vienna, Austria: International Atomic Energy Agency. pp. 83–95. 1984.

Zielinski, R.A. “Tuffaceous Sediments as Source Rocks for Uranium—A Case Study of the White River Formation, Wyoming.” *Journal of Geochemical Exploration*. Vol. 18. pp. 285–306. 1983.

3.4 Nebraska-South Dakota-Wyoming Uranium Milling Region

3.4.1 Land Use

The Nebraska-South Dakota-Wyoming Uranium Milling Region defined in this GEIS is represented by a south-southeast–north-northwest swath of land encompassing parts of Sioux and Dawes Counties in Nebraska; Fall River, Custer, Pennington, and Lawrence Counties in South Dakota; and Niobrara, Weston and Crook Counties in Wyoming (Figure 3.4-1).

This region lies within portions of the Missouri Plateau, the Black Hills and the High Plains sections of the Great Plains province (U.S. Geological Survey, 2004). The locations of past, current, and potential uranium milling operations are found in the Crow Butte Uranium District located in Dawes County, Nebraska; in the Southern Black Hills Uranium District in Fall River County, South Dakota, and Niobrara County, Wyoming; and in the Northern Black Hills Uranium District in Crook County, Wyoming (Figure 3.4-2). Details on the geology and soils of these three districts are provided in Section 3.4.3.

The general land ownership and use statistics for the Nebraska-South Dakota-Wyoming Uranium Milling Region shown next were calculated using the Geographic Information System used to construct the map shown in Figure 3.4-1. Private (surface ownership) lands (59 percent) and national forest and national grassland (38 percent combined) account for 97 percent of this region (Table 3.4-1). As described for the Wyoming West Uranium Milling Region in Section 3.1.1, there are also in this region privately owned surface rights and publicly owned subsurface mineral rights resulting in split estate situations (BLM, 2000a) (Section 3.1.2.2).

In the areas of interest in Dawes and Sioux Counties in Nebraska, the predominant land cover consists of a mix of western shortgrass prairie and western wheatgrass prairie, followed by agricultural fields and ponderosa pine forests and woodlands (Henebry, et al., 2005). A large portion of Dawes and Sioux Counties is occupied by the Oglala National Grassland to the north and west and by the Nebraska National Forest in the center, which are both administered by the USFS (Figure 3.4-1). These federal lands offer general recreational activities, including camping, fishing, and hunting (USFS, 2008b). Chadron, a 394-ha [972-acre] state park in the heart of the Nebraska National Forest, and Fort Robinson, a 8,900-ha [22,000-acre] state park of Pine Ridge scenery west of Crawford, also offer general recreational activities to the public. (Nebraska Game and Parks Commission, 2008). Similar to nearby Niobrara County in Wyoming to the west and Fall River County in South Dakota to the north, the dominant land use in these two northwestern Nebraska counties is cattle grazing on both public and private rangeland and associated livestock feed production. Cultivated lands mixed with the rangeland are used primarily to produce winter wheat and hay, which is both grazed and harvested.

Approximately half of Fall River County in the southwest corner of South Dakota is occupied by the Buffalo Gap National Grassland to the south and by the Black Hills National Forest to the north, which are both managed by the USFS. Higher elevation areas to the north into the Black Hills National Forest create favorable growing conditions for ponderosa pine. The lower elevation areas surrounding the Black Hills to the south are primarily used as rangeland for livestock grazing and as agricultural land. Hay and winter wheat farming are the principal agricultural uses in dry land areas, and alfalfa, corn, and vegetables are typically grown in wetter valley areas and on irrigated land (South Dakota State University, 2001). A large part of

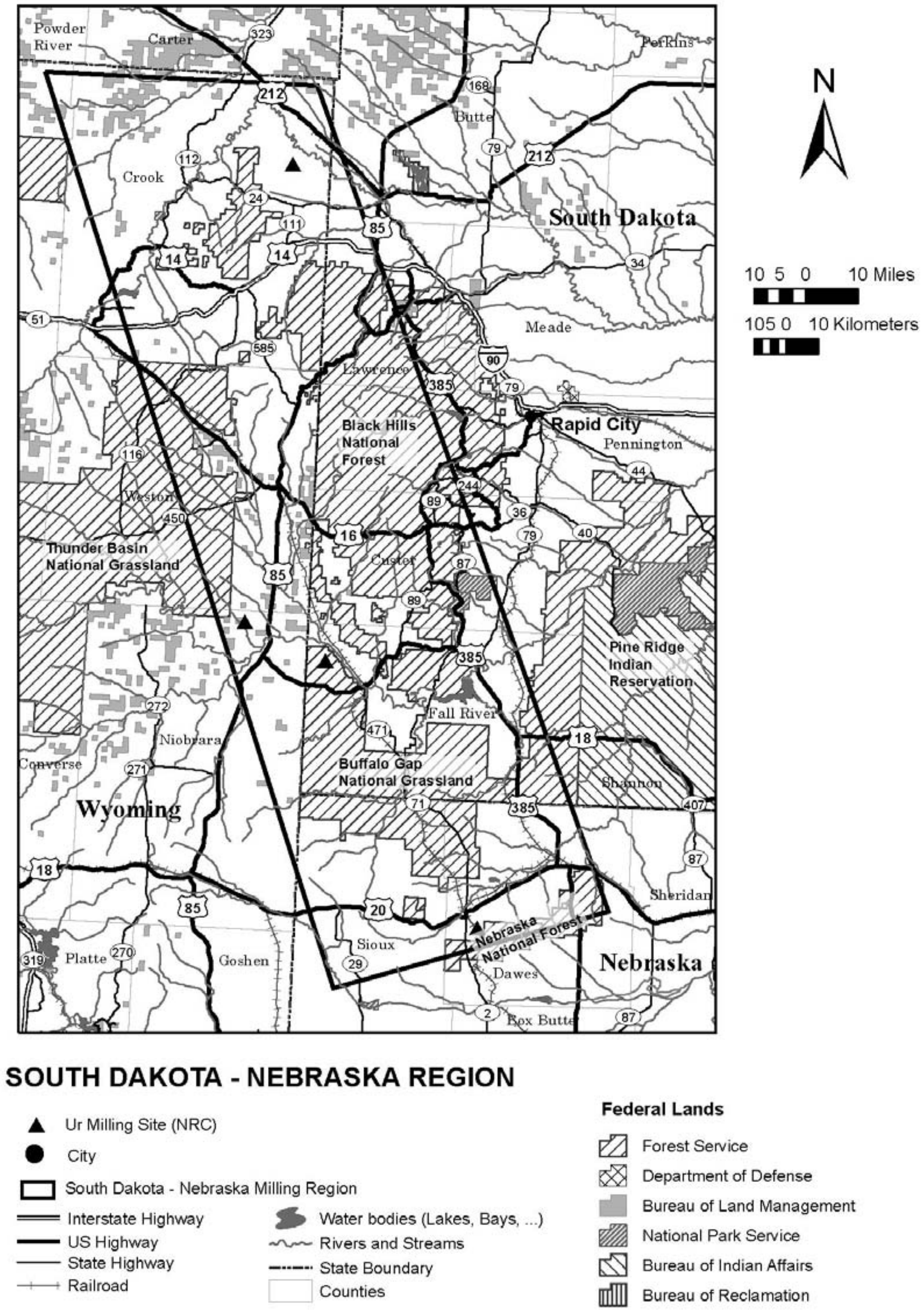


Figure 3.4-1. Nebraska-South Dakota-Wyoming Uranium Milling Region General Map With Current (Crow Butte, Nebraska) and Potential Future Uranium Milling Site Locations

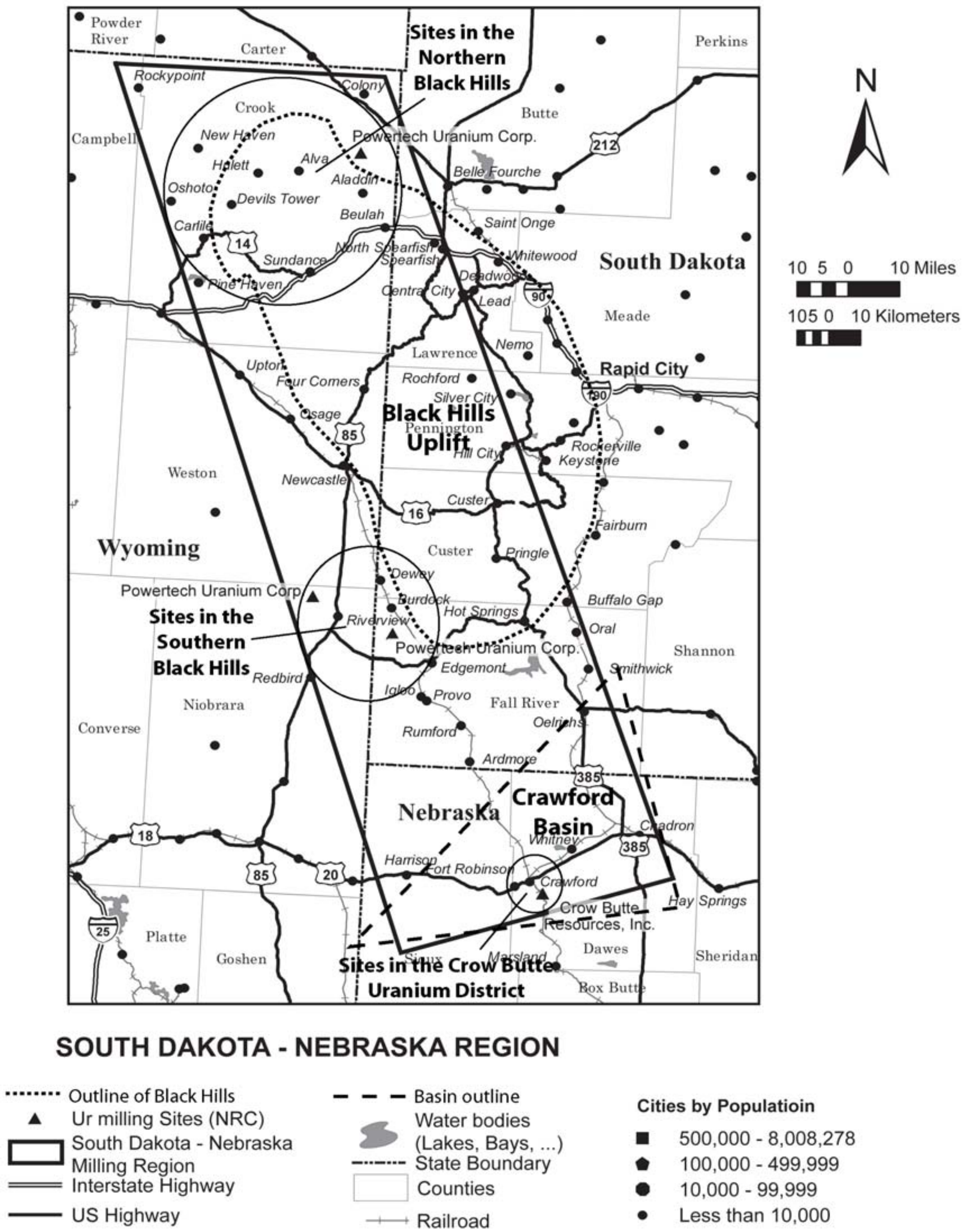


Figure 3.4-2. Map Showing the Nebraska-South Dakota-Wyoming Uranium Milling Region and Uranium Milling Sites in the Black Hills Uranium Districts in South Dakota and Wyoming and in the Crow Butte Uranium District in Nebraska

Table 3.4-1. Land Surface Ownership and General Use in the Nebraska-South Dakota-Wyoming Uranium Milling Region			
Land Surface Ownership and General Use	**Area (mi^2)**	**Area (km^2)**	**Percent**
State and Private Lands	5,379	13,932	58.6
U.S. Forest Service (USFS), National Forest	1,979	5,125	21.5
USFS, National Grassland	1,553	4,022	16.9
U.S. Bureau of Land Management, Public Domain Land	185	480	2
National Park Service, National Park	41	107	0.5
Bureau of Reclamation	16	42	0.2
USFS, Wilderness	22	56	0.2
USFS, National Recreation Area	4	11	0.05
National Park Service, National Monument	4	11	0.05
Totals	9,185	23,788	100

Shannon County, South Dakota, which abuts Fall River County to the east, is occupied entirely by the Pine Ridge Indian Reservation (Figure 3.4-1).

More than half of Custer, Pennington, and Lawrence Counties in South Dakota is also occupied by the Black Hills National Forest (Figure 3.4-1). In these counties, the majority of the land cover consists of ponderosa pine forest associated with short to tall grasslands and agricultural fields (South Dakota State University, 2001).

Historically, the Black Hills have been prospected and mined for many minerals, metals, and materials. Recreational activities provided in the Buffalo Gap National Grassland and in the Black Hills National Forest are similar to those described for USFS lands in Nebraska and in the Wyoming East Uranium Milling Region (USFS, 2008a,b).

In the eastern and northeastern Wyoming Counties of Niobrara and Crook, land ownership is predominantly private as it is in the Wyoming East Uranium Milling Region. BLM-administered lands, which are scattered and mixed with state and private lands, represent less than 10 percent of the land. In Weston County, located between Niobrara and Crook Counties, land ownership is dominated by the USFS Thunder Basin National Grassland. In its eastern half, a large portion of Crook County is occupied by the Black Hills National Forest. To the west of the forest on Route 24, Devils Tower National Monument, administered by the National Park Service, provides additional recreational activities in Crook County (Figure 3.4-1).

The characteristics of open rangeland in these three eastern Wyoming counties are similar to those of the Wyoming East Uranium Milling Region described in Section 3.3.1. Cattle and sheep grazing represent the primary land use on private and federal lands. Recreational activities available on federal lands are also similar to those described previously for parts of Nebraska, South Dakota and the Wyoming East Uranium Milling Region (Section 3.3.1).

3.4.2 Transportation

Past experience at NRC-licensed ISL facilities indicates these facilities rely on roads for transportation of goods and personnel (Section 2.8). As shown in Figure 3.4-3, the

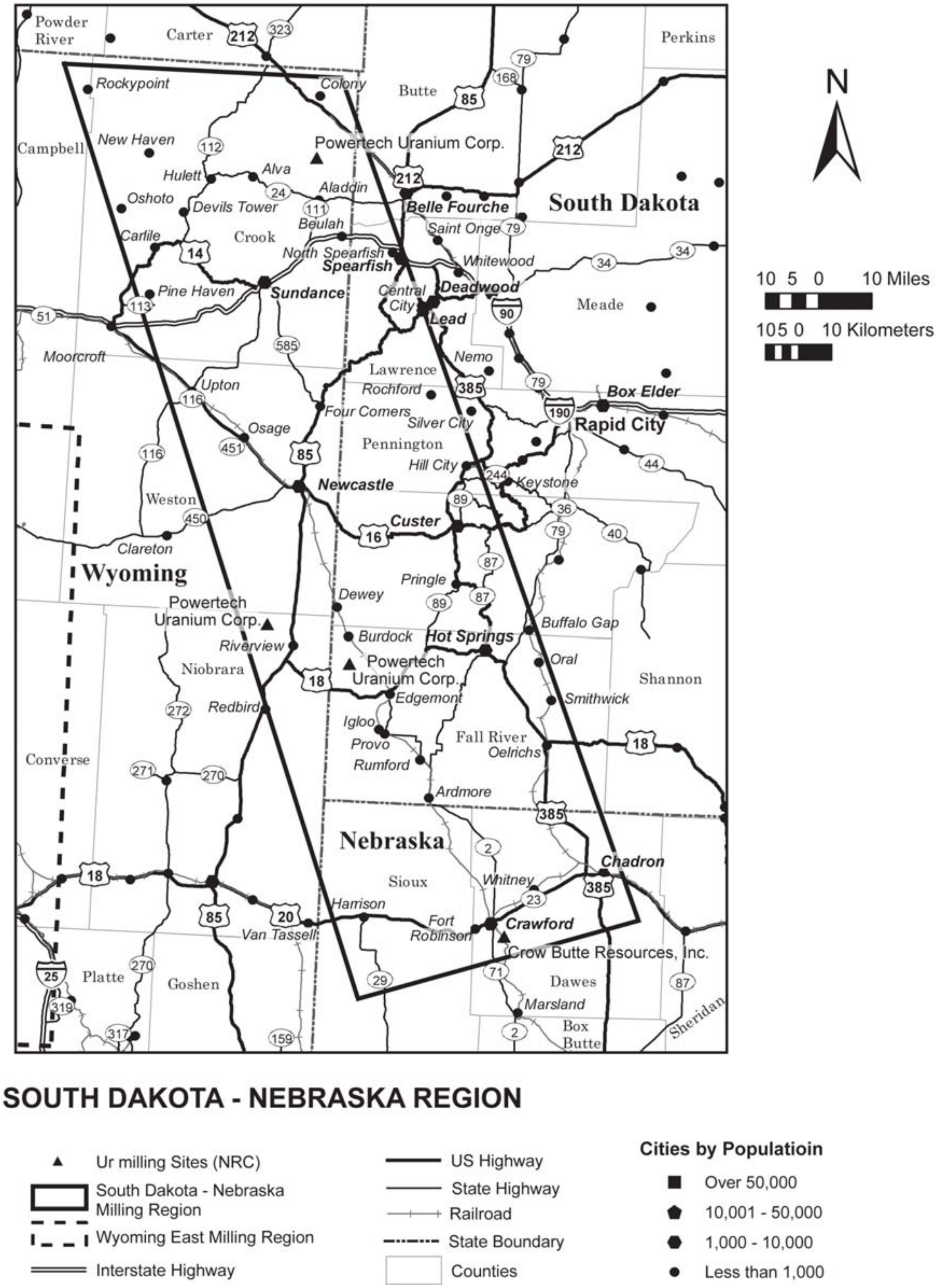


Figure 3.4-3. Nebraska-South Dakota-Wyoming Uranium Milling Region Transportation Corridor

Nebraska-South Dakota-Wyoming Uranium Milling Region is accessible by a variety of highways. In the northern part of the region, Interstate 90 connects Gillette, Wyoming, and Rapid City, South Dakota. U.S. Highway 212 enters the region from Montana to the north intersecting U.S. Highway 85 and then crossing Interstate 90 to the south and traversing the region southbound to intersect U.S. Highway 20. U.S. Highway 20 traverses the south portion of the region and connects with Interstate 25 to the west. A rail line serves the central portion of the South Dakota/Nebraska region along U.S. Highway 16 from the west to the intersection with U.S. Highway 85 at Newcastle and then south to Crawford at the southern boundary of the region.

Areas of past, present, or future uranium milling interest in the region are shown in Figure 3.4-3. These areas are located in three subregions when considering site access by local roads. The area of milling interest in the northeastern part of the region (north of Aladdin, Wyoming) is accessible by local access roads to U.S. Highway 212 southeast to U.S. Highway 85 south, which intersects Interstate 90. Traveling west from Aladdin, State Route 24 connects to U.S. Highway 14 and Interstate 90 continuing west to Gillette. Milling sites farther to the southwest of the region (near Burdock, South Dakota) are served by local access roads and U.S. Highway 18 west to connect with U.S. Highway 85 southbound that exits the region from the southwest. At Lusk, Wyoming, U.S. Highway 20 west provides access to Interstate 25. Areas of milling interest near the southern border of the region (near Crawford, Nebraska) are served by local access roads to U.S. Highway 20, which exits the region to the west to intersect Interstate 25.

Table 3.4-2 provides available traffic count data for roads that support areas of past or future milling interest in the Nebraska-South Dakota-Wyoming Uranium Milling Region. Counts are variable with the minimum all-vehicle count at 333 vehicles per day on U.S. Highway 16 west of Custer (westbound) and the maximum on Interstate 90 east of Spearfish (between Spearfish and Whitewood) at 9,491 vehicles per day. Most of the vehicle counts in the Nebraska-South Dakota-Wyoming Uranium Milling Region are above 400 vehicles per day.

Yellowcake product shipments are expected to travel from the milling facility to a uranium hexafluoride production (conversion) facility in Metropolis, Illinois (the only facility currently licensed by NRC in the United States for this purpose). Major interstate transportation routes are expected to be used for these shipments, which are required to follow NRC packaging and transportation regulations in 10 CFR Part 71 and U.S. Department of Transportation hazardous material transportation regulations at 49 CFR Parts 171–189. Table 3.4-3 describes representative routes and distances for shipments of yellowcake from locations of Uranium milling interest in the Nebraska-South Dakota-Wyoming Uranium Milling Region. Representative routes are considered owing to the number of routing options available that could be used by a future ISL facility. Because transportation risks are dependent on shipment distance, identification of representative routes is used to generate estimates of shipment distances for evaluation of transportation impacts in Chapter 4 (Section 4.2.2). An ISL facility could use a variety of routes for actual yellowcake shipments, but the shipment distances for alternate routes are not expected to differ significantly from those estimated for the representative routes.

3.4.3 Geology and Soils

Sandstone-hosted uranium ore deposits have been identified in western South Dakota, northeastern Wyoming, and in northwestern Nebraska (Figure 3.4-2). In the Nebraska-South

Table 3.4-2. Average Annual Daily Traffic Counts for Roads in the Nebraska-South Dakota-Wyoming Uranium Milling Region*

Road Segment	County, State	All Vehicles
State Route 24 at Devils Tower Junction (intersection with U.S. Highway 14)	Crook, Wyoming	982–1,236
State Route 14 at Devils Tower Junction (west intersection with State Route 24)	Crook, Wyoming	610–675
Interstate 90 at County Border East (near Beulah, Wyoming)	Crook, Wyoming	4,048–5,272
U.S. Highway 85 North of Belle Fourche (southbound in direction of U.S. Highway 212)	Butte, South Dakota	468–905†
Interstate 90 East of Spearfish (between Spearfish and Whitewood)	Lawrence, South Dakota	5,201–9,491†
U.S. Highway 16 West of Custer (westbound)	Custer, South Dakota	333–1,231†
U.S. Highway 385 North of Hot Springs (near north county line)	Fall River, South Dakota	425–1,243†
U.S. Highway 18 at Mule Creek Junction (intersection with U.S. Highway 85)	Niobrara, Wyoming	817–1,192
U.S. Highway 85 at Mule Creek Junction (south of intersection with U.S. Highway 18)	Niobrara, Wyoming	1,327–2,037
U.S. Highway 20 at Van Tassell (at east county line)	Niobrara, Wyoming	415–552
U.S. Highway 20 at Manville South (intersection with State Route 270)	Niobrara, Wyoming	1,418–1,891

*Wyoming Department of Transportation. "Wyoming Department of Transportation Traffic Analysis." 2005. <http://dot.state.wy.us/Default.jsp?sCode=hwyta> (27 December 2005).
South Dakota Department of Transportation. "Automatic Traffic Recorder Data." 2008. <http://gis.sd.gov/dot%5Fctysys/> (January 2008).
†Data for South Dakota are monthly averages of daily counts; Wyoming data are the arithmetic mean of average annual daily counts for each day of the week.

Table 3.4-3. Representative Transportation Routes for Yellowcake Shipments From the Nebraska-South Dakota-Wyoming Uranium Milling Region*

Origin	Destination	Major Links	Distance* (mi)
North of Aladdin, Wyoming	Metropolis, Illinois	Local access road northeast to U.S. Highway 212 U.S. Highway 212 southeast to U.S. Highway 85 U.S. Highway 85 south to Interstate 90 Interstate 90 east to Sioux Falls, South Dakota Interstate 29 south to Kansas City, Missouri Interstate 70 east to St. Louis, Missouri Interstate 64 east to Interstate 57 Interstate 57 south to Interstate 24 Interstate 24 south to U.S. Highway 45 U.S. Highway 45 west to Metropolis, Illinois	1,230

Table 3.4-3. Representative Transportation Routes for Yellowcake Shipments From the Nebraska-South Dakota-Wyoming Uranium Milling Region* (continued)			
Origin	Destination	Major Links	Distance* (mi)
Edgemont, South Dakota	Metropolis, Illinois	Local access road south to U.S. Highway 18 U.S. Highway 18 west to U.S. Highway 85 U.S. Highway 85 south to U.S. Highway 20 U.S. Highway 20 west to Interstate 25 Interstate 25 south to Denver, Colorado Interstate 70 east to St. Louis, Missouri Interstate 64 east to Interstate 57 Interstate 57 south to Interstate 24 Interstate 24 south to U.S. Highway 45 U.S. Highway 45 west to Metropolis, Illinois	1,410
Crawford, Wyoming	Metropolis, Illinois	Local access roads north to U.S. Highway 20 U.S. Highway 20 west to Interstate 25 Interstate 25 south to Denver, Colorado Denver, Colorado, to Metropolis, Illinois (as above)	1,360
*American Map Corporation. "Road Atlas of the United States, Canada, and Mexico." Long Island City, New York: American Map Corporation. p. 144. 2006.			

Dakota-Wyoming Uranium Milling Region, uranium mineralization is found in fluvial sandstones in two major areas: the Black Hills of western South Dakota and northeastern Wyoming and the Crawford Basin of northwestern Nebraska. Uranium mineralization in the sandstone-hosted uranium deposits in these two areas is in a geologic setting amenable to recovery by ISL milling.

3.4.3.1 The Black Hills (Western South Dakota-Northeastern Wyoming)

The Black Hills are an asymmetrical domal uplift elongated in a northwest direction (Figure 3.4-4). Economically significant uranium discoveries in the Black Hills are contained within strata of the Inyan Kara Group (Chenoweth, 1988). Prior to 1968, the Black Hills produced approximately 1,800 metric tons [2,000 tons] of U_3O_8 (Hart, 1968). The bulk of this production came from the Hulett Creek and Carlile districts of the northern Black Hills and the Edgemont district of the southern Black Hills (Figure 3.4-4).

Stratigraphic units present in the Black Hills area are shown in Figure 3.4-5. Jurassic (144 to 206 million year old) and Cretaceous (65 to 144 million year old) rocks crop out low on the flanks of the Black Hills and form the eroded surface upon which younger rocks were deposited (Harshman, 1968). Sedimentary rocks of Tertiary (1.8 to 65 million year old) age are virtually absent from the Black Hills. However, remnants of Miocene (5.3 to 23.8 million year old) and/or Pliocene (1.8 to 5.3 million year old) age rocks on the flanks of the Black Hills indicate that at one time rocks of middle and late Tertiary age may have extended across the area and at least partially buried the Black Hills uplift. The Tertiary rocks are tuffaceous (i.e., they contain materials made from volcanic rock and mineral fragments in a volcanic ash matrix) and clastic (i.e., they contain fragments or grains of older rocks) and are of fluvial (river), lacustrine (lake), and paludal (marsh) origin.

The Inyan Kara Group is Lower Cretaceous (99 to 144-million-years-old) in age and consists of subequal amounts of complexly interbedded sandstone and claystone (Renfro, 1969). The

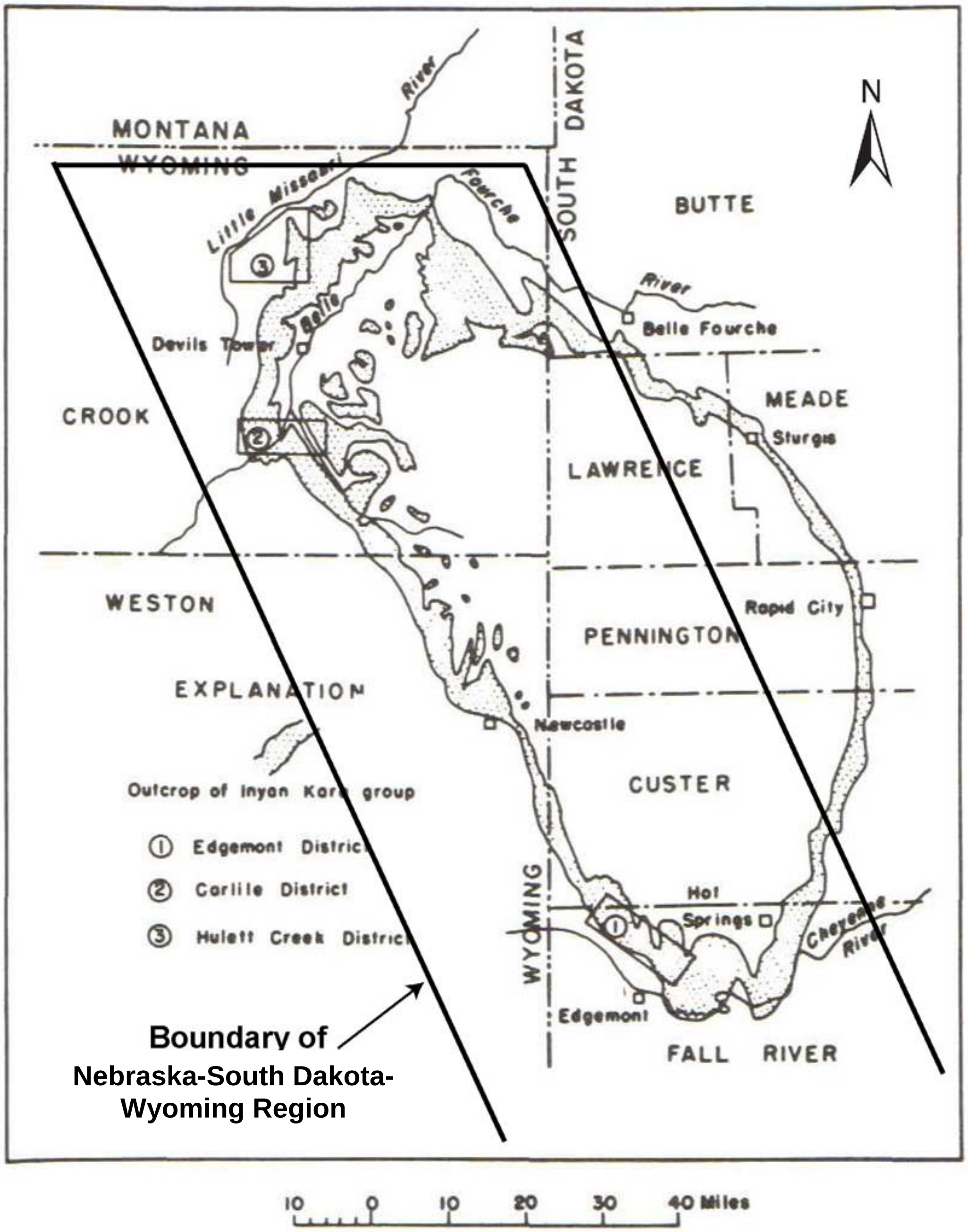


Figure 3.4-4. Outcrop Map of the Inyan Kara Group in the Black Hills of Western South Dakota and Northeastern Wyoming Showing the Locations of Principal Uranium Mining Districts (From Hart, 1968)

<table>
<tr><th colspan="4">Black Hills Area</th></tr>
<tr><th>System</th><th>Series</th><th colspan="2">Formation</th></tr>
<tr><td rowspan="5">Tertiary</td><td>Pliocene</td><td colspan="2">Ogallala Formation</td></tr>
<tr><td>Miocene</td><td colspan="2">Arikaree Formation</td></tr>
<tr><td>Oligocene</td><td colspan="2">White River Formation</td></tr>
<tr><td>Eocene</td><td colspan="2">(Absent)</td></tr>
<tr><td>Paleocene</td><td colspan="2">Fort Union Formation</td></tr>
<tr><td rowspan="8">Cretaceous</td><td rowspan="5">Upper</td><td colspan="2">Hell Creek Formation</td></tr>
<tr><td colspan="2">Fox Hills Sandstone</td></tr>
<tr><td colspan="2">Pierre Shale</td></tr>
<tr><td colspan="2">Niobrara Formation</td></tr>
<tr><td colspan="2">Carlile Shale, Greenhorn Formation, and Belle Fourche Shale</td></tr>
<tr><td rowspan="3">Lower</td><td colspan="2">Mowry Shale</td></tr>
<tr><td colspan="2">Newcastle Sandstone and Skull Creek Shale</td></tr>
<tr><td>Fall River and Lakota Formations</td><td>Inyan Kara Group</td></tr>
<tr><td colspan="2" rowspan="3">Jurassic</td><td colspan="2">Morrison Formation</td></tr>
<tr><td colspan="2">Sundance Formation</td></tr>
<tr><td colspan="2">Gypsum Spring Formation</td></tr>
</table>

Figure 3.4-5. Principal Stratigraphic Units in the Black Hills Area of Western South Dakota and Northeastern Wyoming

Inyan Kara is bounded below by continental Jurassic sediments of the Morrison Formation and is overlain by marine sediments of the Lower Cretaceous Skull Creek Shale. Resistant Inyan Kara sediments form the outermost ring of hogback ridges that crop out in a roughly oval pattern around the flanks of the Black Hills. Major uranium deposits occur from 2 to 8 km [1 to 5 mi] downdip from the main Inyan Kara escarpment at depths ranging from 30 to 180 m [100 to 600 ft].

The Inyan Kara Group is formally subdivided into the Lakota Formation and the Fall River Formation, which are generally accepted to be respectively continental and marginal marine in origin (Robinson, et al., 1964). The source of sediment for the Lakota and Fall River is considered to include all pre-Cretaceous sediments that were exposed to the south and east of the Black Hills (Renfro, 1969).

The Lakota is a sequence of coastal-plain deposits of fine-grained, poorly sorted sandstone and mudstone; channel-fill deposits of cross-bedded sandstone; natural levee and overbank deposits of lenticular (i.e., deposits with a lens-shaped cross section), fine-grained, carbonaceous sandstone and siltstone; and floodplain deposits of bedded siltstone, mudstone, and claystone (Maxwell, 1974). The Lakota Formation is from 15 to 90 m [50 to 300 ft] thick and thickens regionally from northwest to southeast (Chenoweth, 1988).

The oldest Lakota strata are thin, discontinuous dark gray to olive black, humic sandstone and claystone containing sparse subbituminous coal seams (Renfro, 1969). These strata appear to conform with the underlying Morrison Formation. The lowermost Lakota grades upward to a sequence of dark gray, medium- to coarse-grained, cherty and quartzose sandstone containing abundant disseminated carbon and pore-filling, massive pyrite. The uppermost Lakota consists of lenticular greenish gray to dark gray, fine- to medium-grained, quartzose sandstone and varicolored claystone.

Dondanville (1963) divided the Fall River Formation into deltaic and marine facies. The deltaic facies forms approximately 50 percent of the formation and consists of channel sandstone, interchannel sandstone and mudstone, and blanket sandstone formed during erosion of abandoned deltas. The marine and marginal-marine rocks consist of offshore and lagoonal mudstone and shale, and bar and spit sandstone. The Fall River is from 30 to 45 m [100 to 150 ft] thick and thickens regionally from southeast to northwest at the expense of the underlying Lakota Formation.

Renfro (1969) describes the Fall River as a light to dark gray, fine- to medium-grained quartzose sandstone containing traces of glauconite and abundant disseminated carbon, pyrite, and detrital chert. Thin beds of claystone and siltstone are common. The Fall River is in conformable contact and regionally intertongues with the overlying Skull Creek Shale.

Uranium deposits in the Inyan Kara Group are typified by roll-front accumulations (see Section 3.1.1). The geometric complexity of individual roll fronts is governed by the stratigraphic complexity of the Inyan Kara host sediments. Most roll fronts are within tabular sandstones of the Fall River Formation or widespread cherty sandstone facies of the Lakota Formation and have simple C-shaped cross sections that extend laterally for tens of kilometers [tens of miles] (Figure 3.4-6). Roll-front deposits in the more complex sandstone and claystone facies of the upper Lakota Formation are very erratic and generally contain relatively weak mineralization. Mineralization in the roll limbs seldom extends more than 90 to 120 m [300 or 400 ft] up-plunge from the roll fronts. Although roll fronts in the Inyan Kara are common, ore grade

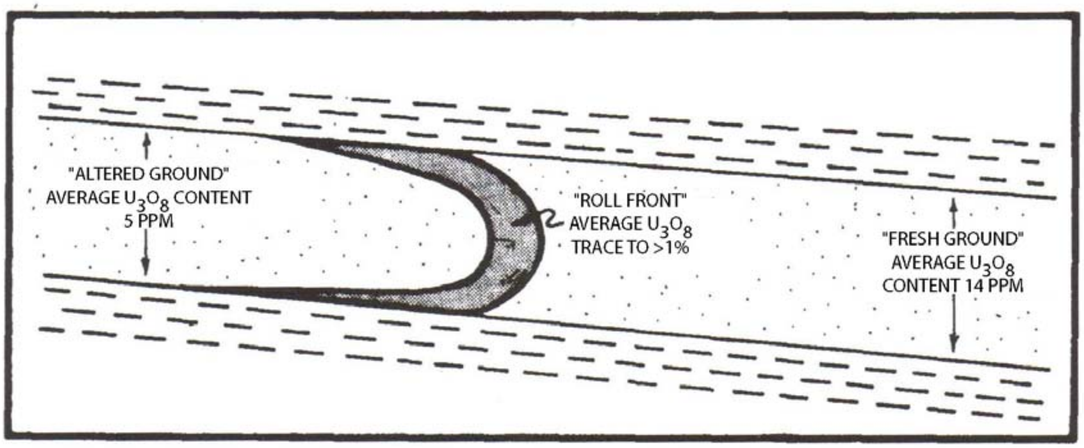


Figure 3.4-6. Schematic Cross Section Through a Typical Inyan Kara Roll-Front Deposit Showing Differences in U_3O_8 Concentration Between "Fresh" (i.e., Unoxidized) and "Altered" Ground (Modified From Renfro, 1969)

mineralization is restricted vertically and laterally. Ore most often occurs in terminal lobes of the roll-front trends. Within Inyan Kara ore bodies, uranium minerals coat sand grains, fill interstices between grains, and are finely disseminated in organic matter (Renfro, 1969). In oxidized deposits, the uranium vanadates, carnotite, tyuyamunite, and meta-tyuyamunite are the principal ore minerals. Uraninite and coffinite are the main minerals in unoxidized ore. Pyrite, marcasite, and calcite are present as gangue minerals (i.e., low-value minerals intermixed with ore minerals).

Tongues of hematite-stained pinkish-red sandstone are present at most of the deposits. This alteration is due to the oxidation of pyrite in the sandstone by migrating groundwater.

The source of uranium in the Inyan Kara deposits is unknown, but two main theories have been proposed. Renfro (1969) proposed that the uranium and other metals indigenous to the Lakota and Fall River sediments were mobilized by oxidizing groundwater and transported downdip, where they were precipitated along an oxidation-reduction boundary. Hart (1968) proposed that uranium was leached by groundwater from tuffaceous beds of the White River Group that were unconformably deposited across the eroded Black Hills uplift. Migrating groundwater carried the uranium into the permeable host rocks where it traveled downdip into reducing environments. Later groundwater movements remobilized and redeposited some of the ore bodies.

The surface of the Black Hills range is still largely mantled by sedimentary rocks that form an outer ring of hogback ridges that crop out in a roughly oval pattern around the flanks of the range. Soils in low lying areas adjacent to the Black Hills of western South Dakota and northeastern Wyoming consist of the weathering products of these sedimentary rocks. The topographic position and texture of typical soils in the Black Hills were obtained from Munn and Arneson (1998). This map was designed primarily for a statewide study of groundwater's vulnerability to contamination and would not be expected to be used for site-specific soil interpretations at proposed ISL milling facilities. For site-specific evaluations, detailed soils information would be expected to be obtained from published county soil surveys or NRCS.

Soils within the Black Hills area of western South Dakota and northeastern Wyoming are mostly fine textured (fine or fine-loamy soils). Shallow fine and fine-loamy soils with little or no subsoil development are found on ridges and steep slopes on the flanks of Black Hills. On gently sloping to moderately steep slopes adjacent to ridges, moderately deep fine and fine-loamy soils with moderate- to well-developed soil horizons are found. These soils are generally light colored and depleted in moisture. On low gradient surfaces, such as terraces and floodplains, deep fine and fine-loamy soils with well-developed subsoil horizons are found. Dark-colored, base-rich soils formed under grass are generally associated with floodplains along streams with permanent high water tables.

3.4.3.2 The Crawford Basin (Northwestern Nebraska)

Uranium deposits in northwestern Nebraska are located in Dawes and Sioux Counties in what has been named the Crawford Basin (Figure 3.4-2) (DeGraw, 1969). In 1979, an area west of the city of Crawford in Sioux County and an area north of Crawford in Dawes County were identified as having considerable weak uranium mineralization associated with vague oxidation-reduction boundaries (Collings and Knode, 1984). In 1981 and 1982, the Crow Butte mineralized trend was discovered southeast of Crawford in Dawes County. The Crow Butte mineralized trend is about 10 km [6 mi] long and up to 900 m [3,000 ft] wide with ore reserves calculated to be over 13,600 metric tons [15,000 tons] of U_3O_8 having an average grade exceeding 0.25 percent U_3O_8 (Collings and Knode, 1984). Uranium mineralization in the Crow Butte area occurs exclusively within the Chadron Sandstone.

The Crawford Basin is a triangular, asymmetrical basin bounded by the Black Hills Uplift on the northwest, the Chadron Arch to the west, and the Cochran Arch to the south (Figure 3.4-7). As a result of the Black Hills Uplift, formations underlying the uranium milling areas in the Crawford Basin dip gently to the south. The single most prominent structural feature within the Crawford Basin is the White River Fault. It is located north of Crawford and strikes northeast to southwest with the upthrown side to the south. The total vertical displacement is 60 to 120 m [200 to 400 ft].

A generalized stratigraphic section of sedimentary strata in the Crow Butte mining area of northwestern Nebraska is shown in Figure 3.4-8. Stratigraphic descriptions presented here are limited to formations that may be involved in potential milling operations or formations that may have environmental significance, such as important aquifers or confining units above and below potential milling zones.

The Upper Cretaceous (65- to 99-million-year-old) Pierre Shale is a widespread, compositionally uniform, dark gray to black marine shale, which outcrops extensively in Dawes County north of the Crow Butte mining area (Collings and Knode, 1984). In Dawes County, the Pierre Shale is 365 to 460 m [1,200 to 1,500 ft] thick and is essentially impermeable. Due to aerial exposure and subsequent erosion, the top of the present-day Pierre Shale contact marks a major unconformity and exhibits a paleotopography with considerable relief (DeGraw, 1969). As a result of the extended exposure to atmospheric weathering, an ancient soil horizon, or paleosol, from 0 to 10 m [0 to 33 ft] thick, was formed on the surface of the Pierre Shale.

The Oligocene (23.8- to 33.7-million-year-old) White River Group lies unconformably on top of the Pierre Shale. The White River Group consists of the Chadron and Brule Formations. The Chadron comprises three distinct units: the Basal Chadron Sandstone Member, Middle Chadron Member, and Upper Chadron Member.

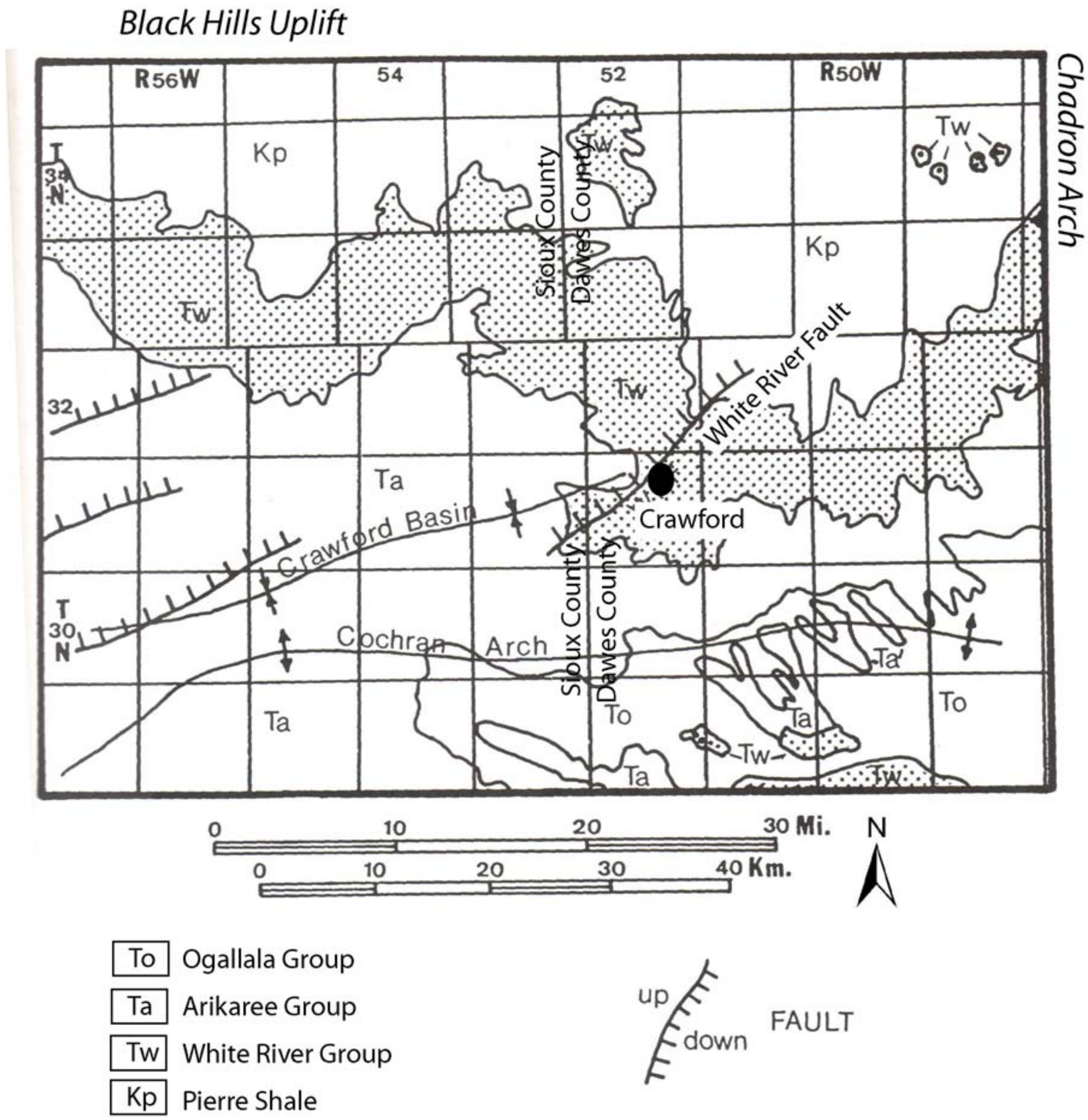


Figure 3.4-7. Bedrock Geology and Major Structural Features of the Crawford Basin (Modified From Gjelsteen and Collings, 1988)

Uranium mineralization in the Crow Butte mineralized trend occurs exclusively within the Basal Chadron Sandstone. The Basal Chadron Sandstone Member consists of coarse-grained arkosic sandstone (i.e., sandstone containing a significant fraction of feldspar) with frequent interbedded thin clay beds. Occasionally, the lower portion of the Basal Member is a very coarse, poorly sorted conglomerate. The Basal Sandstone is the depositional product of a large, braided stream system and ranges from 0 to 105 m [0 to 350 ft] thick.

The Middle Chadron Member overlies the Basal Sandstone Member. The lower part of the Middle Member is impermeable brick-red clay with occasional interbedded gray-green clay. The brick-red clay grades upward to a light green-gray sandy claystone. The upper part of the Middle Member is light gray bentonitic clay. The Middle Member ranges from 12 to 30 m [40 to

<table>
<tr><th colspan="4">Northwestern Nebraska</th></tr>
<tr><th>Age</th><th>Group</th><th>Formation</th><th>Member</th></tr>
<tr><td>Miocene</td><td rowspan="2">Arikaree</td><td>Monroe Creek</td><td rowspan="2"></td></tr>
<tr><td rowspan="6">Oligocene</td><td>Gering</td></tr>
<tr><td rowspan="5">White River</td><td rowspan="2">Brule</td><td>Whitney</td></tr>
<tr><td>Orella</td></tr>
<tr><td rowspan="3">Chadron</td><td>Upper</td></tr>
<tr><td>Middle</td></tr>
<tr><td>Basal</td></tr>
<tr><td>Eocene ?</td><td></td><td>Paleosol</td><td></td></tr>
<tr><td>Cretaceous</td><td></td><td>Pierre Shale</td><td></td></tr>
</table>

Figure 3.4-8. Generalized Stratigraphic Units in the Crow Butte Area of Northwestern Nebraska (Modified From Collings and Knode, 1984)

100 ft] thick. The Upper Chadron Member consists of massive claystones and siltstones, generally considered to be fluvial in origin (Vondra, 1958). The Upper Chadron Member averages 30 m [100 ft] thick throughout the Crow Butte mining area.

The Brule Formation lies conformably on top of the Chadron Formation and consists almost entirely of siltstones with minor sand channels. The Brule is subdivided into two members: the Orella and the Whitney. The Orella lies directly on the Chadron and is composed of buff to brown siltstones. The Whitney comprises massive buff to brown siltstones and contains several volcanic ash horizons.

Uranium deposits in the Basal Chadron Sandstone are associated with oxidation-reduction boundaries or roll fronts (see Section 3.1.1) adjacent to the White River Fault (Figure 3.4-9). Within the Crow Butte uranium ore trend, the Basal Chadron is about 12 m [40 ft] thick (Collings and Knode, 1984). Depth to mineralization varies from 85 to 250 m [275 to 820 ft]. Uranium is present in the matrix and as a coating on grains as coffinite and uraninite, and occurs locally in concentrations as high as 3.0 percent (Gjelsteen and Collings, 1988). The volcaniclastic sediments contained in and overlying the Chadron sandstone are considered to be the most likely source of the uranium of the roll-front deposits in the Crawford Basin because of their abundance, close proximity, and susceptibility to dissolution (Gjelsteen and Collings, 1988).

The distribution and occurrence of soils in Nebraska-South Dakota-Wyoming Uranium Milling Region vary regionally with respect to landform development (e.g., ridges, floodplains, hills) and

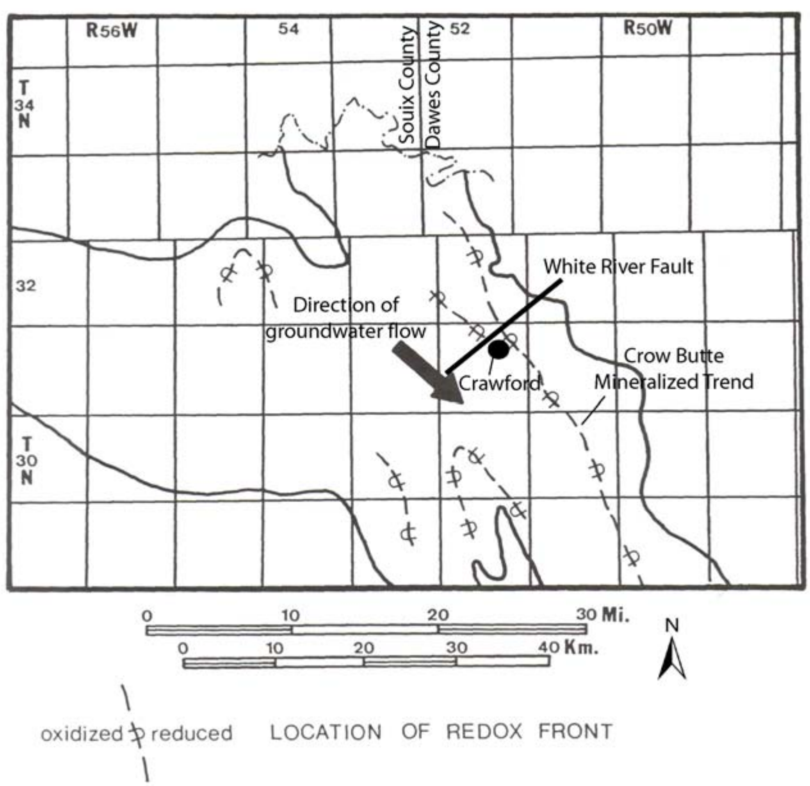


Figure 3.4-9. Location of Oxidation-Reduction Fronts Detected During Exploration Drilling Within the Chadron Sandstone in Northwestern Nebraska. Arrow Shows Direction of Groundwater Flow at the Time of Mineralization as Indicated by Roll-Front Geometry (Modified From Gjelsteen and Collings, 1988).

locally with changes in slope, geology, vegetation, climate, and time. The general characteristics of soils associated with landforms in Dawes County were obtained from the U.S. Department of Agriculture (NRCS, 2007). For site-specific evaluations at proposed ISL milling facilities, more detailed soils information can be obtained from published county soil surveys or the NRCS.

In Dawes County, silt loam and silty clay loam soils having little to moderate horizon development are found on ridges. These shallow to moderately shallow soils occur on steep slopes where erosion activity is greatest. Soils on hillslopes vary from soils having little or moderate horizon development to soils that have well-developed horizons (deep soils). Silty clay and silty clay loam soils having little to moderate horizon development are found on the steeper parts of hillslopes where erosional activity is greatest. Silty clay loam and loamy, very fine sand soils having well-developed horizons are found on gently sloping parts of hillslopes. On plains, which are nearly level or gently sloping, silt loam soils with well-developed clay horizons are found. Soils found on stream terraces and floodplains are generally very deep, with soil textures that are highly variable, depending on the local geology. Silty clay, silty clay loam, silt loam, and loam soils are found on stream terraces. Clay, loamy very fine sand, and sandy loam soils are found on floodplains.

3.4.4 Water Resources

3.4.4.1 Surface Waters

The Nebraska-South Dakota-Wyoming Uranium Milling Region includes portions of northwestern Nebraska, eastern Wyoming, and southwest South Dakota. Average annual surface runoff, in terms of average annual flow per unit area of a watershed in the Nebraska-South Dakota-Wyoming Uranium Milling Region, ranges from approximately 5 cm/yr [2 in/yr] in the higher elevations of the Black Hills to less than 1.3 cm/yr [0.5 in/yr] on the plains surrounding the Black Hills. Watersheds in the Nebraska-South Dakota-Wyoming Uranium Milling Region are shown in Figure 3.4-10. The watersheds within the Nebraska-South Dakota-Wyoming Uranium Milling Region are listed in Table 3.4-4 along with the generic designated uses of surface water bodies in these watersheds. The designated uses of water bodies in these watersheds differ slightly from state to state. Thus, the designated uses for water bodies in watersheds that cross state boundaries may be different. To simplify the discussion of the water quality characteristics of water bodies in each watershed, the designated uses in Table 3.4-4 have been grouped into the following generic categories: fisheries, fish and wildlife propagation, recreation, drinking water supply, agriculture, industrial, and aesthetic. Water bodies with the generic use as a fishery may support either warm-water or cold-water species. More detailed descriptions of the designated uses in each state can be found in the following references

- Wyoming—WDEQ (2001; 2008)
- Nebraska—Nebraska Department of Environmental Quality (2008)
- South Dakota—South Dakota Department of Environmental and Natural Resources (2008)

Not all water bodies within a watershed may have all of the designated uses listed in Table 3.4-4. For example, a watershed may contain perennial streams, intermittent streams that flow only during portions of the year, and ephemeral streams that flow only due to surface runoff from local precipitation events. The perennial streams and possibly portions of

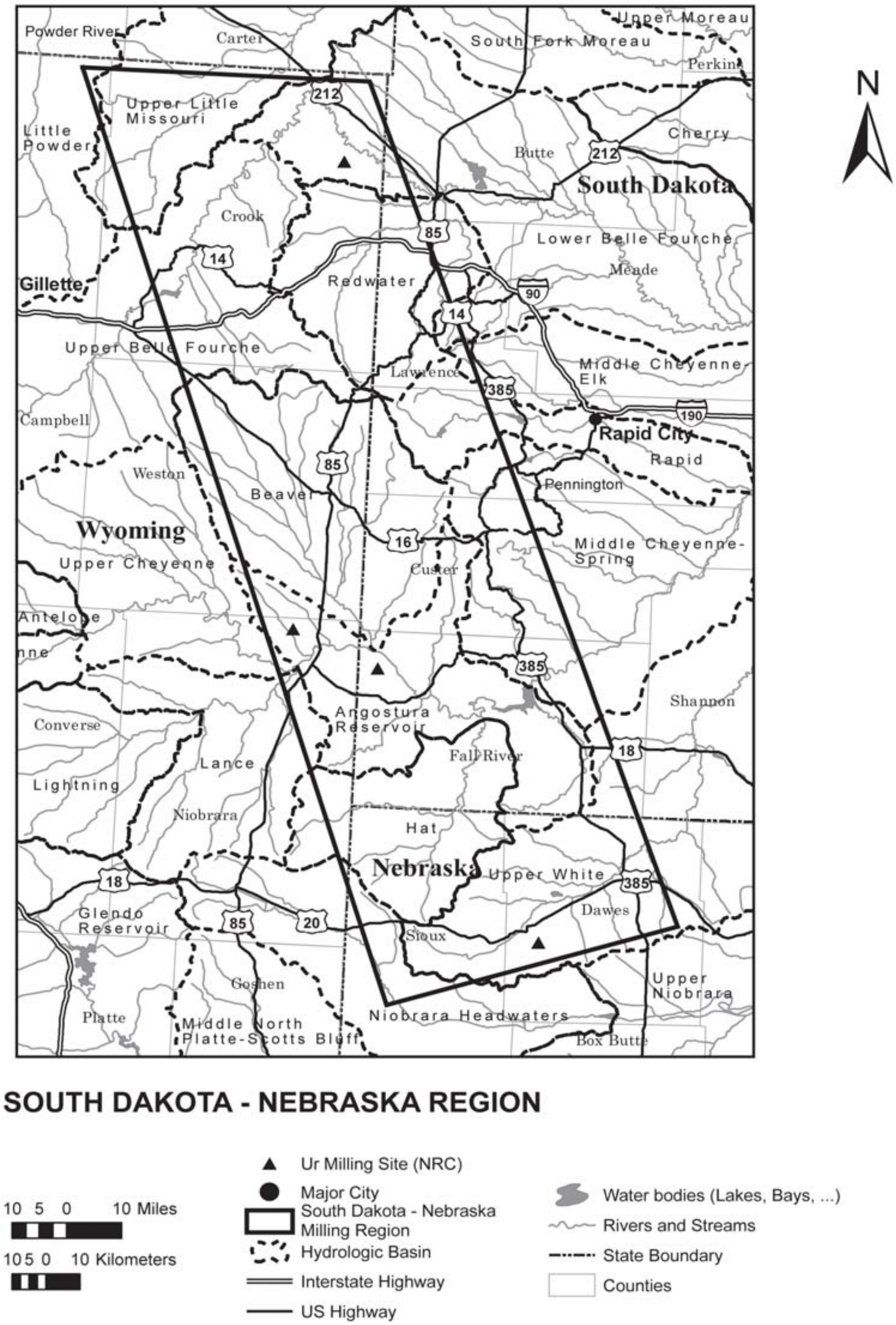


Figure 3.4-10. Watersheds Within the Nebraska-South Dakota-Wyoming Uranium Milling Region

Table 3.4-4. Primary Watersheds in the Nebraska-South Dakota-Wyoming Uranium District and Range of Generic Designated Uses of Water Bodies Within Each Watershed

Watershed	Generic State Designated Uses of Water Bodies in the Watershed	
Upper White River	Nebraska	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Aesthetics
Hat Creek	Nebraska	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Aesthetics
	South Dakota	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Aesthetics
Angostura Reservoir	South Dakota	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Aesthetics
Cheyenne River Above Angostura Reservoir	South Dakota	Fisheries Fish and Wildlife Propagation Recreation Agriculture Aesthetics
	Wyoming	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Industrial Aesthetics

Table 3.4-4. Primary Watersheds in the Nebraska-South Dakota-Wyoming Uranium District and Range of Generic Designated Uses of Water Bodies Within Each Watershed (continued)

Watershed	Generic State Designated Uses of Water Bodies in the Watershed	
Beaver Creek	South Dakota	Fisheries Fish and Wildlife Propagation Recreation Agriculture Aesthetics
	Wyoming	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Industrial Aesthetics
Upper Belle Fourche River and Tributaries	Wyoming	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Industrial Aesthetics
Lower Belle Fourche River and Tributaries	South Dakota	Fisheries Fish and Wildlife Propagation Recreation Agriculture Aesthetics
	Wyoming	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Industrial Aesthetics
Redwater River and Tributaries	South Dakota	Fisheries Fish and Wildlife Propagation Recreation Agriculture Aesthetics
	Wyoming	Fisheries Fish and Wildlife Propagation Drinking Water Recreation Agriculture Industrial Aesthetics

intermittent streams may be designated as “fisheries,” whereas ephemeral streams are unlikely to be designated as fisheries. The descriptions of the water bodies and their classifications in this section focus on perennial streams that generally have higher designated uses than the intermittent and ephemeral streams.

Surface water features in specific areas of uranium mineralization within the Nebraska-South Dakota-Wyoming Uranium Milling Region are discussed next.

Nebraska

The area of known uranium mineralization in Nebraska is located in Dawes County within the Upper White River Watershed (Figure 3.4-10). The average annual flow of the White River at the Nebraska-South Dakota state line, near the northern limit of known uranium deposits, was approximately 1.1 m^3/s [40 ft^3/s] for water years 1988 through 2007 (U.S. Geological Survey, 2008a). The state-designated uses for the White River above Chadron, Nebraska, are drinking water supply, aquatic life (cold water), agriculture, and aesthetics (Nebraska Department of Environmental Quality, 2008).

The immediate area of uranium mineralization is drained by White Clay Creek, Squaw Creek, and English Creek, with headwaters in the Nebraska National Forest along Pine Ridge. Small surface impoundments are present along these creeks and are used for stock watering. The state-designated uses for these perennial creeks are aquatic life (cold water), fish consumption, agriculture, and aesthetics (Nebraska Department of Environmental Quality, 2008). These streams are not identified as having impaired water quality.

The Nebraska-South Dakota-Wyoming Uranium Milling Region also includes a portion of Sioux County and the Hat Creek Watershed. Hat Creek is a tributary to the Cheyenne River above Angostura Reservoir in South Dakota. The average flow of Hat Creek at the gauging station near Edgemont, South Dakota, is 0.45 m^3/s [16 ft^3/s] (U.S. Geological Survey, 2008a). The only impaired water body reported in the Hat Creek Watershed is Meng Lake, which has high conductivity and impaired pH (Nebraska Department of Environmental Quality, 2008).

South Dakota and Wyoming

The uranium deposits in the Nebraska-South Dakota-Wyoming Uranium Milling Region of South Dakota and Wyoming occur around the western and northern flanks of the Black Hills. The principal uranium deposits are in Fall River County, South Dakota, within the Angostura Reservoir Watershed and in Niobrara, Weston, and Crook Counties in Wyoming (Hart, 1968) within the Angostura Reservoir and Lower Belle Fourche River Watersheds. Although Custer, Pennington, and Lawrence Counties in South Dakota are included within the Nebraska-South Dakota-Wyoming Uranium Milling Region, uranium deposits are not known to exist in these counties. The primary watersheds in South Dakota and Wyoming that may contain uranium deposits within the Nebraska-South Dakota-Wyoming Uranium Milling Region are listed in Table 3.4-4 along with their generic state-designated uses and any known impairments to these uses. Although the Nebraska-South Dakota-Wyoming Uranium Milling Region shown in Figure 3.4-10 includes small portions of additional watersheds on its periphery, these secondary watersheds are not in areas of anticipated uranium milling activities.

The uranium deposits in South Dakota occur within the watersheds of the Cheyenne River upstream of Angostura Reservoir, Beaver Creek, Redwater River, and Lower Belle Fourche River (Figure 3.4-10). Within South Dakota, the Cheyenne River has generic designated uses of fisheries, fish and wildlife propagation, recreation, irrigation, and aesthetics. According to South Dakota Department of Environment and Natural Resources (2008), the Cheyenne River above Angostura Reservoir is impaired due to high salinity from natural salts. The average flow of the Cheyenne River at Edgemont, South Dakota, is 2.1 m^3/s [75 ft^3/s] (U.S. Geological Survey, 2008a). The upland portions of the uranium district are primarily drained by ephemeral and intermittent streams with the exception of the lower reach of Red Canyon Creek, which is perennial and fed by springs on the flanks of the Black Hills.

The Beaver Creek Watershed includes portions of Custer and Pennington counties in South Dakota and Weston County in Wyoming. The generic designated uses of Beaver Creek and its tributaries are listed in Table 3.4-4. Portions of Beaver Creek and its tributaries within South Dakota are impaired due to elevated temperature, salinity, and turbidity (South Dakota Department of Environment and Natural Resources, 2008). The average flow of Beaver Creek at Mallo Camp, Wyoming, is 0.05 m^3/s [1.8 ft^3/s] for water years 1992 and 2008.

The Upper Belle Fourche Watershed is located in Wyoming northwest of the Beaver Creek Watershed in Weston and Crook Counties. The generic designated uses of the Upper Belle Fourche River and its tributaries are listed in Table 3.4-4. A number of perennial streams flowing from the flanks of the Black Hills, such as Inyan Kara Creek, are also present in this watershed. These streams are fed by springs on the flanks of the Black Hills. Streams in portions of the Upper Belle Fourche Watershed are impacted by elevated fecal coliform from unidentified sources (WDEQ, 2008).

The Lower Belle Fourche Watershed extends from northeastern Crook County in Wyoming (downstream of the Upper Belle Fourche Watershed) into Butte, Meade, and Lawrence Counties in South Dakota. The designated uses of the Lower Belle Fourche Watershed and some of its tributaries are impacted by elevated temperature, salinity, turbidity, and fecal coliform (South Dakota Department of Environment and Natural Resources, 2008). The elevated salinity, turbidity, and fecal coliform are from agricultural livestock grazing activities. Some of the tributaries to the Belle Fourche River drain historical mining districts and are impacted by metals and acidity due to mine drainage. The average flow of the Belle Fourche River at the Wyoming-South Dakota state line is 2.4 m^3/s [85 ft^3/s] for water years 1959 through 2007 (U.S. Geological Survey, 2008a).

The Redwater River watershed straddles the Wyoming-South Dakota state line between the Upper and Lower Belle Fourche Watersheds (Figure 3.4-10) The generic designated uses of the Redwater River and its tributaries are listed in Table 3.4-4. The average flow of the Redwater River at the gauging station above Belle Fourche, South Dakota, is 3.9 m^3/s [139 ft^3/s] for water years 1946 through 2007 (U.S. Geological Survey, 2008a). Water bodies in this watershed are not listed as impaired.

3.4.4.2 Wetlands and Waters of the United States

Wetland areas found in this region are consistent with those found in the Wyoming East Uranium Milling Region (Section 3.3.4.2). Waters of the United States and special aquatic sites that include wetlands would be expected to be identified and the impact delineated upon individual site selection. Based on impacts and consultation with each area, appropriate permits would be obtained from the local USACE district. Section 401 state water quality certification is required for work in Waters of the United States. Within Wyoming, the State of Wyoming regulates isolated wetlands and waters. Cumulative total project impacts greater than 0.4 ha [1 acre] require a general permit for wetland mitigation by WDEQ. Within Nebraska, waters of the state are under the authority of the Nebraska Department of Environmental Quality. Isolated wetlands are included in Title 117, Nebraska Surface Water Quality Standards. No permitting mechanism is in place to authorize projects in isolated waters; however, state water quality standards apply.

3.4.4.3 Groundwater

Groundwater resources in the Nebraska-South Dakota-Wyoming Uranium Milling Region are part of regional aquifer systems that extend well beyond the areas of uranium milling interest in this part of Nebraska, South Dakota, and Wyoming. Uranium-bearing aquifers exist within these regional aquifer systems in the Nebraska-South Dakota-Wyoming Uranium Milling Region. This section provides a general overview of the regional aquifer systems to provide context for a more focused discussion of the uranium-bearing aquifers in the Nebraska-South Dakota-Wyoming Uranium Milling Region, including hydrologic characteristics, level of confinement, groundwater quality, water uses, and important surrounding aquifers.

3.4.4.3.1 Regional Aquifer Systems

Major regional aquifers in the Nebraska-South Dakota-Wyoming Uranium Milling Region include the Northern Great Plains aquifer system (Whitehead, 1996) and the High Plains aquifer system (Miller and Appel, 1997).

Northern Great Plains Aquifer System (underlying South Dakota): The Northern Great Plains aquifer system underlies most of the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region (Whitehead, 1996). The Upper Cretaceous aquifers (important for uranium mineralization and water supplies) and the Paleozoic aquifers (important only for water supplies) of the Northern Great Plains aquifer system are the most extensive aquifers in the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region.

Groundwater in the upper Cretaceous aquifers (including minor aquifers in the region) contains less than 3,000 mg/L [3,000 ppm] dissolved solids except for small areas in South Dakota where concentrations are as large as 10,000 mg/L [10,000 ppm]. Water with dissolved-solids concentrations of less than 1,000 mg/L [1,000 ppm] is near the Black Hills Uplift (in west South Dakota) and in smaller areas near the boundaries of the aquifers. Groundwater from the upper Cretaceous aquifers provides domestic- and livestock-watering supplies as well as water for several small communities in northwestern South Dakota.

The lower Cretaceous aquifers are composed of several sandstones. The principal water-yielding units are the Newcastle Sandstone (equivalent to the Dakota Sandstone) and the Inyan Kara Group in the Williston Basin. The Newcastle Sandstone is only a few tens of kilometers [tens of feet] thick where it crops out on the flanks of the Black Hills Uplift, but its subsurface equivalent, the Dakota Sandstone, is more than 122 m [400 ft] thick in southeastern South Dakota. In many places, the Newcastle Sandstone is separated from the underlying Inyan Kara Group through the Skull Creek Shale. The Inyan Kara Group merges eastward into the lower part of the Dakota Sandstone in South Dakota.

The Lower Cretaceous aquifers are confined except at outcrop areas that encircle structural uplifts, such as the Black Hills Uplift and the Bighorn Mountains. In South Dakota, the lower Cretaceous aquifers are overlain by poorly permeable till and glacial-lake deposits, and the aquifers behave like a confined to semiconfined aquifer. The regional groundwater flow direction is northeastward from aquifer recharge areas at high altitudes to discharge areas. Although the groundwater in the lower Cretaceous aquifers is slightly saline in most of South Dakota, the aquifers are the principal source of water for livestock watering and domestic use. The water is very saline or a brine in the deep parts of the Williston Basin.

The upper Paleozoic aquifers consist primarily of the Madison Limestone, which is called the Madison Group in the Williston Basin. The Tensleep Sandstone in the western parts of the Powder River Basin and sandstone beds of the Minnelusa Formation in the Williston Basin and the eastern part of the Powder River Basin are treated as separated aquifers at the regional scale. The Pennsylvanian sandstones are not usually considered to be a principal aquifer. The Madison Limestone exhibits karst features in outcrop areas of the Madison in western South Dakota where large springs originate from solution conduits. In the upper Paleozoic aquifers, the regional groundwater flow direction is northeastward from recharge areas near structural uplifts close to the southern and western limits of the aquifer system. Withdrawal of the oil and gas from the hydrocarbon reservoir have resulted in water leaking downward from the upper Paleozoic aquifers through confining units into deeper permeable zones. Groundwater in the upper Paleozoic aquifers is fresh only in small zones near recharge areas, including the area of freshwater encircling the Black Hills Uplift in western South Dakota. The water becomes slightly saline to saline away from the recharge areas into the Williston Basin. Due to the upward leakage of the mineralized water from the upper Paleozoic aquifers into upper Cretaceous aquifers in central South Dakota, the groundwater becomes saline in shallower aquifers.

Lower Paleozoic aquifers are deeply buried for the most part. They consist of sandstone and carbonate rocks. There are great uncertainties in water yield characteristics of these aquifers at the regional scale. The regional groundwater flow direction is northeastward. Lower Paleozoic aquifers contain fresh water only in a small area near the Black Hills Uplift, but contain slightly saline to moderately saline groundwater throughout the southern one-half of their extent. In a large area in central South Dakota, some of the slightly saline water in the Lower Paleozoic aquifers leaks upward into shallower aquifers.

High Plains Aquifer System (underlying Nebraska): The High Plains aquifer underlies the southernmost part of Nebraska-South Dakota-Wyoming Uranium Milling Region. The High Plains aquifer is the principal source of groundwater for the High Plains region. The High Plains aquifer is unconfined for the most part. The water table is usually less than 61 m [200 ft] below the land surface in western Nebraska. However, the water table is between 61 and 91 m [200 and 300 ft] below the land surface in parts of western Nebraska. The regional groundwater flow direction is from west to east at an average velocity of 0.3 m/day [1 ft/day]. The saturated thickness of the High Plains aquifer ranged from 0 to approximately 305 m [0 to 1,000 ft] in 1980 with an average saturated thickness of 104 m [340 ft]. The average specific yield for entire aquifer is 15 percent. Recharge to the aquifer includes precipitation infiltrating through dune sands in western Nebraska, infiltration locally from streams and canals, and infiltration by a small quantity of water moving upward from the underlying bedrock. The rates of recharge are highly variable and range from about 0.3 to 20 percent of the average annual precipitation. Discharge from the aquifer includes water losses to springs, seeps, and streams; evapotranspiration; minor water losses to bedrocks and withdrawals mostly for irrigation.

The High Plains aquifer consists of all or parts of several geologic units of Quaternary and Tertiary age. Clay- to gravel-sized unconsolidated deposits of Quaternary age overlie the Ogallala Formation. These unconsolidated deposits are considered to be part of the High Plains aquifer, if they are saturated as in southeastern Nebraska. The High Plains aquifer is locally confined above by thick loess that consists mostly of silt and clay-sized materials. Highly porous dune sands of Quaternary age, where they are saturated, are also considered to be part of the aquifer (e.g., in west-central Nebraska) and recharge the High Plains aquifers.
The Ogallala Formation is underlain by the Arikaree Group. The Arikaree Group, which is composed of massive sandstone, overlies the Brule Formation. The maximum thickness of the Arikaree Group is about 305 m [1,000 ft] in western Nebraska. The Oligocene-aged Brule Formation of Oligocene, which is the upper unit of the White River Group, underlies much of western Nebraska. It is predominantly composed of massive siltstone and sandstone and is considered to be an aquifer only where it is fractured or it contains solution openings.

In large parts of Nebraska, the High Plains aquifer is underlain by upper Cretaceous rocks that primarily consist of shale, chalk, limestone, and sandstone. Only the chalk, where it is fractured or contains solution openings, yields enough water for irrigation. The Chadron Formation, part of the White River Group, directly underlies the High Plains aquifer in most of western Nebraska. It is predominantly composed of clay and silt units with minimal permeability.

In parts of western Nebraska, the High Plains aquifer is underlain by Jurassic- and Triassic-age rocks that primarily consist of shale and sandstone. The Jurassic and Triassic age rocks generally have low permeability, but some sandstone beds are locally permeable enough to yield water. In other areas, the High Plains aquifer is underlain by Tertiary and Permian rocks that predominantly consist of red shale, siltstone, sandstone, gypsum, anhydrite, and dolomite and locally include limestone and halite (rock salt) as beds or disseminated grains.

During 1990, about 17 million L/day [4.6 million gal/day] of groundwater was pumped from the High Plains aquifer, mostly (97 percent) for agricultural purposes. The potential water yield from wells in most of Nebraska is typically greater than 4.1 million L/day [1.1 million gal/day], although the water yield varies with the geologic formation tapped. For example, water yields from the Brule Formation are typically less than 1.6 million L/day [430,000 million gal/day]. Water yields from the Arikaree Group are not usually large, but locally in Western Nebraska are as large as 1.9 million L/day [500,000 million gal/day]. The water yields from the Brule Formation and the Arikaree Group are relatively larger where these rocks have secondary fractures. Water yields from the Ogallala Formation are 5.5 million L/day [1.4 million gal/day] in many parts of Nebraska.

In most of Nebraska, dissolved-solids concentrations in the High Plains aquifer are less than 500 mg/L [500 ppm], but locally exceed 1,000 mg/L [1,000 ppm] {the limit of dissolved solids recommended by the EPA for drinking water is 500 mg/L [500 ppm]}. Sodium concentrations in the High Plains aquifer are less than 25 mg/L [25 ppm] in most of Nebraska. However, excessive fluoride concentrations are a widespread problem in the High Plains aquifer. High fluoride concentrations in the range of 2–8 mg/L [2–8 ppm] are reported for the High Plains aquifer where the aquifer contains volcanic ash deposits or it is underlain by rocks of Cretaceous age.

The unconfined nature of the High Plains aquifer system along with the shallow water table makes the aquifer vulnerable to contamination by fertilizers and organic pesticides. Elevated concentrations of sodium, alkalinity, nitrate, and triazine (a herbicide) have been found in the aquifer in Nebraska. For example, during 1984–1985, nearly 33 percent of well samples in Nebraska showed measurable concentrations {greater than 0.04 μg/L [0.04 ppb]} of the herbicide atrazine (Whitehead, 1996).

3.4.4.3.2 Aquifer Systems in the Vicinity of Uranium Milling Sites

An underlying hydrogeological system in past and current areas of uranium milling interest in the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling Region consists of a thick sequence of primarily sandstone and also limestone aquifers typically separated by shale aquitards. Uranium-bearing sandstone aquifers in the Inyan Kara Group at the potential ISL sites are used for local irrigation water supplies.

Areas of uranium milling interest in the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region are underlain by water-bearing layers including, from shallowest to deepest, the alluvial aquifers, the Newcastle sandstone (equivalent to the Muddy Sandstone), the sandstone aquifers in the Inyan Kara Group, the Morrison Formation, the Sundance Formation, the Spearfish Formation, the Minnekahta Limestone, the Minnelusa Formation, the Madison Formation, and the Deadwood Formation. Among these aquifers, the Inyan Kara Group, the Minnekahta Limestone, the Minnelusa Formation, the Madison Formation, and the Deadwood Formation contain important aquifers for water supplies. The rest of the water-bearing units in the region are pumped for limited local water uses (Williamson and Carter, 2001).

An underlying hydrogeological system in past and current areas of uranium milling interest in the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling Region consists of a thick sequence of primarily sandstone and also limestone aquifers typically separated by shale aquitards.

At the Crow Butte ISL sites in Nebraska, only the Basal Chadron sandstone is considered to be an aquifer (NRC, 1998). The Arikaree and Brule Formations are not considered to be important aquifers for water supplies in this region (Miller and Appel, 1997; NRC, 1998).

3.4.4.3.3 Uranium-Bearing Aquifers

In the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region, the sandstone aquifers in the Inyan Kara Group are important aquifers for uranium mineralization (Driscoll, et al., 2002). In this region, uranium may have been introduced into the Inyan Kara Group through upward leakage of uranium-rich water from the Minnelusa aquifer (Gott, et al., 1974). In the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling Region, the Basal Chadron sandstone aquifer (in the Chadron Formation) hosts uranium mineralization (NRC, 1998).

For ISL operations to begin, portions of the uranium-bearing sandstone aquifers in the Inyan Kara Group and the Basal Chadron Sandstone of the Nebraska-South Dakota-Wyoming Uranium Milling Region would need to be exempted by the appropriate EPA- or state-administered underground injection program (Section 1.7.2.1).

Hydrogeological characteristics: In the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region, the Inyan Kara sandstone aquifers are typically confined except at outcrop areas. Transmissivity of the Inyan Kara aquifer ranges from

0.08–560 m^2/day [0.8–6,000 ft^2/day]. For ISL operations to be practical, the hydraulic conductivity of the production aquifer must be large enough to allow reasonable water flow from injection to production wells. Hence, the portions of the Inyan Kara aquifer with low hydraulic conductivities may not be readily amenable to uranium recovery using ISL techniques. The storage coefficient is in the range of 2.5×10^{-5}–1.0×10^{-4} (Driscoll, et al., 2002), indicating the confined nature of the production aquifer (typical storage coefficients for confined aquifers range from 10^{-5}–10^{-3}) (Driscoll, 1986, p. 68).

In the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling region, the Basal Chadron Sandstone aquifer is confined by a thick sequence of aquitards. Transmissivity of the Basal Chadron Sandstone aquifer ranges from 30 to 45 m^2/day [350 to 480 ft^2/day] and the average aquifer storage coefficient is in the range of 1.3×10^{-5}–8.4×10^{-4} (NRC, 1998), indicating the confined nature of the production aquifer (typical storage coefficients for confined aquifers range from 10^{-5}–10^{-3} (Driscoll, 1986; p. 68).

Level of confinement: The production aquifer is typically confined in the Nebraska-South Dakota-Wyoming Uranium Milling Region. The thickness of the confinement varies spatially.

In South Dakota, the Inyan Kara Group is generally confined by several thick shale layers, except in the outcrop area around structural uplifts, such as the Black Hills. The Inyan Kara Group is confined above by the Skull Creek Shale with a thickness of 46–80 m m [150–270 ft]. The Skull Creek Shale is confined above by the regionally continuous Pierre Shale unit with a thickness of 1,220 m [4,000 ft] in the Black Hills area. The Inyan Kara Group is hydraulically separated from the underlying Minnekahta limestone by low permeability units including, from shallowest to deepest, the Morrison Formation, the Sundance Formation, and the Spearfish Formation. The total thickness of these low permeability layer varies from 190 to 450 m [625 to 1,470 ft] at the Black Hills. Thus, except at the outcrop areas, the sandstone aquifers in the Inyan Kara Group are confined above and below by thick confining units in the Nebraska-South Dakota-Wyoming Uranium Milling Region. A vertical hydraulic conductivity of 0.4×10^{-6} m/day [1.3×10^{-6} ft/day] for the Skull Creek Shale and 1.5×10^{-8}–1.5×10^{-4} m/day [5×10^{-8}–5×10^{-4} ft/day] for the Pierre Shale is estimated in South Dakota (Kansas Geological Survey, 1991).

In Nebraska, the ore-bearing aquifer is confined below by the Pierre Shale with an average thickness of 365 m [1,200 ft] and a vertical hydraulic conductivity of 3.4×10^{-11} to 3.6×10^{-12} m/s [11.2×10^{-11} to 11.8×10^{-12} ft/s]. The upper confinement unit is composed of a red clay bed up to 3–8 m [10–25 ft] thick with a vertical hydraulic conductivity of 3×0^{-8} to 2×0^{-7} m/day [1×10^{-7} to 7×10^{-7} ft/day]. The red clay bed is overlain by another thick confining layer (the Middle Chadron) with an average thickness of 95–100 m [315–325 ft]. The thickness of the upper confining unit is about 60–90 m [200–300 ft] in the permit area. Aquifer testing indicates that movement of lixiviant would be vertically contained by the confining units and horizontally captured in the production zone in the Crow Butte region (NRC, 1998).

Groundwater quality: Water from the Inyan Kara aquifer in South Dakota is locally fresh to slightly saline. However, generally high concentrations of dissolved solids, iron, sulfate, and manganese may hamper the use of water from the Inyan Kara aquifer. Hard water from wells located on or near the outcrop may require special treatment. Suitability for irrigation may be affected by high specific conductance and sodium adsorption ratio [the ratio of the sodium (detrimental element) concentration to the combined concentration of calcium and magnesium (beneficial elements)]. Almost 18 percent of samples collected from the Inyan Kara aquifer exceed the maximum concentration level for combined radium-226 and radium-228. About 4 percent of these samples exceed the maximum concentration level for uranium. The uranium and radium-226 concentrations ranged from 0.1 to 109 ppm and 7.4×10^{-3}–1.59 Bq/L [0.2–43 pCi/L] in the Inyan Kara aquifer, respectively. In the southern Black Hills, radium-226 and uranium concentrations may preclude use of untreated water from Inyan Kara aquifer for drinking (Williamson and Carter, 2001).

Based on baseline (preoperational) water quality data, the Basal Chadron Sandstone is generally of good quality (with the total uranium less than 3.7×10^{-4}–8.9×10^{-2} Bq/L [0.01–2.40 pCi/L] and the total conductivity in the range of 1,500–2,500 mhos. The State of Nebraska Department of Environmental Quality defines the Basal Chadron sandstone as an underground source of drinking water (NRC, 1998). However, in the vicinity of the mineralized zone, uranium and radium concentrations are elevated. Radium-226 levels range from 3.7×10^{-3} – 22.9 Bq/L [0.1–619 pCi/L], which exceeds the 5 pCi/L EPA primary drinking water standard. As a result, water drawn from Chadron sandstone is not considered potable near the mineralization zone (NRC, 1998).

Current groundwater uses: Groundwater from Inyan Kara aquifer is typically pumped for local irrigation. Groundwater from the Basal Chadron Sandstone is pumped for agricultural and domestic uses.

3.4.4.3.4 Other Important Surrounding Aquifers for Water Supply

The major aquifers in the hydrologic setting of the Black Hills area all underlie the Inyan Kara Group. The major aquifers include, from shallowest to deepest, the Minnekahta Limestone, the Minnelusa Formation, the Madison Formation, and the Deadwood Formation. These aquifers are separated by relatively impermeable layers, but they are (including the Inyan Kara Group) collectively confined by the underlying Precambrian basement rocks and the overlying the Skull Creek and the Pierre Shales. These aquifers are used extensively for water supplies in the region (Williamson and Carter, 2001). The average saturated thicknesses of the Minnekahta Limestone, the Minnelusa Formation, the Madison Formation, and the Deadwood Formation are 15, 224, 159, and 152 m [50, 736, 521, and 500 ft], respectively. The aquifer transmissivity for the Minnelusa Formation, the Madison Formation, and the Deadwood Formation are estimated to be 2.8–28 m^2/day [30–300 ft^2/day], 9.2×10^{-4}–5,000 m^2/day [0.01–54,000 ft^2/day], and 23–93 m^2/day [250–1,000 ft^2/day], respectively. The storage coefficient for the Minnelusa Formation and the Madison Formation are estimated to be 6.6×10^{-5} through 2.0×10^{-4} and 1.12×10^{-6} through 0.002 (Driscoll, et al., 2002). At the Crow Butte ISL sites in Nebraska, only the Basal Chadron sandstone is considered to be an aquifer (NRC, 1998).

3.4.5 Ecology

3.4.5.1 Terrestrial

Nebraska-South Dakota-Wyoming Uranium Milling Region Flora

According to the EPA, the identified ecoregions in the Nebraska-South Dakota-Wyoming Uranium Milling Region primarily consist of Middle Rockies, Northwestern Great Plains, Western High Plains, and the Nebraska Sand Hills ecoregions (Figure 3.4-11). Uranium districts are located in ecoregions including the Black Hills Foothills, Sagebrush Steppe, the Pine Ridge Escarpment, and the Powder River Basin. The Middle Rockies ecoregion is discussed in the Wyoming West region (Section 3.2.5).

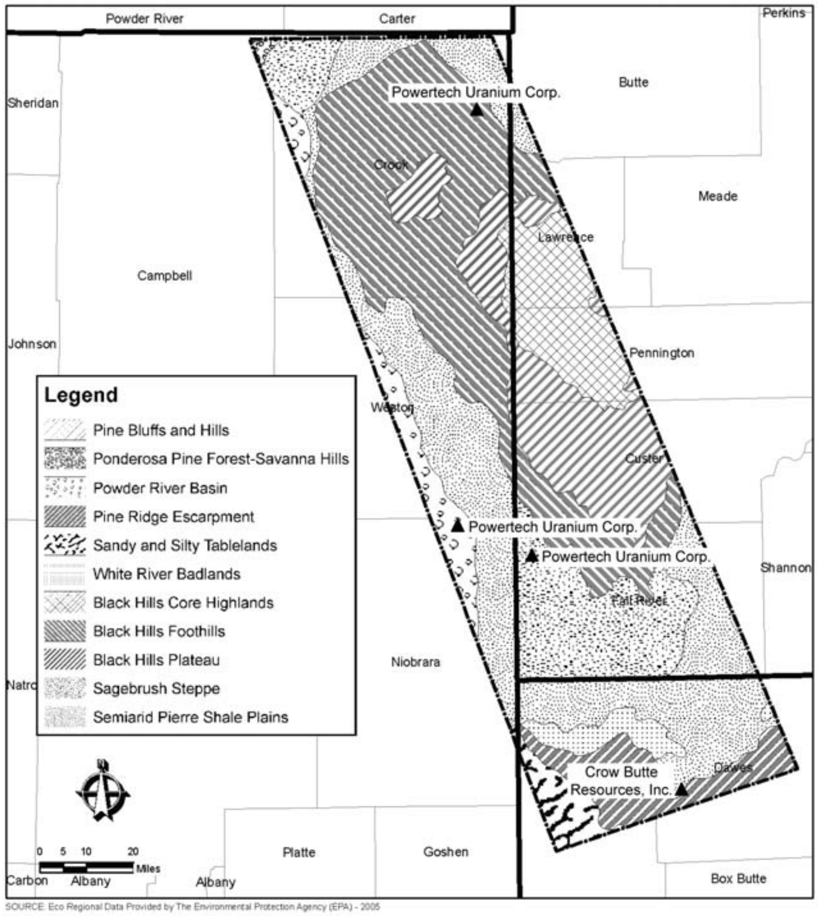


Figure 3.4-11. Ecoregions for the Nebraska-South Dakota-Wyoming Uranium Milling Region

The Black Hills Foothills ecoregion is composed of the Hogback Ridge and the Red Valley. The Hogback Ridge forms a ring of foot hills surrounding the Black Hills. The Red Valley encircles most of the Black Hills dome and acts as a buffer between the Hogback Ridge. Natural vegetation within this region includes ponderosa pine woodlands and open savannas with an understory of western wheat grass, needle-and-thread grass, little bluestem (*Schizachyrium scoparium*), blue grama, buffalo grass (*Hierochloe odorata*), and leadplant (*Amorpha canescens*). In addition, some burr oak (*Quercus macrocarpa*) is found in the north and Rocky Mountain juniper (*Juniperus scopulorum*) occurs in the south (Chapman, et al., 2004).

The Black Hills Plateau ecoregion is a relatively flat, elevated expanse, with broad ridges and entrenched canyons, covering the mid-elevation slopes of the Black Hills. The Black Hills, a mountainous outlier in the Great Plains, has a highly diverse vegetative cover, with an overlap of eastern, boreal, and Rocky Mountain species. The dominant tree spies found in the region is the ponderosa pine; however, it blends with eastern boxelder (*Acer negundo* ssp.), burr oak, and boreal paper birch (*Betula papyrifera*). White spruce and sedges can be found in moist areas. The understory includes grasses like little bluestem and timber oatgrass (*Danthonia intermedia*) and shrubs such as juniper, snowberry, bearberry, and buffaloberry (*Shepherdia argentea*) (Chapman, et al., 2004).

The Black Hills Core Highlands ecoregion includes the higher portions of the limestone plateau above 1,500 m [5,000 ft] and the granitic intrusions that form the major peaks to elevations greater than 2,130 m [7,000 ft]. Due to the high elevation, temperature, and high rainfall boreal species such as white spruce, quaking aspen, and paper birch can be found on the northern slopes and moist canyons. Ponderosa pine forests interspersed with high meadows are predominant in the region. Understory species include sedges in moist areas, bearded wheatgrass, oatgrass, brome grass (*Bromus* spp.), common juniper, snowberry, Oregon bent grass (*Agrostis oregonensis*), bearberry, and iris (*Iris* spp.) (Chapman, et al., 2004)

The Northwestern Great Plains is discussed in Section 3.3.5.1.

The Montana Central Grassland ecoregion is found mostly in Montana with only a small area continuing into northern Wyoming. The dominant vegetation within this region is a mixed grass prairie composed of blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbush, fringed sage, and grama-needlegrass-wheatgrass. The shrub or woodland component found in other ecoregions (Sagebrush Steppe) is absent (Chapman, et al., 2004).

The Sagebrush Steppe ecoregion is found in Montana and in the Dakotas with only a small area extending into Wyoming. Vegetation types in this region consist of big sagebrush, Nuttall saltbush (*Atriplex nuttallii*), and short grass prairie. The sparse sagebrush communities consist of dusky gray sagebrush (*Artemisia arbuscula* ssp*. Arbuscula)*, dwarf sage (*Artemisia columbiensis*), and big sagebrush. Prairie vegetation that can be found include western wheatgrass, green needlegrass, blue grama, Sandberg bluegrass, junegrass, rabbit brush, fringed sage, and buffalograss. The shrub vegetation of this ecoregion is transitional between the grasslands of the Montana Central Grassland and the woodland of the Pine Scoria Hills (Bryce, et al., 1996)

The Semiarid Pierre Shale Plains are relatively treeless consisting of rolling hills and grasslands. This is an arid region with rainfall between 38 and 43 cm [15 and 17 in] annually (Bryce, et al., 1996). The natural mixed-grass prairies of the region include shortgrass species such as buffalograss, western wheatgrass, bluebunch wheatgrass, needle-and-thread grass, blue grama, and Sandberg bluegrass. In this ecoregion the sagebrush component found is the neighboring Sagebrush Steppe (Chapman, et al., 2004).

The Powder River Basin and Pine Scoria Hills ecoregions are discussed in Section 3.3.5.1.

The White River Badlands in Nebraska border the northern edges of the Pine Ridge Escarpment and are southern outliers of a more extensive area in South Dakota. The landscape is broken by grass-covered, perched “sod tables” that may be grazed or tilled typical native vegetation found in this region consists of silver sagebrush, western wheatgrass saltbush, and rabbitbrush (Chapman, et al., 2001).

Western High Plains

The Pine Ridge Escarpment forms the boundary between the Missouri Plateau to the north and the High Plains to the south. This escarpment consists of a ponderosa pine woodland composed of Rocky Mountain juniper, western soapberry (*Sapindus drummondii*), skunkbush sumac, choke cherry (*Prunus virginiana*), and Arkansas rose (*Rosa arkansana*). The vegetation found in the mixed-grass prairies of the region consist of little bluestem, western wheatgrass, reed grass (*Phalaris* spp.), needle-and-thread grass, blue grama, and threadleaf sedges (*Carex filifolia*) in moist areas (Chapman, et al., 2001).

The Pine Bluffs and Hills ecoregion is discussed in Section 3.3.5.1.

The Sandy and Silty Tablelands ecoregion is discussed in Section 3.3.5.1.

The Flat to Rolling Cropland ecoregion has extensive drylands farming, irrigated crops, and rangelands throughout this region. Winter wheat, grain sorgum, corn, and alfalfa are the main cash crops, with smaller acreages in forage crops consisting of grain (Chapman, et al., 2001).

The Dense Clay Prairie differs from the surrounding ecoregions in its relative lack of vegetative cover. The grassland in this ecoregion is missing its short- and midlevel layers; however, it does include tall grasses composed mostly of western wheatgrass. Little to no woodlands are found along waterways (Bryce, et al., 1996).

Nebraska Sand Hills Ecoregions

The Nebraska Sand Hills consist of one of the most distinct and homogeneous ecoregions in North America. With one of the largest areas of grass-stabilized sand dunes in the world, this region is generally devoid of cropland agriculture, and except for some riparian areas in the north and east, the region is treeless. Numerous lakes and wetlands dot the region, and parts of the region are without streams (Chapman, et al., 2001).

The Sand Hills include grass stabilized sand dunes and open sand areas. Dune size, pattern, and alignment generally follow a west-to-east trending axis, with the larger dune hills in the west having local relief as great as about 120 m [400 ft]. Grasses found in the area consist of prairie sandreed (*Calamovilfa longifolia*), little bluestem, sand bluestem (*Andropogon hallii*), switchgrass (*Panicum virgatum*), sand love grass (*Eragrostis trichodes*), needle-and-thread grass, blue grama, and hairy grama (*Bouteloua hirsuta*) (Chapman, et al., 2001).

The Alkaline Lakes Area is dominated by sand dunes and many scattered alkaline lakes. These lakes are located in what is commonly referred to as the “closed basin area.” This area is generally devoid of streams. The high alkalinity around lakes restricts wetland vegetation growth with the exception of alkaline tolerant species such as certain alkaline bulrush (*Schoenoplectus maritimus)*, alkali sacaton (*Sporobolus airoides*), and inland saltgrass (*Distichlis stricta*). Grass species found in the region are similar to those found in the Sand Hills region and consist of prairie sandreed, little bluestem, sand bluestem, switchgrass, sand love grass, needle-and-thread grass, blue grama, and hairy grama (Chapman, et al., 2001).

Nebraska-South Dakota-Wyoming Uranium Milling Region Fauna

Animal species that may occur in the Middle/Southern Rockies which include the Black Hills, the Northwest Great Plains/Northern short grasslands, and Western High Plains/Western Short Grasslands have been discussed in the Wyoming East Uranium Milling Region (Section 3.3.5.1). According to the Wyoming Game and Fish Department, crucial wintering habitats are found with this region for large game animals and nesting leks for the sage-grouse. Figures 3.4-12 to 3.4-18 depict the crucial winters, yearlong areas ranges for large game found in this region. Within this region the Northern Black Hills Uranium District, located in the northeastern portion of the region, is near the crucial winter/yearlong area for white-tailed deer.

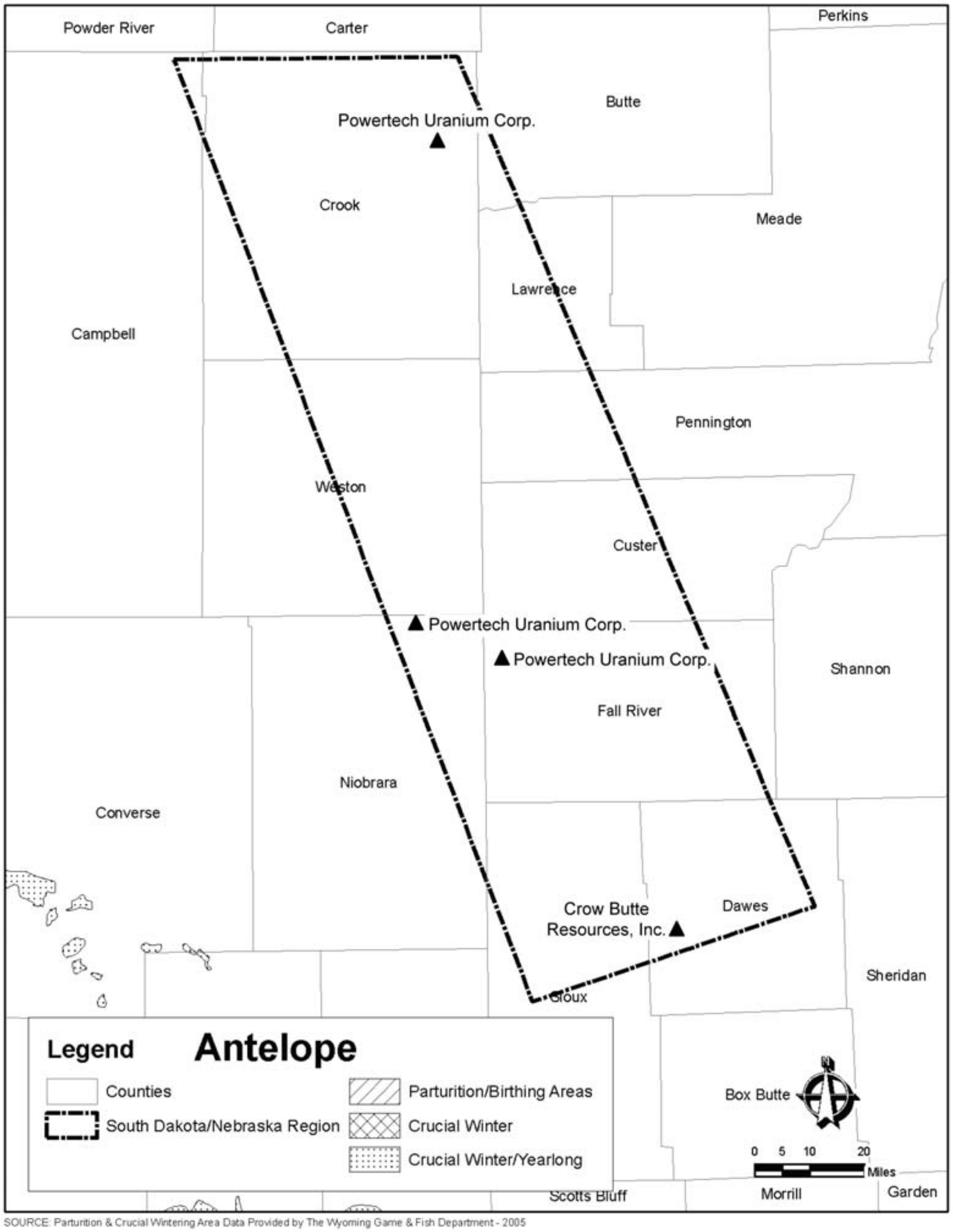


Figure 3.4-12. Antelope Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region

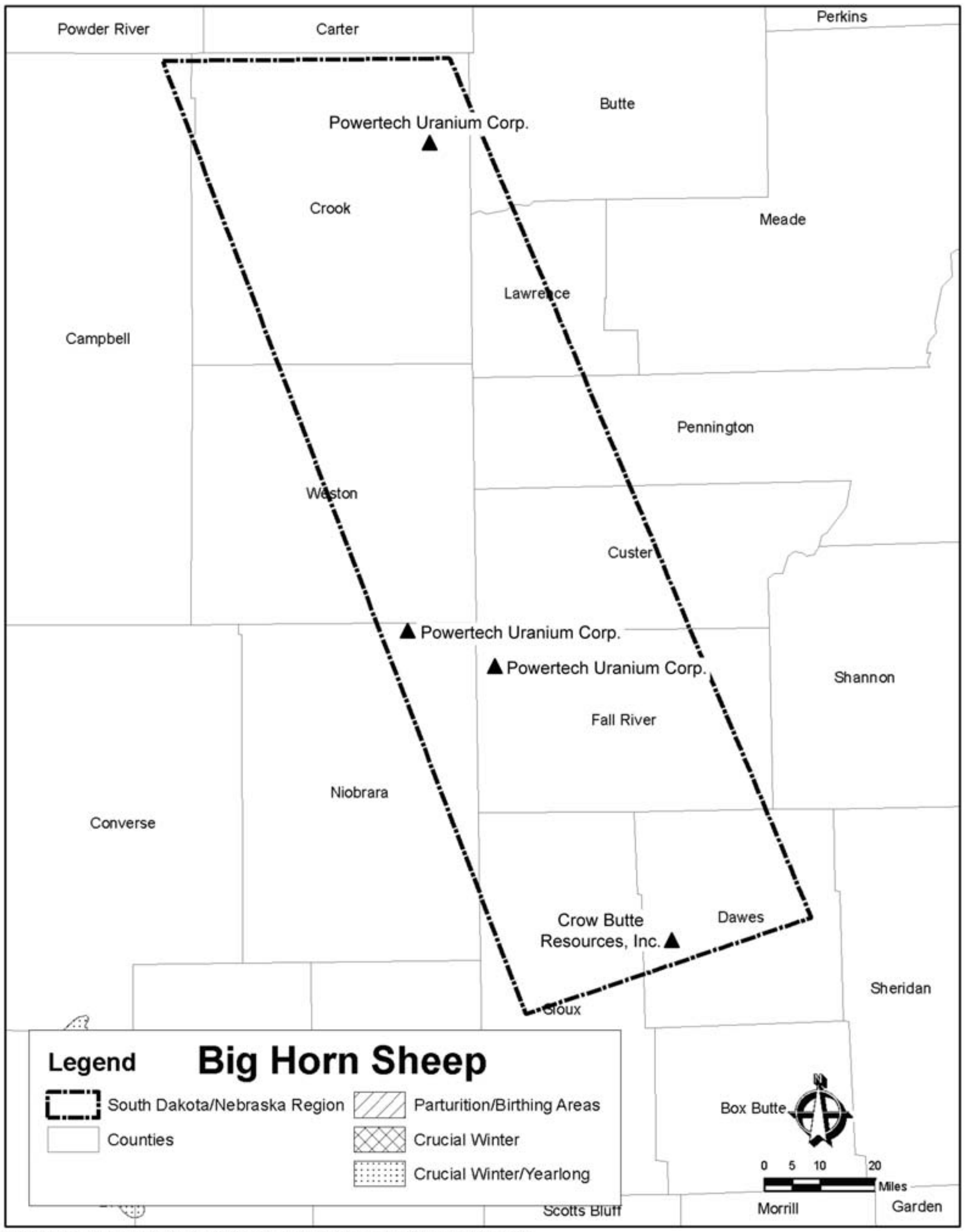


Figure 3.4-13. Big Horn Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region

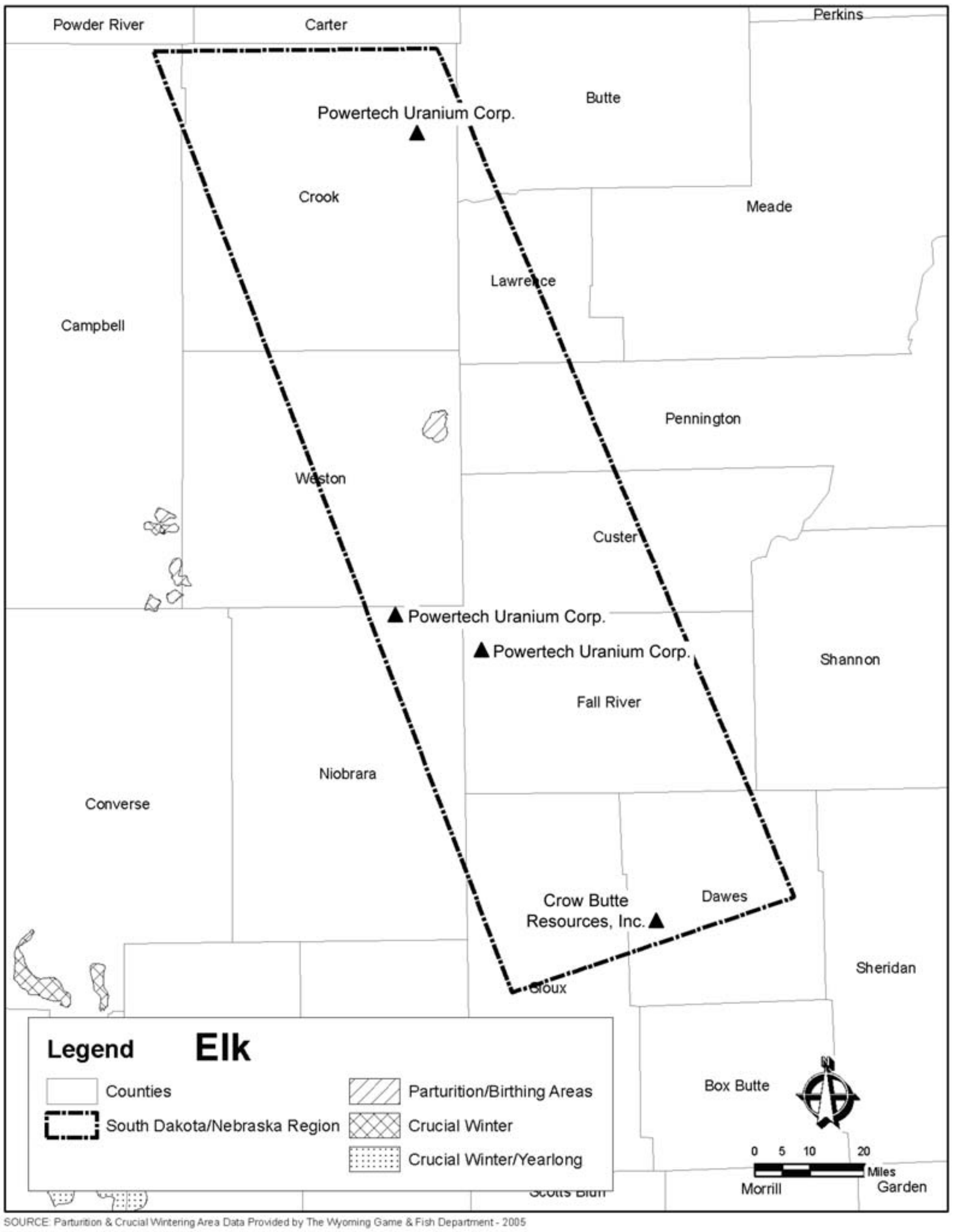
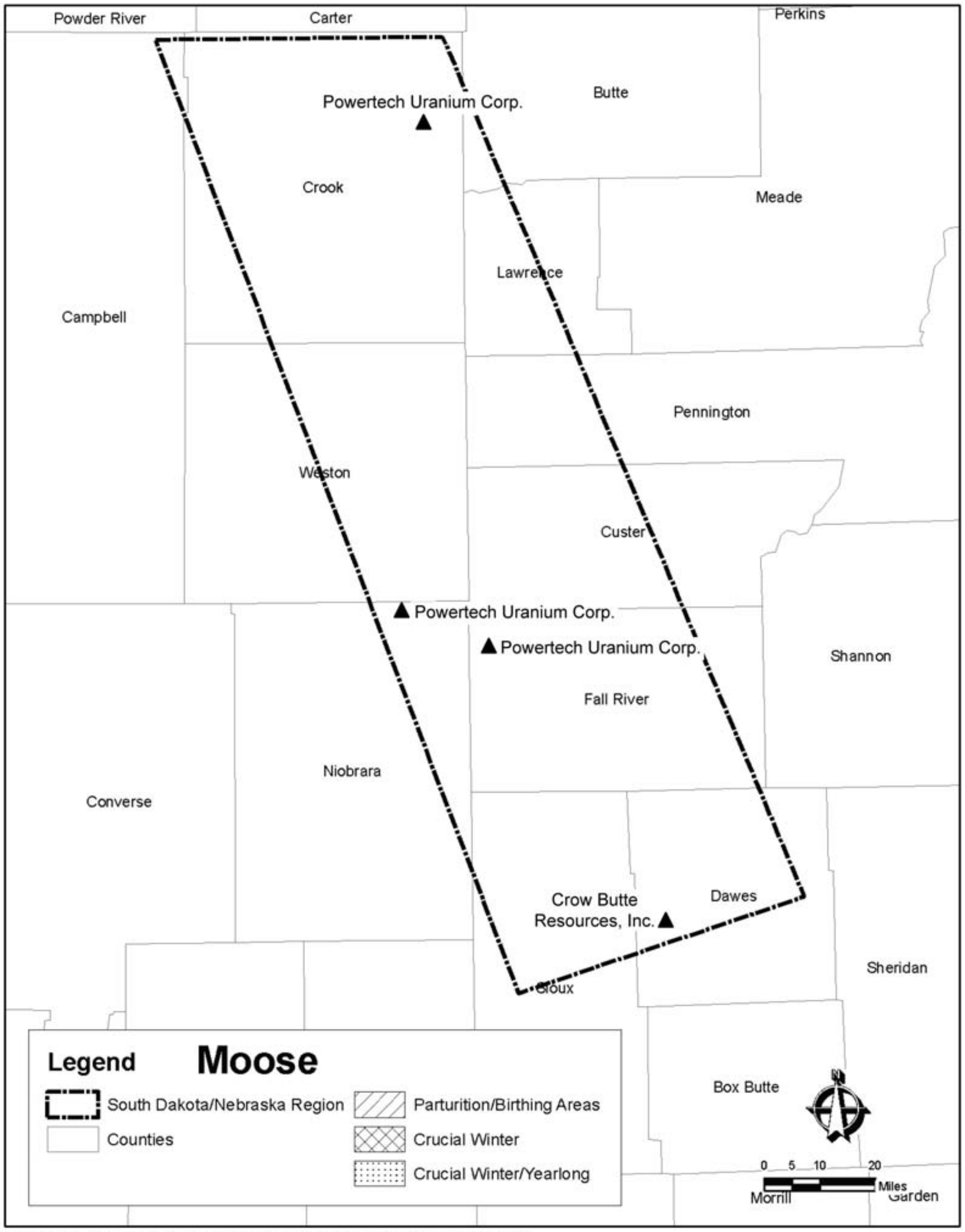


Figure 3.4-14. Elk Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region



SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

Figure 3.4-15. Moose Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region

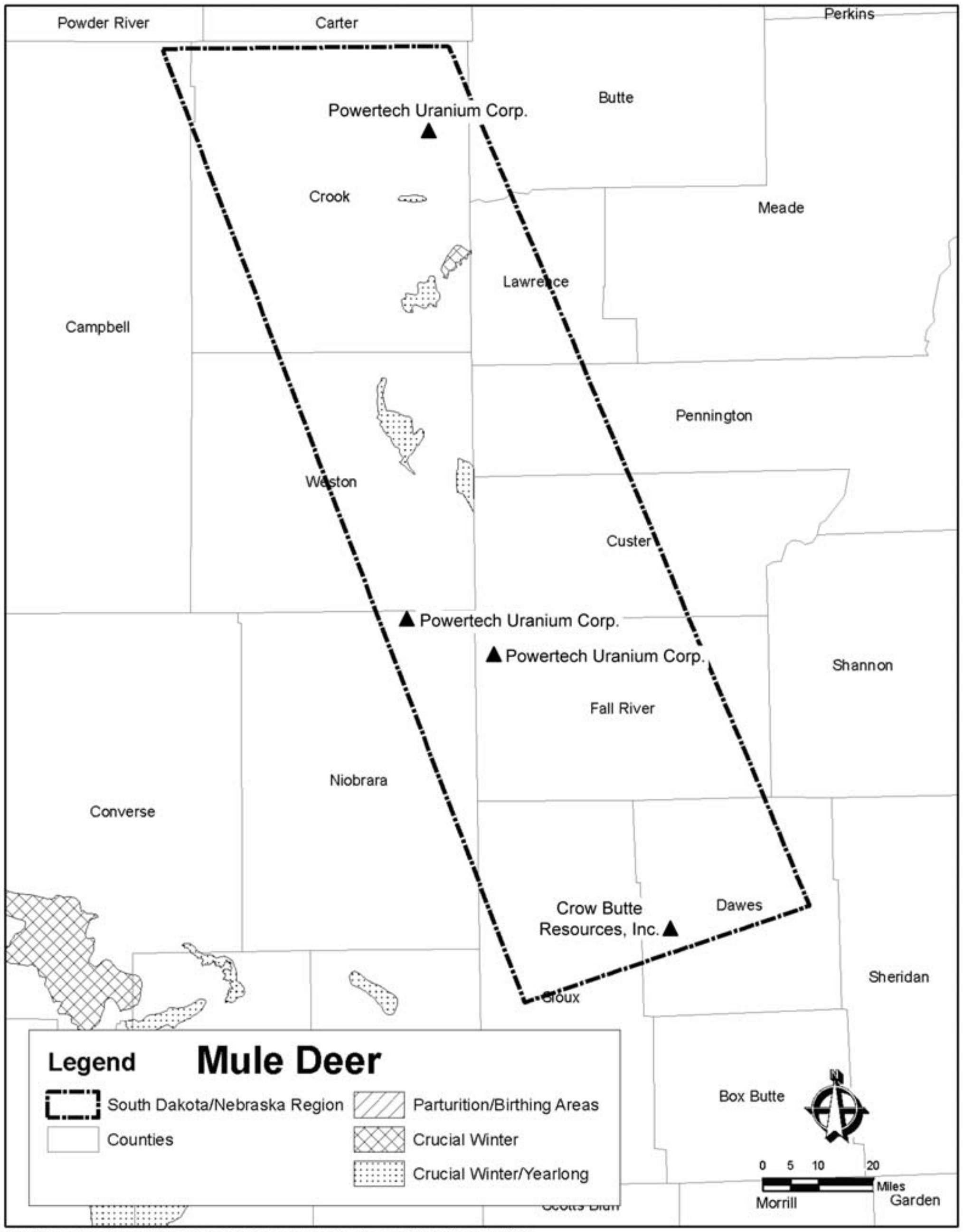


Figure 3.4-16. Mule Deer Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region

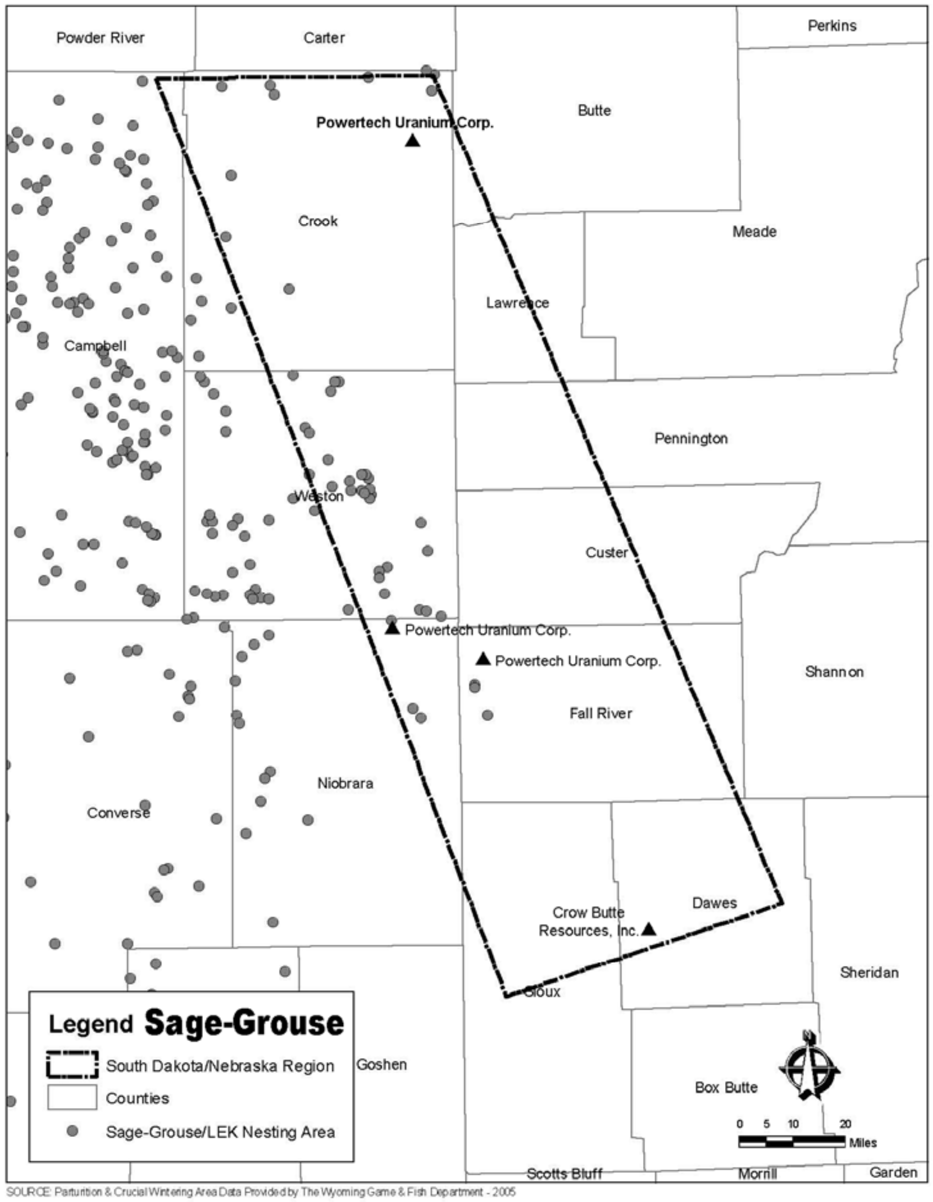


Figure 3.4-17. Sage-Grouse/Lek Nesting Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region

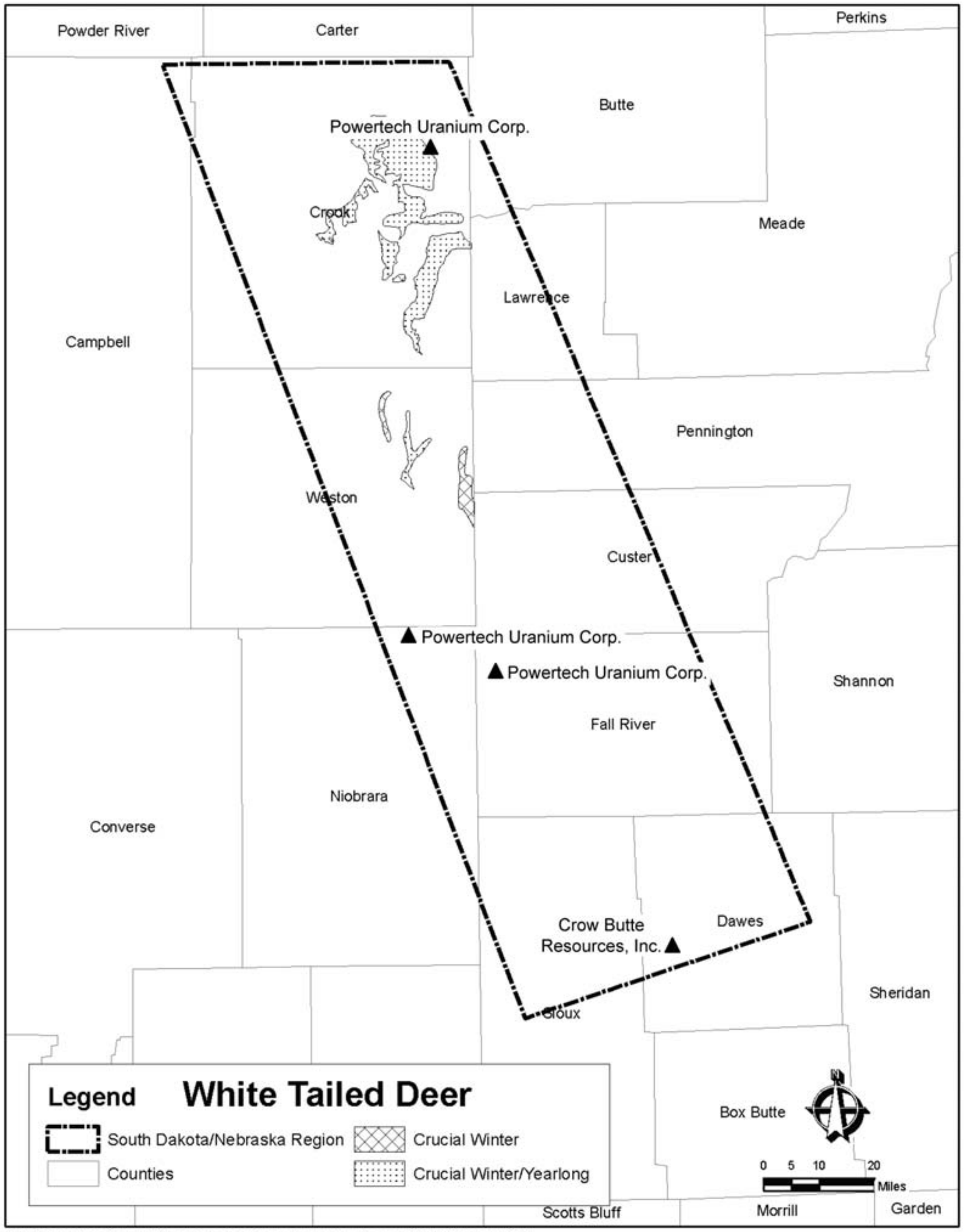


Figure 3.4-18. White Tailed Deer Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region

Sage-grouse leks appear to be located on the western side of the Nebraska-South Dakota-Wyoming Uranium Milling Region in the vicinity of the Southern Black Hills Uranium District.

A comprehensive listing of habitat types and species that have been surveyed within South Dakota are compiled as part of the South Dakota Gap Analysis Project (South Dakota State University, 2007).

According to the Nebraska Game and Parks Commission, Nebraska has approximately 400 bird species, 95 mammal species, and more than 60 reptile and amphibian species.

A comprehensive listing of habitat types and species that have been surveyed within Nebraska are compiled as part of the Gap Analysis Project (University of Nebraska, 2007).

3.4.5.2 Aquatic

Wyoming

As previously discussed, there are approximately 49 native fish species found in the watersheds throughout the state of Wyoming. These species are identified in Table 3.2-5. Current conditions of these watersheds found within the Nebraska-South Dakota-Wyoming Uranium Milling Region have been evaluated, and fish species that would benefit from conservation measures within these watersheds have been identified. These watersheds include the Little Missouri and the Cheyenne River Watersheds.

The Little Missouri Watershed is composed of numerous creeks such as Prairie and Cottonwood Creeks and the north fork of the Little Missouri River. This watershed is located in the northwestern portion of the Nebraska-South Dakota-Wyoming Uranium Milling Region in the vicinity of the Northern Black Hills Uranium District. The game fish habitat in the watershed is restricted to reservoirs and the streamflow in the Little Missouri River. Limiting conditions include small stream size, periods of low flow, high turbidity and sedimentation. Game fish species found in the watershed include brook trout, black bullhead, channel catfish, large mouth bass, rainbow trout, small mouth bass, and stonecat. Nongame species include brassy minnow, flathead chub, fathead minnow, goldeye, green sunfish, lake chub, longnose dace, shorthead redhorse, sand sucker, western silvery minnow, and white sucker (Wyoming Game and Fish Department, 2007).

The Cheyenne River Watershed is composed of the Lower Cheyenne River, Upper Cheyenne River, Bear Creek, Upper and Lower Antelope Creek, Little Thunder Creek, Black Thunder, and the Lodgepole Creek. This watershed is located in the central western portion of the Nebraska-South Dakota-Wyoming Uranium Milling Region in the vicinity of the Southern Black Hills Uranium District. The Cheyenne River is a free-flowing prairie stream until it reaches the Angostura reservoir in South Dakota. Most of the tributaries are intermittent with some perennial stream segments. Most game species are limited to small reservoirs and impoundments. Species found in the watershed include game fish such as the black bull head and channel catfish and nongame fish such as the carp, fathead minnow, green sunfish, longnose dace longnose sucker, plains killi fish, river carpsucker (*Carpiodes carpio*), sand shiner, and white sucker (Wyoming Game and Fish Department, 2007).

South Dakota

The major watersheds in South Dakota include the Red Water, Beaver, Middle Cheyenne-Spring, Rapid Creek, Angostura Reservoir Watershed, which includes the Cheyenne River. The list of fishes present in South Dakota is summarized in Table 3.4-5.

The South Dakota Division of Wildlife (2004) indicates that the Angostura Reservoir Watershed has an area of approximately 23,570 km^2 [9,100 mi^2]. Primary game fish in the watershed include walleye, channel catfish, smallmouth bass (*Micropterus dolomieu*), gizzard shad

Table 3.4-5. Fishes of the Angostura Reservoir, Cheyenne River Watershed*

Common Name	Scientific Name
American Eel	*Anguilla rostrata*
Banded Killifish	*Fundulus diaphanus*
Bighead Carp	*Aristichthys nobilis*
Bigmouth Buffalo	*Ictiobus cyprinellus*
Bigmouth Shiner	*Notropis dorsalis*
Black Buffalo	*Ictiobus niger*
Black Bullhead	*Ameiurus melas*
Black Crappie	*Pomoxis nigromaculatus*
Blackchin Shiner	*Notropis hederdon*
Blacknose Dace	*Rhinichthys atratulus*
Blacknose Shiner	*Notropis hedrolepis*
Blackside Darter	*Percina maculata*
Blackspot Shiner	*Notropis atrocaudalis*
Blue Catfish	*Ictalurus furcatus*
Blue Sucker	*Cycleptus elongatus*
Bluegill	*Lepomis macrochirus*
Bluegill/Green Sunfish Hybrid	*Lepomis macrochirus x L. cyanellus*
Bluntnose Minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Brassy Minnow	*Hybognathus hankinsoni*
Brook Silverside	*Labidesthes sicculus*
Brook Stickleback	*Culaea inconstans*
Brook Trout	*Salvelinus fontinalis*
Brown Bullhead	*Ameiurus nebulosus*
Brown Trout	*Salmo trutta*
Bullhead Minnow	*Pimephales vigilax*
Burbot	*Lota lota*
Central Mudminnow	*Umbri limi*
Central Stoneroller	*Campostoma anomalum*
Channel Catfish	*Ictalurus punctatus*
Chinook Salmon	*Oncorhynchus tshawytscha*
Coho Salmon	*Oncorhynchus kisutch*
Common Carp	*Cyprinus carpio*
Common Shiner	*Luxilus cornutus*
Creek Chub	*Semotilus atromaculatus*
Cutthroat Trout	*Oncorhynchus clarki*
Emerald Shiner	*Notropis atherinoides Rafinesque*

Table 3.4-5. Fishes of the Angostura Reservoir, Cheyenne River Watershed* (continued)	
Common Name	**Scientific Name**
European Rudd	*Scardinius erythrophthalmus*
Fathead Minnow	*Pimephales promelas*
Finescale Dace	*Phoxinus neogaeus Cope*
Flathead Catfish	*Pylodictis olivaris*
Flathead Chub	*Platygobio gracilis*
Freshwater Drum	*Aplodinotus grunniens Rafinesque*
Gizzard Shad	*Dorosoma cepedianum*
Golden Redhorse	*Moxostoma erythrurum*
Golden Shiner	*Notemigonus crysoleucas*
Goldeye	*Hiodon alosoides*
Grass Carp	*Ctenopharyngodon idella*
Greater Redhorse	*Moxostoma valenciennesi*
Green Sunfish	*Lepomis cyanellus*
Hornyhead Chub	*Nocomis biguttatus*
Iowa Darter	*Etheostoma exile*
Johnny Darter	*Etheostoma nigrum*
Kokanee Salmon	*Oncorhynchus nerka*
Lake Chub	*Couesius plumeus*
Lake Herring	*Coregonus artedi*
Lake Sturgeon	*Acipenser flavescens Rafinwsque*
Lake Trout	*Salvelinus namaycush*
Lake Whitefish	*Coregonus clupeaformis*
Largemouth Bass	*Micropterus salmoides*
Logperch	*Percina caprodes*
Longnose Dace	*Rhinichthys cataractae*
Longnose Gar	*Lepisosteus osseus*
Longnose Sucker	*Catostomus catostomus*
Mississippi Silvery Minnow	*Hybognathus nuchalis*
Mooneye	*Hiodon tergisus Lesueur*
Mottled Sculpin	*Cottus bairdi*
Mountain Sucker	*Catostomus platyrhynchus*
Muskellunge	*Esox masquinongy*
Northern Hog Sucker	*Hypentelium nigricans*
Northern Pike	*Esox lucius*
Northern Redbelly Dace	*Phoxinus eos*
Orangespotted Sunfish	*Lepomis humilis*
Paddlefish	*Polyodon spathula*
Pallid Sturgeon	*Scaphirhynchus albus*
Pearl Dace	*Margariscus margarita Cope*
Plains Killifish	*Fundulus zebrinus*
Plains Minnow	*Hybognathus placitus*
Plains Topminnow	*Fundulus sciadicus*
Pugnose Shiner	*Notropis anogenus*
Pumpkinseed	*Lepomis gibbosus*
Quillback	*Carpiodes cyprinus*
Rainbow Smelt	*Osmerus mordax*

Table 3.4-5. Fishes of the Angostura Reservoir, Cheyenne River Watershed* (continued)	
Common Name	**Scientific Name**
Rainbow Trout	*Oncorhynchus mykiss*
Red Shiner	*Cyprinella lutrensis*
Redear Sunfish	*Lepomis microlophus*
Ribbon Shiner	*Lythrurus Fumeus*
River Carpsucker	*Carpiodes carpio*
River Darter	*Percina shumardi*
River Shiner	*Notropis blennius*
Rock Bass	*Ambloplites rupestris*
Rosyface Shiner	*Notropis rubellus*
Sand Shiner	*Notropis stramineus*
Sauger	*Stizostedion canadense*
Saugeye	*Stizostedion vitreum x S. canadense*
Shorthead Redhorse	*Moxostoma macrolepidotum*
Shortnose Gar	*Lepisosteus platostomus*
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*
Sicklefin Chub	*Macrhybopsis meeki*
Silver Chub	*Macrhybopsis storeriana*
Silver Lamprey	*Ichthyomyzon unicuspis*
Silverband Shiner	*Notropis shumardi*
Skipjack Herring	*Alosa chrysochloris*
Slender Madtom	*Noturus exilis Nelson*
Slenderhead Darter	*Percina phoxocehpala*
Smallmouth Bass	*Micropterus dolomieu*
Smallmouth Buffalo	*Ictiobus bubalus*
Spotfin Shiner	*Cyprinella spiloptera*
Spottail Shiner	*Notropis hudsonius*
Stonecat	*Noturus flavus*
Sturgeon Chub	*Macrhybopsis gelida*
Suckermouth Minnow	*Phenacobius mirabilis*
Tadpole Madtom	*Noturus gyrinus*
Threadfin Shad	*Dorosoma petenense*
Tiger Muskie	*Esox lucius X E. masquinongy*
Topeka Shiner	*Notropis topeka*
Trout-perch	*Percopsis omiscomaycus*
Walleye	*Stizostedion vitreum*
Western Silvery Minnow	*Hybognathus argyritis*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
White Perch	*Morone americana*
White Sucker	*Catostomus commersoni*
Wiper (hybrid)	*Morone saxatilis*
Yellow Bullhead	*Ameiurus natalis*
Yellow Perch	*Perca flavescens*
*South Dakota Department of Game, Fish, and Parks. "Fishing in South Dakota." Pierce, South Dakota: South Dakota Game, Fish, and Parks. 2008. <www.sdgfp.info/Wildlife/fishing> (15 February 2008).	

(*Dorosoma cepedianum*), largemouth bass, black crappie, and emerald shiner (*Notropis atherinoides*). (South Dakota Game ,Fish, and Parks, 2008)

The Cheyenne River originates in eastern Wyoming flowing on the south side of the Black Hills Uplift in the vicinity of the Southern Black Hills Uranium District. The Cheyenne River Watershed Assessment study area is approximately 4,690 km^2 [1,811 mi^2] in Pennington, Custer, and Fall River Counties in South Dakota. Approximately 45 fish species can be found in the Cheyenne River (South Dakota Game and Fish, 2008).

Nebraska

The White River-Hat Creek Basin is located in northwestern Nebraska above the Niobrara River basin north of the Crow Butte Uranium District. This basin originates in Nebraska and drains in the northeast to the confluence with the Missouri River (White River) and the Cheyenne River (Hat Creek) in South Dakota. The basin encompasses approximately 5,450 km^2 [2,130 mi^2]. Key aquatic species identified in the basin are the brown trout, rainbow trout, and channel catfish (Nebraska Department of Environmental Quality, 2005a).

The Niobrara River Basin located in the vicinity of the Crow Butte Uranium District in northwestern and north-central Nebraska originates in eastern Wyoming. The watershed covers approximately 30,745 km^2 [11,870 mi^2] and has approximately 4,054 km [2,519 mi] of streams. The basin also has watersheds that originate in South Dakota. Streamflow in the basin is a function of surface runoff and groundwater contributions. Major tributaries to the watershed include Ponca Creek, Verdigre Creek, Keya Paha River, Long Pine Creek, Plum Creek, Snake River, and Minnechaduza Creek (Nebraska Department of Environmental Quality, 2005b). Fish species found in the Niobrara Watershed region are listed in Table 3.4-6.

Table 3.4-6. Fishes of the Niobrara River Watershed*

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Blacknose Shiner	*Notropis hedrolepis*
Blue Catfish	*Ictalurus furcatus*
Bluegill	*Lepomis macrochirus*
Brook Stickleback	*Culaea inconstans*
Brook Trout	*Salvelinus fontinalis*
Brown Trout	*Salmo trutta*
Channel Catfish	*Ictalurus punctatus*
Common Shiner	*Luxilus cornutus*
Finescale Dace	*Phoxinus neogaeus Cope*
Flathead Catfish	*Pylodictis olivaris*
Golden Shiner	*Notemigonus crysoleucas*
Iowa Darter	*Etheostoma exile*
Johnny Darter	*Etheostoma nigrum*
Lake Chub	*Couesius plumeus*
Lake Sturgeon	*Acipenser flavescens Rafinwsque*
Largemouth Bass	*Micropterus salmoides*
Muskellunge	*Esox masquinongy*
Northern Pike	*Esox lucius*
Northern Redbelly Dace	*Phoxinus eos*

Table 3.4-6. Fishes of the Niobrara River Watershed* (continued)	
Common Name	**Scientific Name**
Orange Throat Darter	*Etheostoma spectabile*
Paddlefish	*Polyodon spathula*
Pallid Sturgeon	*Scaphirhynchus albus*
Pearl Dace	*Margariscus margarita Cope*
Pumpkinseed	*Lepomis gibbosus*
Rainbow Trout	*Oncorhynchus mykiss*
Redear Sunfish	*Lepomis microlophus*
Rock Bass	*Ambloplites rupestris*
Sauger	*Stizostedion canadense*
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*
Smallmouth Bass	*Micropterus dolomieu*
Spotted Bass	*Micropterus punctulatus*
Striped Bass	*Morone saxatilis*
Sturgeon Chub	*Macrhybopsis gelida*
Topeka Shiner	*Notropis topeka*
Walleye	*Stizostedion vitreum*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Yellow Perch	*Perca flavescens*
*Nebraska Department of Environmental Quality. "Total Maximum Daily Loads for the Niobrara River Basin." Lincoln, Nebraska: Nebraska Department of Environmental Quality. December 2005.	

3.4.5.3 Threatened and Endangered Species

Federally listed threatened and endangered species that are known to exist within habitats found within the region include the following:

- Black-Footed Ferret—discussed in Section 3.2.5.3
- Blowout Penstemon—discussed in Section 3.2.5.3
- Interior Least Tern—discussed in Section 3.2.5.3
- Piping Plover—discussed in Section 3.2.5.3
- Pallid Sturgeon—discussed in Section 3.2.5.3
- Ute Ladies' Tresses Orchid—discussed in Section 3.2.5.3
- Western Praire Fringed Orchid—discussed in Section 3.2.5.3
- Whooping Crane—discussed in Section 3.2.5.3

State-listed threaten and endangered species for South Dakota, Nebraska, and special Status 1 and 2 species of concern for Wyoming that occur within the region include the following.

South Dakota

- American Dipper (*Cinclus mexicanus)*, State Threatened—This bird is found in the cold, fast streams in the Black Hills. American dippers feed on insects found on stream bottoms, swimming underwater to depths of up to 6 m [20 ft] and even walking on the stream bed. Often nests on the underside of bridges over mountain streams (South Dakota Birds and Birding, 2008).

- Osprey (*Pandion haliaetus*), State Threatened—Osprey habitat includes lakes, large rivers and coastal bays. A reversible front toe and spiny nodules under its toes (spicules) to aid in grasping fish captured by plunge-diving feet first. Ospreys nest at the tops of large living or dead trees, on cliffs, on utility poles, or on other tall manmade structures. Clutch size ranges from two to four eggs with hatching in about 30 days. Young fly at 44–59 days and are dependent on parents for 6–12 weeks. This species has a worldwide distribution. In North America, the osprey breeds from northern Saskatchewan, Labrador, and Newfoundland in Canada, to the Great Lakes states and along the Pacific and Atlantic coasts. In South Dakota, it is a historical nester in the southeastern part of the state and an uncommon migrant. Many summer observations and the first modern (1991) successful osprey nest in the state raise hopes for the future of this species in South Dakota (U.S. Geological Survey, 2008b).

- Swift Fox State (*Vulpes velox*), Threatened—discussed in Section 3.3.5.3

- Finescale Dace (*Phoxinus neogaeus*) State Threatened—The finescale dace ranges widely but populations existing in Wyoming and Nebraska are considered glacial relics. Commonly occurs in the Niobrara River and several sites in Crook County where they are native to the North Fork Cow Creek in the Cheyenne River drainage. Typically occur in cool, boggy lakes and sluggish acidic streams. They are commonly found in lakes and ponds and are often associated with beaver ponds. Considered to be widespread, abundant, and globally secure but are considered threatened in South Dakota and of special concern in North Dakota, Nebraska, and Wyoming. Distribution is believed to be stable at drainage or subdrainage scale but is declining on the site and stream scale (Wyoming Game and Fish Department, 2008).

- Longnose Sucker *Catostomus catostomus)*, State Threatened—The longnose sucker is found in cool, spring-fed creeks where it feeds on the bottom on algae, crustaceans, snails, and insect larvae (caddisflies, mayflies, midges). It spawns in lakes or in shallow-flowing streams over gravel, where fry remain until 1–2 weeks old. Longnose suckers do not sexually mature until 4–9 years of age. The longnose is the most widespread sucker species in North America. It is found in Canada and Alaska, south from western Maryland, north to Minnesota, west and north through northem Colorado and through Washington. South Dakota populations are on the edge of its range and are found in the Belle Fourche River drainage north of the Black Hills (U.S. Geological Survey, 2008b).

- Bald Eagle (*Haliaeetus leucocephalus*), State Threatened—discussed in Section 3.2.5.3

- Piping Plover (*Charadrius melodus)*, State Threatened—The piping plover is present on breeding grounds from late March through August. It nests on sandbars and sand and gravel beaches with short, sparse vegetation along inland lakes; on natural and dredge islands in rivers; in gravel pits along rivers; and on salt-encrusted bare areas of sand, gravel or pebbly mud on interior alkali ponds and lakes. Nests are shallow, scraped depressions, occasionally lined with small pebbles, shells, or other material. A clutch of four eggs is usually laid in late May or early June, with hatching in 27–31 days. Both eggs and young are tended by both parents. Piping plovers feed along the water's edge on small insects, crustaceans, and mollusks. In South Dakota, the piping plover is a common breeding associate of the endangered interior least tern. Three North American breeding populations of piping plovers are recognized and have the following distributions: the Atlantic Coast from Newfoundland to Virginia; the Great Lakes, excluding the rocky north shores of Lakes Superior and Huron; and the northern Great Plains. The greatest number of piping plovers breed in the northern Great Plains. This breeding population occurs in scattered alkaline wetlands of the northern Great Plains and on the Missouri River and its tributaries in the Dakotas and Nebraska. In South Dakota, nesting occurs primarily on the natural stretches of the Missouri River below the Gavins Point and Fort Randall Dams, although some nesting may occur on tributaries. Piping plovers have also been reported from Bitter and Waubay Lakes in Day County and Horseshoe Lake in Codington County in northeastern South Dakota. This species overwinters along the Atlantic coast from North Carolina to Florida, along the Gulf coast, and in the Bahamas and West Indies (U.S. Geological Survey, 2008b).

- Northern River Otter *(Lontra Canadensis)*, State Threatened—The river otter is found in rivers, ponds, lakes and unpolluted waters in wooded areas. Key habitat components are riparian vegetation, temporary den and resting sites (cavities under tree roots, shrub patches, tall grass) and adequate food. It is active all year, mainly at night. Air trapped in the fur insulates the river otter while underwater, where it can stay for up to 4 minutes. Long, stiff whiskers to locate prey and good underwater vision aid in hunting success. The river otter is sexually mature at 2 years, breeding in early spring. The female has two–three pups (range one–six) in a secluded natal den site. Young leave the den at 2 months, are weaned by 3 months, but remain with the female until just prior to the birth of the mother's next litter. It occupies dens built by other animals, log jams and unused human structures. River otters primarily eat fish. Other aquatic foods include frogs, crayfish, and turtles, making the river otter a good barometer of water quality. The river otter is distributed throughout North America north of Mexico, except for the extreme southwestern United States. In South Dakota, it has been reported from Hughes County along the Missouri River, with unverified reports from adjacent counties.

In addition to federal- and state-listed species, South Dakota's Natural Heritage Program has identified species of greatest conservation need. South Dakota's Natural Heritage Program issued conservation modifiers for each species, which are defined as follows:

- G1 S1—Critically imperiled because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

- G2 S2—Imperiled because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

- G3 S3—Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21 of 100 occurrences.

- G4 S4—Apparently secure, though it may be quite rare in parts of its range, especially at the periphery. Cause for long-term concern.

- G5 S5—Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.

- GU SU—Possibly in peril, but status uncertain; more information needed.

- GH SH—Historically known, may be rediscovered.
- GX SX—Believed extinct, historical records only.
- T—Rank of subspecies or variety.
- Q—Taxonomic status is questionable, rank may change with taxonomy.
- SZ—No definable occurrences for conservation purposes, usually assigned to migrants.
- SP—Potential exists for occurrence in the state, but no occurrences.
- SR—Element reported for the state, but no persuasive documentation.
- SA—Accidental or casual.

Subspecies are listed in some cases if the populations are disjunct and may be genetically unique. In addition to being important components of the ecosystems, subspecies can be federally listed if the U.S. Fish and Wildlife Service determines there is justification.

Species of greatest conservation need listed for South Dakota's Comprehensive Management Plan are identified as

- Birds
  - American white pelican (*Pelecanus erythrorhynchos*), G3, S3B, SZN
  - Trumpeter swan (*Cygnus buccinators*), G4, S3
  - Osprey (*Pandion haliaetus*), G5, S1B, SZN
  - Bald eagle (*Haliaeetus leucocephalus*), G4, S1B, S2N
  - Northern goshawk (*Accipiter gentilis*), G5, S3B, S2N
  - Ferruginous hawk (*Buteo regalis*), G4, S4B, SZN
  - Peregrine falcon (*Falco peregrinus*), G4, SXB, SZN
  - Greater sage-grouse (*Centrocercus urophasianus*), G4, S2
  - Greater prairie-chicken (*Tympanuchus cupido*), G4, S4
  - Whooping crane (*Grus americana*), G1, SZN
  - Piping plover (*Charadrius melodus*), G3, S2B, SZN
  - Willet (*Catoptrophorus semipalmatus*), G5, S5
  - Long-billed curlew (*Numenius americanus*), G5, S3B, SZN
  - Marbled godwit (*Limosa fedoa*), G5, S5
  - Wilson's phalarope (*Phalaropus tricolor*), G5, S4
  - Interior least tern (*Sterna antillarum athalassos*), G4, T2Q, S2B, SZN
  - Black tern (*Chlidonias niger*), G4, S3B, SZN
  - Burrowing owl (*Athene cunicularia*), G4, S3S4B, SZN
  - Lewis's woodpecker (*Melanerpes lewis*), G4, S3B,S3N
  - American three-toed woodpecker (*Picoides dorsalis*), G5, S2
  - Black-backed woodpecker (*Picoides arcticus*), G5, S3
  - American dipper (*Cinclus mexicanus*) G5, S2
  - Sprague's pipit (*Anthus spragueii*), G4, S2B, SZN
  - Lark bunting (*Calamospiza melanocorys*), G5, S5
  - Baird's sparrow (*Ammodramus bairdii*), G4 S2B, SZN

- — Le Conte's sparrow (*Ammodramus leconteii*), G4, S1S2B, SZN
- — White-winged junco (*Junco hyemalis aikeni*), G5T4, S5
- — Chestnut-collared longspur *(Calcarius ornatus)*, G5, S4

- Mammals
  - — Fringe-tailed myotis *(Myotis thysanodes pahasapensis),* G4G5T2, S2
  - — Northern myotis *(Myotis septentrionalis),* G4 S3
  - — Townsend's big-eared bat *(Corynorhinus townsendii),* G4, S2S3
  - — Franklin's ground squirrel *(Spermophilus franklinii),* G5, S5
  - — Richardson's ground squirrel *(Spermophilus richardsonii),* G5, S5
  - — Northern flying squirrel *(Glaucomys sabrinus),* G5, S2
  - — Bear lodge meadow jumping mouse *(Zapus hudsonius campestris),* G5T3, not ranked
  - — Kit or swift fox *(Vulpes velox),* G3, S1
  - — Black-footed ferret *(Mustela nigripes),* G1, S1
  - — Northern river otter *(Lontra Canadensis),* G5, S2

- Freshwater Mussels
  - — Elktoe *(Alasmidonta marginata),* G4, S1
  - — Rock pocketbook *(Arcidens confragosus),* G4, S1
  - — Creek heelsplitter *(Lasmigona compressa),* G5, S1
  - — Higgins eye *(Lampsilis higginsii),* G1, S1
  - — Scaleshell *(Leptodea leptodon),* G1, S1
  - — Hickorynut *(Obovaria olivaria),* G4, S1
  - — Mapleleaf *(Quadrula quadrula),* G5, S2

- Gastropods
  - — Dakota vertigo *(Vertigo arthuri),* G2, S2
  - — Mystery vertigo *(Vertigo paradoxa),* G2G4, S1
  - — Frigid ambersnail *(Catinella gelida),* G2, S1
  - — Cooper's Rocky Mountain snail *(Oreohelix strigosa cooperi),* G5T1, S2

- Insects
  - — Ghost tiger beetle *(Cicindela lepida),* G4, S1
  - — Great Plains tiger beetle *(Amblycheila cylindriformis),* G5, S1
  - — American burying beetle *(Nicrophorus americanus),* G2G3, S1
  - — Powesheik skipperling *(Oarisma powesheik),* G2, S2
  - — Ottoe skipper *(Hesperia ottoe),* G3G4, S2
  - — Dakota skipper *(Hesperia dacotae),* G2G3, S2
  - — Iowa skipper *(Atrytone arogos iowa),* G3G4T3T4, S2
  - — Regal fritillary *(Speyeria idalia),* G3, S3
  - — Black Hills fritillary *(Speyeria atlantis pahasapa),* G5T3, S3

- Fishes
  - — Banded killifish *(Fundulus diaphanous),* G5, S1
  - — Blacknose shiner *(Notropis heterolepis),* G5, S1
  - — Central mudminnow *(Umbra limi),* G5, S1
  - — Finescale dace *(Phoxinus neogaeus),* G5, S1
  - — Longnose sucker *(Catostomus catostomus),* G5, S1
  - — Northern redbelly dace *(Phoxinus eos),* G5, S2

- Pallid sturgeon *(Scaphirhynchus albus),* G1G2, S1
- Paddlefish *(Polyodon spathula),* G4, S4
- Pearl dace *(Margariscus margarita),* G5, S2
- Sicklefin chub *(Macrhybopsis meeki),* G3, S1
- Sturgeon chub *(Macrhybopsis gelida),* G2, S2
- Topeka shiner *(Notropis Topeka),* G3, S3
- Trout-perch *(Percopsis omiscomaycus),* G5, S2
- Lake chub *(Couesius plumbeus),* G5, S1
- Mountain sucker *(Catostomus platyrhynchus),* G5, S3
- Southern redbelly dace *(Phoxinus erythrogaster),* G5, S1
- Hornyhead chub *(Nocomis biguttatus),* G5, S3
- Rosyface shiner *(Notropis rubellus),* G5, S2
- Logperch *(Percina caprodes),* G5, S3
- Blackside darter *(Percina maculate),* G5, S2

- Reptiles and Amphibians
  - Blanding's turtle *(Emys blandingii),* G4, S1
  - False map turtle *(Graptemys pseudogeographica),* G5, S3
  - Lined snake *(Tropidoclonion lineatum),* G5, S1
  - Eastern hognose snake *(Heterodon platirhinos),* G5, S2
  - Black Hills redbelly snake *(Storeria occipitomaculata pahasapae),* G5T3, S3
  - Cope's gray treefrog *(Hyla chrysoscelis),* G5, S2
  - Smooth softshell *(Apalone mutica),* G5, S2
  - Western box turtle *(Terrapene ornate),* G5, S2
  - Lesser earless lizard *(Holbrookia maculate),* G5, S2
  - Northern cricket frog *(Acris crepitans),* G5, S1
  - Many-lined skink *(Eumeces multivirgatus),* G5, S1
  - Short-horned lizard *(Phrynosoma hernandesi),* G5, S2

Nebraska

- Finescale Dace, State Special Concern—discussed previously for South Dakota
- Swift Fox, State Endangered—discussed in Section 3.3.5.3
- Ute Ladies' Tresses Orchid, State Endangered—discussed in Section 3.2.5.3
- Whooping Crane State Endangered—discussed in Section 3.3.5.3

Wyoming

- Finescale Dace, Native Species Status 1—discussed previously for South Dakota

- Pearl Dace, Native Species Status 1—The pearl dace occurs in cool bogs, ponds, lakes, creeks, and clear streams. It spawns in the spring in clear water with a weak to moderate current over sand or gravel. This species feeds on invertebrates (insects and zooplankton) and algae (U.S. Geological Survey, 2008b).

- Western Silvery Minnow, Native Species Status 1—discussed in Section 3.2.5.3

- Canada Lynx (*Lynx canadensis*), Native Species Status 1—discussed in Section 3.2.5.3

- Plains Topminnow, Native Species Status 2— discussed in Section 3.2.5.3

- Goldeye, Native Species Status 2—In Wyoming, the goldeye can be found in the Powder, Little Powder and Little Missouri Rivers and in Clear and Crazy Woman Creeks. It prefers large rivers and their associated backwaters and marshes, or the shallow waters of large lakes and reservoirs. Young goldeye have never been found in Wyoming; it is thought that populations in the northeastern part of the state are maintained by the migration of adult fish seeking spawning grounds (Wyoming Game and Fish Department, 2008).

- Pale Milk Snake, Native Species Status 2—The pale milksnake prefers grasslands, sandhills, and scarp woodlands below 1,830 m [6,000 ft] in elevation. It is distributed throughout the northern Great Plains. In Wyoming, it can be found in the eastern counties and the Bighorn Basin (Wyoming Game and Fish Department, 2008).

- Smooth Green Snake (*Opheodrys vernalis*), Native Species Status 2—discussed in Section 3.2.5.3

- Yellow-Billed Cuckoo (*Coccyzus americanus*), Native Species Status 2—discussed in Section 3.2.5.3

- Greater Sage-Grouse, Native Species Status 2—discussed in Section 3.2.5.3

- Bald Eagle, Native Species Status 2—discussed in Section 3.2.5.3

- Trumpeter Swan Native, Species Status 2—discussed in Section 3.2.5.3

- Fringed Myotis (*Myotis thysanodes*), Native Species Status 2—discussed in Section 3.2.5.3

- Long-Eared Myotis (*Myotis evotis*), Native Species Status 2—discussed in Section 3.2.5.3

- Long-Legged Myotis (*Myotis volans*), Native Species Status 2—discussed in previous regions.

- Pallid Bat (*Antrozous pallidus*), Native Species Status 2—discussed in Section 3.2.5.3

- Spotted Bat (*Euderma maculatum*), Native Species Status 2—discussed in Section 3.2.5.3

- Townsend’s Big-Eared Bat, Native Species Status 2—discussed in Section 3.2.5.3

3.4.6 Meteorology, Climatology, and Air Quality

3.4.6.1 Meteorology and Climatology

The Nebraska-South Dakota-Wyoming Uranium Milling Region contains portions of three states: Wyoming, Nebraska, and South Dakota. This region is characterized by hot summers and cold winters, and rapid temperature fluctuations are common. The Rocky Mountains have a great influence on the climate. As air crosses the Rockies from the west, much moisture is lost on the windward sides of the mountains and becomes warmer as it descends on the eastern slopes.

Table 3.4-7 identifies three climate stations located in the Nebraska-South Dakota-Wyoming Uranium Milling Region. Climate data for these stations are found in the National Climatic Data Center's Climatography of the United States No. 20 Monthly Station Climate Summaries for 1971–2000 (National Climatic Data Center, 2004). This summary contains climate data for 4,273 stations throughout the United States and some territories. Table 3.4-8 contains temperature data for three stations in the Western Nebraska-South Dakota-Wyoming Uranium Milling Region.

Most precipitation in the Nebraska-South Dakota-Wyoming Uranium Milling Region occurs in the spring and summer. Rainstorms, hailstorms, and lighting are most likely to occur in the summer. Heavy rain can accompany thunderstorms and may cause some flooding. This flooding intensifies if these storms coincide with snow pack melting. Table 3.4-8 contains precipitation data for three stations in the Nebraska-South Dakota-Wyoming Uranium Milling Region. The wettest month varies for the stations identified in Table 3.4-8. May is the wettest month for the Newcastle (Weston County, Wyoming) and Ardmore (Fall River County, South Dakota) stations and June is the wettest month for the Colony (Crook County, Wyoming) station. Based on the snow depth data, the wettest months coincide with melting snow pack (National Climatic Data Center, 2004). Data from National Climatic Data Center's Storm Events Database from 1950 to 2007 indicate that the vast majority of thunderstorms in Crook, Weston, and Fall River Counties occurs between May and August with most occurring in July (National Climatic Data Center, 2007).

Table 3.4-7. Information on Three Climate Stations in the Nebraska-South Dakota-Wyoming Uranium Milling Region*

Station (Map Number)	County	State	Longitude	Latitude
Colony	Crook	Wyoming	104°11W	44º55N
Newcastle	Weston	Wyoming	104°13W	43º51N
Ardmore 2 N	Fall River	South Dakota	103°39W	43º03N

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

Table 3.4-8. Climate Data for Stations in the Nebraska-South Dakota-Wyoming Uranium Milling Region*

		Colony	Newcastle	Ardmore 2 N
Temperature (°C)†	Mean—Annual	8.3	7.9	8.1
	Low—Monthly Mean	−5.3	−5.7	−6.0
	High—Monthly Mean	22.4	22.5	22.5
Precipitation (cm)‡	Mean—Annual	37.8	40.7	43.7
	Low—Monthly Mean	0.9	1.1	1.0
	High—Monthly Mean	6.8	6.5	7.3
Snowfall (cm)	Mean—Annual	93.2	95.5	105
	Low—Monthly Mean	0	0	0
	High—Monthly Mean	19.6	19.8	18.5

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.
†To convert Celsius (°C) to Fahrenheit (°F), multiply by 1.8 and add 32.
‡To convert centimeters (cm) to inches (in), multiply by 0.3937.

The mountains typically receive the most snow. Occasionally snow can accumulate to a considerable depth. During snow periods, there is often wind that may cause a large proportion to collect in gullies and behind windbreaks. Peak snowfall generally occurs in February and early March. Table 3.4-8 contains snowfall data for three stations in the Nebraska-South Dakota-Wyoming Uranium Milling Region.

The pan evaporation rates for the Western Nebraska-South Dakota-Wyoming Uranium Milling Region range from about 102–127 cm [40–50 in] (National Weather Service, 1982). Pan evaporation is a technique that measures the evaporation from a metal pan typically 121 cm [48 in] in diameter and 25 cm [10 in] tall. Pan evaporation rates can be used to estimate the evaporation rates of other bodies of water such as lakes or ponds. Pan evaporation rate data are typically available only from May to October. Freezing conditions often prevent collection of quality data during the other part of the year.

3.4.6.2 Air Quality

The air quality general description for the Western Nebraska-South Dakota-Wyoming Uranium Milling Region would be similar to the description in Section 3.2.6 for the Wyoming West Uranium Milling Region. The Nebraska-South Dakota-Wyoming Uranium Milling Region information in Section 3.4.6.2 is limited to the modification, supplementation, or summarization of the Wyoming West Uranium Milling Region information presented in Section 3.2.6.

As described in Section 1.7.2.2, the permitting process is the mechanism used to address air quality. If warranted, permits may set facility air pollutant emission levels, require mitigation measures, or require additional air quality analyses. The Nebraska-South Dakota-Wyoming Uranium Milling Region covers portions of Wyoming, South Dakota, and Nebraska. Except for Indian Country, New Source Review permits in these three states are regulated under the EPA-approved State Implementation Plan except for the Prevention of Significant Deterioration permits in South Dakota, which are regulated by 40 CFR 52.21 (EPA, 2007a). For Indian Country in these three states, the New Source Review permits are regulated under 40 CFR 52.21 (EPA, 2007a).

State implementation plans and permit conditions are based in part on federal regulations developed by the EPA. The NAAQS are federal standards that define acceptable ambient air concentrations for six common nonradiological air pollutants: nitrogen oxides, ozone, sulfur oxides, carbon monoxide, lead, and particulates. In June 2005, EPA revoked the 1-hour ozone standard nationwide in all locations except certain Early Action Compact Areas. None of the 1-hour ozone Early Action Compact Areas is in Wyoming, South Dakota, or Nebraska. States may develop standards that are stricter or supplement the NAAQS. Wyoming has a more restrictive annual average standard for sulfur dioxide at 60 $\mu g/m^3$ [1.6×10^{-6} oz/yd^3] and a supplemental 50 $\mu g/m^3$ [1.3×10^{-6} oz/yd^3] PM_{10} standard with an annual averaging time (Wyoming Department of Environmental Quality, 2006). Nebraska has a 50 $\mu g/m^3$ [1.3×10^{-6} oz/yd^3] PM_{10} standard with an annual averaging time (Nebraska Department of Environmental Quality, 2002). South Dakota standards implement NAAQS straightforward (South Dakota Department of Environment and Natural Resources, 2007).

Prevention of Significant Deterioration requirements identify maximum allowable increases in concentrations for particulate matter, sulfur dioxide, and nitrogen dioxide for areas designated as attainment. Different increment levels are identified for different classes of areas and Class I areas have the most stringent requirements.

The Nebraska-South Dakota-Wyoming Uranium Milling Region air quality description focuses on two topics: NAAQS attainment status and Prevention of Significant Deterioration classifications in the region.

Figure 3.4-19 identifies the counties in and around the Western Nebraska-South Dakota-Wyoming Uranium Milling Region that are partially or entirely designated as nonattainment or maintenance for NAAQS at the time this GEIS was prepared (EPA, 2007b). All of the area within the Nebraska-South Dakota-Wyoming Uranium Milling Region is classified as attainment. Wyoming only has one area that is not in attainment. The City of Sheridan in Sheridan County is designated as nonattainment for PM_{10}. Nebraska only has one area not in attainment. A portion of the city of Omaha in Douglas County is designated as maintenance for lead but this is in eastern Nebraska, about 500 km [311 mi] from the Nebraska-South Dakota-Wyoming Uranium Milling Region. No areas in South Dakota are designated as nonattainment or maintenance. Two counties in southeast Montana are not in attainment. However, the two Montana counties that border the Nebraska-South Dakota-Wyoming Uranium Milling Region are in attainment.

Table 3.4-9 identifies the Prevention of Significant Deterioration Class I areas in Wyoming, South Dakota, Nebraska, and Montana. These areas are shown in Figure 3.4-20. The Nebraska-South Dakota-Wyoming Uranium Milling Region does contain a Class I area for the Wind Cave National Park in South Dakota (40 CFR Part 81).

3.4.7 Noise

The existing ambient noise levels for undeveloped rural and more urban areas in the Nebraska-South Dakota-Wyoming Uranium Milling Region would be similar to those described in Section 3.2.7 for the Wyoming West Uranium Milling Region. This is a large region spanning parts of three different states. The largest community within the region, with a population of about 12,500, is Spearfish, South Dakota, in the northeastern portion. Smaller communities with populations from around 1,000 to 6,000 include Sundance and Newcastle, Wyoming; Hot Springs and Custer, South Dakota; and Crawford and Chadron in Dawes County, Nebraska (see Section 3.4.10). Ambient noise levels in these communities would likely be in the range of 45 to about 78 dB (Washington State Department of Transportation, 2006). In addition, the Pine Ridge Indian Reservation is just to the east of the Nebraska-South Dakota-Wyoming Uranium Milling Region.

A number of major highways cross the region, including Interstate 90 in the northern portion and a number of U.S. and state undivided highways. Ambient noise levels near these highways would be similar to or less than those measured at up to 70 dBA for Interstate 80, as the total traffic count and the percentages of heavy truck traffic are less (Wyoming Department of Transportation, 2005; Federal Highway Administration, 2004; see also Sections 3.2.7 and 3.4.2).

A number of scenic byways through the Black Hills could be more sensitive to noise impacts, but these are located more than 16 km [10 mi] east of the areas of interest for ISL uranium recovery.

For the three uranium districts located in the Nebraska-South Dakota-Wyoming Uranium Milling Region, there are several National Park Service and U.S. Forest Service properties, state parks, and other properties (see Figure 3.4-1) that may be sensitive to noise impacts. Much of this

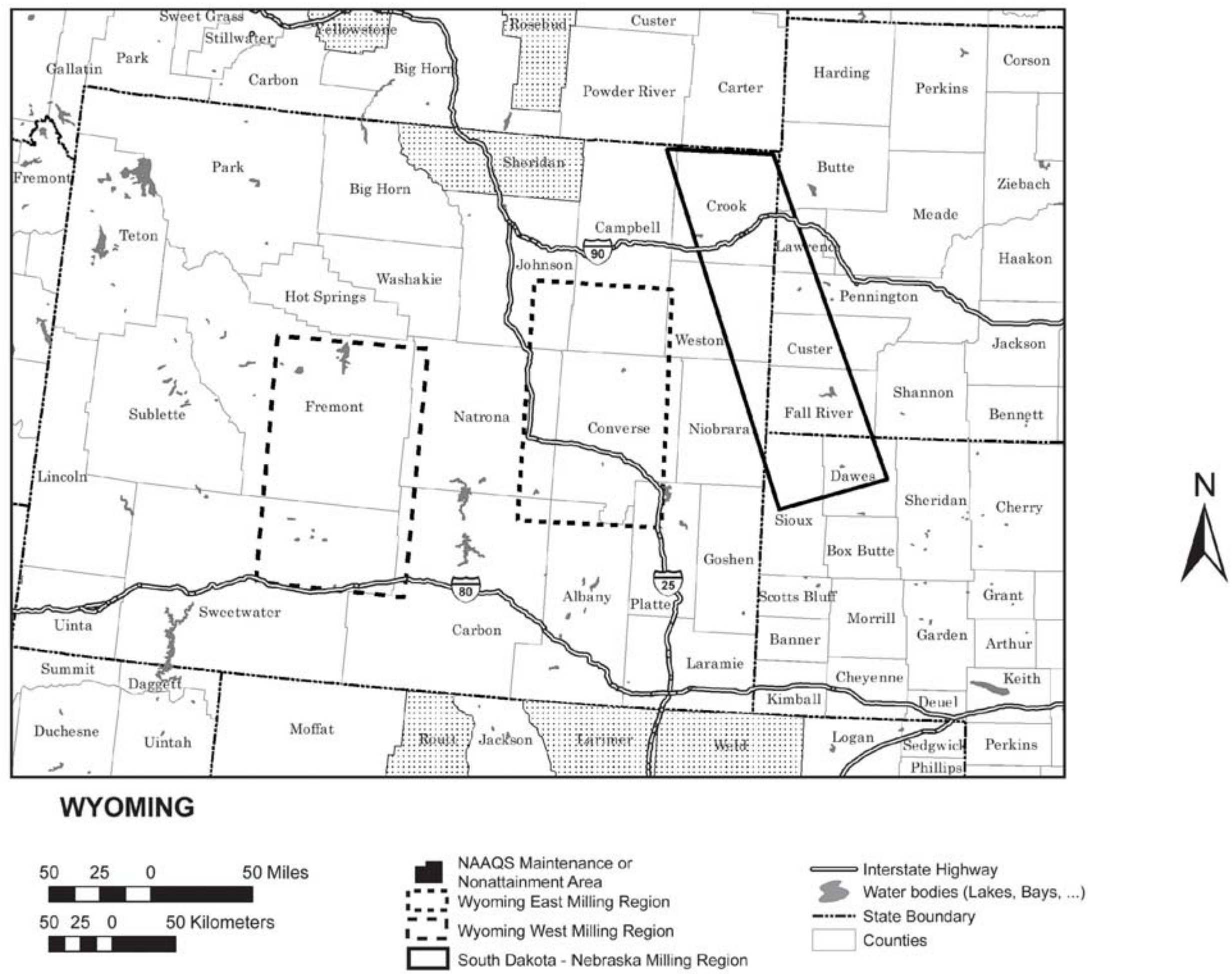


Figure 3.4-19. Air Quality Attainment Status for Nebraska-South Dakota-Wyoming Uranium Milling Region and Surrounding Areas (EPA, 2007b)

Table 3.4-9. U.S. Environmental Protection Agency Class I Prevention of Significant Deterioration Areas in Wyoming, South Dakota, Nebraska, and Montana*

WYOMING	MONTANA
Bridger Wilderness Fitzpatrick Wilderness Grand Teton National Park North Absaroka Wilderness Teton Wilderness Washakie Wilderness Yellowstone National Park	Anaconda-Pintlar Wilderness Bob Marshall Wilderness Cabinet Mountains Wilderness Gates of the Mountain Wilderness Glacier National Park Medicine Lake Wilderness Mission Mountain Wilderness Red Rock Lakes Wilderness Scapegoat Wilderness Selway-Bitterroot Wilderness U.L. Bend Wilderness Yellowstone National Park
SOUTH DAKOTA Badlands Wilderness Wind Cave National Park	NEBRASKA None

*Modified from Code of Federal Regulations. "Prevention of Significant Air Deterioration of Air Quality." Title 40—Protection of the Environment, Part 81. Washington, DC: U.S. Government Printing Office. 2005.

area is protected from extensive development, and the ambient noise levels would be expected to be similar to undeveloped rural areas (up to 38 dB) (DOE, 2007).

Northernmost uranium district (Wyoming)

- Devil's Tower National Monument (Wyoming)
- Black Hills National Forest (Wyoming-South Dakota)

Central uranium district (Wyoming, South Dakota)

- Thunder Basin National Grassland (Wyoming)
- Buffalo Gap National Grassland (South Dakota)

Southern uranium district (Nebraska)

- Oglala National Grassland (Nebraska)
- Nebraska National Forest (Nebraska)
- Fort Robinson State Park (Nebraska)

Small communities are located within and near each of the three uranium districts, including Aladdin, Wyoming, in the northernmost district; Riverview, Wyoming, and Burdock and Edgemont, South Dakota, in the central district; and Crawford, Nebraska, near the Crow Butte ISL facility in the southern district. In general, these small towns are located 8 km [5 mi] or more from the uranium projects.

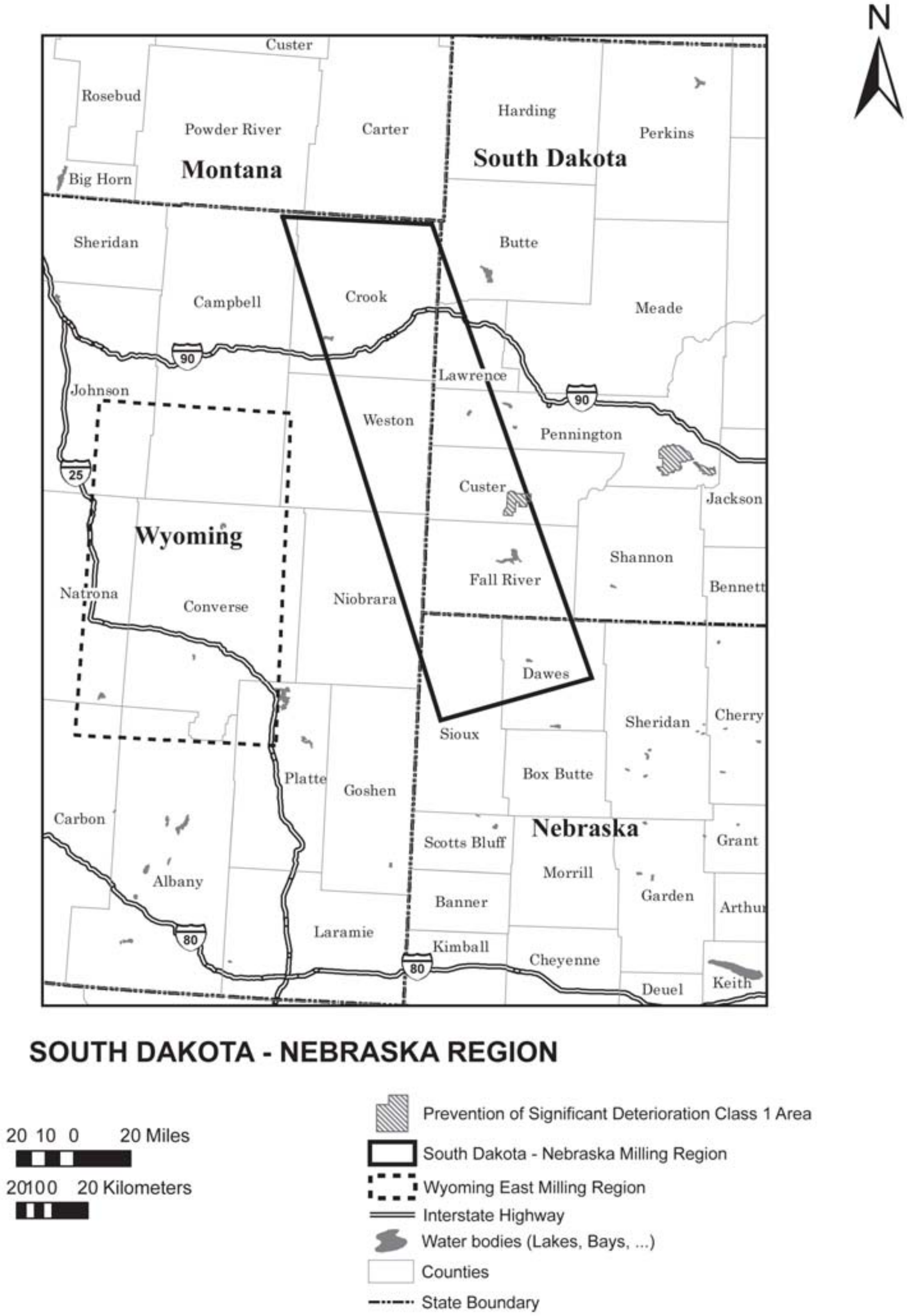


Figure 3.4-20. Prevention of Significant Deterioration Class I Areas in the Nebraska-South Dakota-Wyoming Uranium Milling Region and Surrounding Areas (40 CFR Part 81)

3.4.8 Historical and Cultural Resources of Western South Dakota and Nebraska

Appendix D provides a general overview of historical and cultural resource impact assessment at the federal level. As noted in Section 3.2.8, specific cultural resources in Wyoming, South Dakota, Nebraska, and New Mexico are described at the state level by the responsible state agencies. For the purposes of describing cultural and historical resources for the Nebraska-South Dakota-Wyoming Uranium Milling Region, an overview of Wyoming cultural and historical resources is provided in Section 3.2.8. Cultural and historical resources in South Dakota and Nebraska are described separately in this section (Section 3.4.8).

The South Dakota SHPO is a division of the South Dakota State Historical Society. The director of the South Dakota State Historical Society serves as the state's historic preservation officer. The South Dakota SHPO administers and is responsible for oversight and compliance with the NRHP, compliance and review for Section 106 of the NHPA, Preservation of Historic Property Procedures (South Dakota Codified Law 1-19-11.1), traditional cultural properties, NAGPRA, and archaeological survey through its Archaeology Division as well as compliance with other federal and state historic preservation laws, regulations, and statutes. Their webpage can be found at <http://www.sdhistory.org>. The State of South Dakota also has laws regarding human remains, entitled Cemeteries and Burials (SDCL 1-20-32, Chapter 34-27).

The Nebraska SHPO is a division of the Nebraska State Historical Society. The director of the Nebraska State Historical Society serves as the state's historic preservation officer. The NSHPO administers and is responsible for oversight and compliance with the NRHP, the Nebraska Historic Buildings Survey, compliance and review for Section 106 of the NHPA and traditional cultural properties, NAGPRA, and archaeological survey through its Archaeology Division and compliance with other federal and state historic preservation laws, regulations, and statutes. Their webpage can be found at <http://www.nebraskahistory.org/histpres>. The State of Nebraska also has laws regarding human remains, entitled Unmarked Human Burial Sites {Revised Statutes of Nebraska 1989 Supplement Article 12 [12-1201 to 12-1212]} and Human Skeletal Remains or Burial Goods, Prohibited Acts; Penalty (Article 28-1301).

3.4.8.1 Cultural Resources Overview

3.4.8.1.1 Cultural Resources of Western and Southwestern South Dakota

The following provides a brief overview of prehistoric and historical cultures recognized in the central and northern plains region, which includes western South Dakota. The dating of cultural periods for the prehistoric period is provided in BP. Most prehistoric archaeological sites are concentrated along the James, Missouri, White, Cheyenne and Big Sioux River valleys, but can be found along many drainages in the state. Figures 3.2-18 and 3.2-19 illustrate the division of the plains into regional subdivisions.

Paleoindian Big Game Hunters (12,000 to 6,500 B.P.). The earliest well-defined cultural tradition in the central plains region is the Paleoindian. Early humans entered the areas shortly after deglaciation allowed movement onto the central plains sometime after 14,000 B.P. A variety of cultures, each defined by the presence of distinctive projectile points, are recognized during the Paleoindian period: Clovis, Goshen, Folsom, Hell Gap-Agate Basin, Cody Complex, and Plano. Most post-Clovis Paleoindian sites on the northern and upper central plains are known from bison kill sites. The Clovis culture (12,000 to 10,000 B.P.) is recognized by a distinctive projectile point style and a subsistence mode heavily reliant on hunting large, now-extinct mammals, notably mammoth and mastodon, which became extinct at the end of the Clovis period. The poorly defined Goshen Complex found at the Jim Pitts site in the Black Hills may be contemporary with Clovis and is technologically similar. The Folsom culture (ca. 10,000 to 8,500 B.P.) is also known for a distinctive projectile point style. Folsom subsistence is also characterized by reliance on large game—the ancient bison. Folsom sites consist of camp sites and kill sites. The latter tend to be located near cliffs and around water, such as ponds and springs. The Plano, Hell Gap-Agate Basin, and Cody Complex cultures (ca. 8,500 to 6,500 B.P.) are, in their earliest forms, a continuation of earlier Paleoindian hunting traditions. The distinctive projectile point forms that define these cultural complexes are, in comparison to earlier Clovis and Folsom, much more restricted in geographic distribution. Toward the middle and end of the period encompassing these cultures, however there is a transition in subsistence modes following the extinction of the ancient bison form to the modern form of bison and ultimately, a transition to Archaic broad-spectrum foraging. Post molds and stone circles suggesting the presence of ephemeral shelters are sometimes found, primarily toward the end of the period.

Archaic Foragers (6,500 to 3,500 B.P.). The Plains Archaic period represents the continuation of change in subsistence and settlement linked to an increasingly arid environment that occurs in the latter portion of the preceding late Paleoindian cultures. Distinctive Archaic cultures, from early to late, include Mummy Cave, Oxbow, McKean, and Pelican Lake complexes. Kill sites, characteristic of the preceding Paleoindian period, are virtually absent. Hunting and gathering wild plant foods is the primary mode of subsistence. Dietary breadth, indicated by increasing diversity and numbers of subsistence items, is believed to expand significantly with more medium and small mammals being hunted and the introduction of seed-bearing plants: dietary staples indicated by the introduction of stone seed-grinding implements. Through time, settlement is increasingly tethered to highly productive resource areas and sites tend to become larger and increasingly complex, indicating the presence of somewhat more sedentary lifestyles relative to earlier periods. Settlement is focused on river valleys and elevated areas. Artifact styles, principally projectile points, become increasingly diversified, suggesting increasing regionalization and cultural differentiation.

Late Prehistoric/Plains Woodland (3,500 to 300 B.P.). Early in the period, the preceding late Archaic broad-spectrum foraging subsistence and settlement patterns continue with little change. In the Northern Plains, the Besant and Avonlea Complexes continued the Archaic, virtually unchanged lifestyles until contact with European and American cultures. Subsistence focused on scheduled small- and medium-game hunting, gathering plant foods, and bison hunting according to a seasonal round. In western South Dakota, a basic hunting and gathering lifestyle differing little from the preceding Late Archaic period predominates. At the very end of the period, some villages located along water courses in western South Dakota may have practiced horticulture, but its contribution to diet among such Northern Plains groups was limited. Food procurement and site location appears to be focused primarily on elevated landforms near larger riverine systems and tributaries with increasing utilization of upland resources later in time. The Late Prehistoric/Plains Woodland of South Dakota is also characterized by the appearance of ceramics late in the period (Avonlea Complex), perhaps introduced from the Eastern Woodland cultural area. The late Avonlea Complex and later Old Woman Complex sites contain artifact types that suggest a high degree of specialization in hunting large, upland game animals, primarily bison.

In the eastern portions of South Dakota along the Missouri River, seasonal or permanent sedentary villages of various sizes occur. These villages were largely reliant on domesticated plants (corn, beans, and squash). Although horticulture was an important part of the subsistence base, wild plants and game animals formed a substantial part of the diet. Villages were primarily located along major river systems and larger tributaries. Most sites consisted of small clusters of rectangular wattle and daub lodges with a few larger village sites. Storage pits for food and other times are located within the structures. Pottery was diverse with globular jars and decorated exterior rims common.

In the 1500s to early 1700s A.D., large migrations occurred. The ancestors of the modern Apache, Arapaho, Comanches, and Kiowa migrated southward through western South Dakota in the 1500s and 1600s. The Crow also resided in western South Dakota for a time. The central portion of the state was occupied by the Arika, Mandan, and Cheyenne while, the Lakota, Omaha, Ponca, Otoe, and Ioway occupied the eastern portion of the state.

Post-Contact Tribes (300 to 100 B.P.). The post-contact period on the northern plains is that period after initial contact with Europeans and Americans. Although Euro-American trade goods may have appeared as early as the mid-1600s, the earliest documented contact in the northern and central plains is by Spanish and French explorers in the early 1700s A.D. The horse appears to have been introduced at about the same time. The lifeways of the late Avonlea and post-Avonlea/Old Woman nomadic bison-hunting cultural complexes appear to have continued well into the mid to late 1700s A.D. At the time of European exploration, Arikara and Mandan farming villages were noted along the Missouri river in central South Dakota. In the 1700s, the Cheyenne moved westward along with the Lakota and displaced the Mandan and Arikara. The Dakota and Nakota moved into eastern South Dakota from Minnesota and displaced the Ponca and the Omaha. By the mid-1800s, the entire state was occupied by nomadic Siouan-speaking tribes, primarily the Santee, Yankton, and Teton.

Europeans and Americans (300 to 100 B.P.). The earliest European presence in South Dakota was by French explorers of the de la Vénendrye family in 1743. In 1803, the United States completed the purchase of the Louisiana Territory from France. A portion of South Dakota was visited by the Lewis and Clark Expedition in 1804–1806. These early expeditions provide descriptions of varying quality for some of the early historical tribes in the region. In the later 1700s and early 1800s, more intensive contact and settlement occurred first through missionaries and then through the fur trade period in the 1830s through the 1860s. The American Fur Company and its fur trading posts located along the Big Sioux, James, Vermillion, Missouri, Cheyenne and White Rivers, and Big Stone Lake formed the foundation for later settlements. By the mid-1800s, missionary, settler, and military contacts led to increasing conflict with the Siouan tribes of South Dakota. The slowly increasing number of settlers passing through traditional tribal use areas in the mid-1800s led to increasing conflict over time and the establishment of military forts in tribal lands—yet another irritant to tribes.

Treaties, notably the Fort Laramie Treaty of 1851, were signed with the intent of removing tribes from along the emigrant trails and allowing for the building of trails and forts to protect settlers moving west. Continued conflict resulted in the creation of the Great Sioux Reservation bounded by the Missouri River on the east, the Bighorn Mountains on the west, and the 46th and 43rd parallels to the north and south, respectively. Continued conflict with the U.S. military over the failure of the government to abide by treaty obligations led to several punitive expeditions to return tribes to reservations. In 1874, General George Armstrong Custer led an expedition to the Black Hills where the presence of gold, previously only rumored, was confirmed. The intense interest by Americans to go to the Black Hills to mine for gold led to numerous treaty violations; the Black Hills regions was, by treaty, part of the Sioux reservation. The continued conflict over the Black Hills, along with reduction of the buffalo herds, led to the final military conquest of the Great Sioux Nation and their confinement to small reservations. The Black Hills gold rush led to the rapid settlement of much of South Dakota and the development of towns and cattle ranching.

Ranching, a livelihood well suited to the grassland plains of South Dakota, was practiced by settlers by the early 1870s. The arrival of the railroads (the Milwaukee) led to increased settlement and opened South Dakota to a flood of new settlers, most of them recent European immigrants intent on farming. These early settlers began a period of extensive agriculture throughout the state, mostly around well-watered regions, with many of the new farmers pursuing newly developed dry-land farming techniques. The Great Depression and the droughts that occurred at the same time led to the abandonment of many farms and the outmigration of a significant portion of South Dakota’s population.

3.4.8.1.2 Cultural Resources of Western Nebraska

The following provides a brief overview of prehistoric and historical cultures recognized in the central plains region, which includes Nebraska. The dating of cultural periods for the prehistoric period are provided in B.P. Figures 3.2-18 and 3.2-19 illustrate the division of the plains into regional subdivisions.

Paleoindian Big Game Hunters (12,000 to 8,000 B.P.). The earliest well-defined cultural tradition in the central plains region is the Paleoindian. Early humans entered the plains shortly after deglaciation allowed movement onto the central plains sometime after 14,000 B.P. Three cultures are recognized during the Paleoindian period: Clovis, Folsom, and Plano. The Clovis culture (12,000 to 10,000 B.P.) is recognized by a distinctive projectile point style and a subsistence mode heavily reliant on big-game hunting, notably mammoth and mastodon, which became extinct at the end of the period. The Folsom culture (ca. 10,000 to 8,500 B.P.) is also known for a distinctive projectile point style. Folsom subsistence is also characterized by reliance on large game—the ancient bison. Folsom sites consist of camp sites and kill sites. The latter tend to be located near cliffs and around water, such as ponds and springs. The Plano culture (ca. 8,500 to 6,500 B.P.) is, in its earliest form, a continuation of earlier Paleoindian hunting traditions. Toward the end of the period, however, there is a transition in subsistence modes with the extinction of the ancient bison to the modern form of bison and a transition to Archaic foragers. Plano sites containing circular rock alignments and post mold circles suggest the present of structures.

Archaic Foragers (6,500 to 2,000 B.P.). The Plains Archaic period represents the continuation of change in subsistence and settlement linked to an increasingly arid environment that occurs in the latter portion of the preceding late Paleoindian Plano culture. Kill sites, characteristic of the preceding Paleoindian period, are virtually absent. Although hunting and gathering is the only mode of subsistence, dietary breadth, indicated by increasing diversity and numbers of subsistence items, is believed to expand significantly with more medium and small mammals being hunted and the introduction of seed-bearing plants as staples. Through time, settlement is increasingly tethered to highly productive resource areas and sites tend to become larger and increasingly complex, indicating the presence of more sedentary lifestyles relative to earlier periods. Artifact styles, principally projectile points, become increasingly diversified, suggesting increasing regionalization and cultural differentiation.

Plains Woodland (2,000 to 1,000 B.P.). The Plains Woodland period is characterized by largely sedentary lifestyles and a mixed subsistence economy consisting of wild game animals and plants and horticulture utilizing the domesticates, maize and beans. The defining settlement pattern of the Woodland Period consists of earth lodge villages, some of which may have been occupied only seasonally. There is variability in the size of Plains Woodland communities. The communities can be small, with as few as two or three structures, to very large (two to three hectares) with numerous contemporary structures. The majority of the larger settlements tended to be located along larger drainages (e.g., Missouri, Republican, Arkansas, and Red Rivers) with permanent water and located near abundant biotic and abiotic resources. The Plains Woodland is also characterized by the appearance of ceramics, perhaps introduced from the Eastern Woodland cultural area.

Plains Village (1,000 to 600 B.P.). The Plains Village period continues the trend toward increasing sedentism and increasing reliance on domesticated plants (corn, beans, and squash). Although horticulture was an important part of the subsistence base, wild plants and game animals formed a substantial part of the Plains Village diet. Villages were primarily located along major river systems and larger tributaries. Most sites, however, consisted of small clusters of rectangular wattle and daub lodges. Storage pits for food and other items are located within the structures. Pottery was diverse with globular jars and decorated exterior rims being common. Small, triangular side- and corner-notched projectile points are common. Early historical Plains Village groups include the Siouan-speaking Omaha, Ponca, Otoe-Missouria, Ioway, and Kansa along with the Caddoan-speaking groups including the Arikara and Pawnee. The Plains Village period is divided into several regional phases and includes the St. Helena, Nebraska, Itskari, and Smokey Hill phases.

Post-Contact Tribes (400 to 100 B.P.). The postcontact period on the central plains is that period after initial contact with Europeans and Americans. The earliest documented contact in the central plains is by Spanish and French explorers in the early 1700s A.D. Tribes present in Nebraska include the Caddoan farming villages of the Pawnee and Arikara in eastern Nebraska. Siouan-speaking tribes were the Omaha, Ponca, Otoe-Missouria, Ioway, and Kansa. Both Caddoan and Siouan-speaking groups lived in permanent earth lodge villages, were agriculturalists, and hunted bison in western Nebraska. Western Nebraska was also home to “nomadic” tribes that resided in tepee villages and were dependent on bison hunting. These tribes include the Apache, Crow, Kiowa, Cheyenne, Teton, Comanche, and Arapaho. The Lakota, Northern Cheyenne, and Arapaho resided in northwestern Nebraska, and the Oglala and Brule Sioux were concentrated around the Black Hills and the upper White and Niobrara Rivers in northern Sioux County. By the mid-1800s, the Oglala and Brule had extended their range to include the Platte River region.

Europeans and Americans (300 to 100 B.P.). The earliest European presence in Nebraska was by French and Spanish explorers in the early 1700s A.D. and possibly earlier in the late 1600s. The Villasur expedition to explore the area was led by Pedro de Villasur out of the Spanish province of New Mexico in 1720 AD. Later explorers included Lewis and Clark and Zebulon Pike. These early expeditions provide descriptions of varying quality for some of the early historical tribes in the region. In the later 1700s and early 1800s, more intensive contact and settlement occurred first through the fur trade in the 1830s and 1840s, and then through missionary and military contacts. By the mid-1800s, emigrant trails, notably the Oregon-California Trail, among others, traversed the Nebraska area.

The large number of settlers moving along the emigrant trails passing through tribal use areas led to increasing conflict over time and the establishment of military forts in tribal lands—yet another irritant to tribes. Treaties, notably the Fort Laramie Treaty of 1851 were signed with the intent of removing tribes from along the emigrant trails and allowing for the building of trails and forts to protect settlers moving west. Continued conflict resulted in the creation of the Great Sioux Reservation bounded by the Missouri River on the east, the Bighorn Mountains on the west, and the 46th and 43rd parallels to the north and south, respectively. Fort Robinson in Dawes County was established in 1874 adjacent to the Red Cloud Agency near the White River. Fort Robinson served as a military outpost to contain the Sioux tribes on the Great Sioux Reservation during the Sioux Wars and the Cheyenne Outbreak. Fort Robinson is important in both Native American and American history because it is the place in which the Oglala Sioux chief, Crazy Horse, was killed and the place where Dull Knife, chief of the Northern Cheyenne, broke free of U.S. military confinement. Use of Fort Robinson continued through World War I, and in World War II, it was a training site for soldiers and a prisoner of war camp. It ceased to be used as a military camp in 1948, and today is a Nebraska state park and historic site.

Ranching, a livelihood well suited to the grassland plains of western Nebraska, was practiced by early settlers by the early 1870s. The arrival of the railroads (Chicago and Northwestern and the Fremont, Elkhorn, and Missouri Valley) in 1885 opened northwestern Nebraska to a flood of settlers, most of them recent European immigrants. These early settlers began a period of extensive agriculture throughout western Nebraska, mostly around well-watered regions, but many of the settlers pursued newly developed dry-land farming techniques. The established ranching community relied on open range cattle grazing. Agricultural practices relied on fencing cattle out of fields. In response, ranchers would often fence off public lands to prevent settlement. This and other issues often led to conflict between farmers and ranchers and the eventual decline of ranching. In 1903, the North Platte irrigation project was authorized by Congress. The project included the construction of five reservoirs, six power plants, and an irrigation canal system (the Interstate Canal).

3.4.8.2 National Register of Historic Properties and State Registers

3.4.8.2.1 Historic Properties in Western South Dakota

In addition to the sites listed in Table 3.4-10, the following sites in western South Dakota are listed on South Dakota state and/or the National Register of Historic Places. There are no historic properties listed in the NRHP or state register in Butte, Fall River, or Pennington Counties as of this writing.

Custer County

- Custer Campsite #1 rural road
- Borglum Ranch & Studio Historic District rural road

Lawrence County

- Thoen Stone & Site
- Frawley Ranch

Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region			
County	Resource Name	City	Date Listed YYYY-MM-DD
Wyoming			
Crook	DXN Bridge Over Missouri River	Hulett	1985-02-22
Crook	Entrance Road—Devils Tower National Monument	Devils Tower	2000-07-24
Crook	Entrance Station—Devils Tower National Monument	Devils Tower	2000-07-24
Crook	Inyan Kara Mountain	Sundance	1973-04-24
Crook	Old Headquarters Area Historic District	Devils Tower	2000-07-20
Crook	Ranch A	Beulah	1997-03-17
Crook	Sundance School	Sundance	1985-12-02
Crook	Sundance State Bank	Sundance	1984-03-23
Crook	Tower Ladder—Devils Tower National Monument	Devils Tower	2000-07-24
Crook	Vore Buffalo Jump	Sundance	1973-04-11
Crook	Wyoming Mercantile	Aladdin	1991-04-16
Niobrara	DSD Bridge Over Cheyenne River	Riverview	1985-02-22
Weston	Cambria Casino	Newcastle	1980-11-18
Weston	Jenney Stockade Site	Newcastle	1969-09-30
Weston	U.S. Post Office—Newcastle Main	Newcastle	1987-05-19
Weston	Weston County Courthouse	Newcastle	2001-09-01
Weston	Wyoming Army National Guard Cavalry Stable	Newcastle	1994-07-07
South Dakota			
Custer	Archaeological Site No. 39CU1619	Custer	1999-06-03
Custer	Archaeological Site No. 39CU70	Custer	1993-10-20
Custer	Archaeological Site No. 39CU890	Hermosa	1993-08-06
Custer	Ayres, Lonnie and Francis, Ranch	Custer	1991-01-25
Custer	Badger Hole	Custer	1973-03-07
Custer	Bauer, Maria, Homestead Ranch	Custer	1992-06-09
Custer	Beaver Creek Bridge	Hot Springs	1984-08-08
Custer	Beaver Creek Rockshelter	Pringle	1993-10-25
Custer	Buffalo Gap Cheyenne River Bridge	Buffalo Gap	1988-02-08
Custer	Buffalo Gap Historic Commercial District	Buffalo Gap	1995-06-30
Custer	CCC Camp Custer Officers' Cabin	Custer	1992-06-09
Custer	Cold Springs Schoolhouse	Custer	1973-03-07
Custer	Custer County Courthouse	Custer	1972-11-27
Custer	Custer State Game Lodge	Custer	1983-03-30
Custer	Custer State Park Museum	Hermosa	1983-03-30
Custer	Fairburn Historic Commercial District	Fairburn	1995-06-30
Custer	First National Bank Building	Custer	1982-03-05
Custer	Fourmile School No. 21	Custer	1991-01-25
Custer	Garlock Building	Custer	2004-01-28
Custer	Grace Coolidge Memorial Log Building	Custer	2001-06-21
Custer	Historic Trail and Cave Entrance	Custer	1995-04-19
Custer	Lampert, Charles and Ollie, Ranch	Custer	1990-07-05
Custer	Mann, Irene and Walter, Ranch	Custer	1990-07-05
Custer	Norbeck, Peter, Summer House	Custer	1977-09-13
Custer	Pig Tail Bridge	Hot Springs	1995-04-07
Custer	Ranger Station	Custer	1995-04-05
Custer	Roetzel, Ferdinand and Elizabeth, Ranch	Custer	1991-01-25
Custer	Site No. 39 Cu 510	City Restricted	1982-05-20
Custer	Site No. 39 Cu 511	City Restricted	1982-05-20

Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued)			
County	Resource Name	City	Date Listed YYYY-MM-DD
South Dakota (continued)			
Custer	Site No. 39 Cu 512	City Restricted	1982-05-20
Custer	Site No. 39 Cu 513	City Restricted	1982-05-20
Custer	Site No. 39 Cu 514	City Restricted	1982-05-20
Custer	Site No. 39 Cu 515	City Restricted	1982-05-20
Custer	Site No. 39 Cu 516	City Restricted	1982-05-20
Custer	Site No. 39 Cu 91	City Restricted	1982-05-20
Custer	South Dakota Dept. of Transportation Bridge No. 17–289–107	Custer	1993-12-09
Custer	Stearns, William, Ranch	Custer	1990-07-05
Custer	Streeter, Norman B., Homestead	Buffalo Gap	1995-06-30
Custer	Towner, Francis Averill (T.A.) and Janet Leach, House	Custer	1990-06-21
Custer	Tubbs, Newton Seymour, House	Custer	1993-12-09
Custer	Ward, Elbert and Harriet, Ranch	Custer	1990-07-05
Custer	Way Park Museum	Custer	1973-03-07
Custer	Wind Cave National Park Administrative and Utility Area Historic District	Custer	1984-07-11
Custer	Young, Edna and Ernest, Ranch	Custer	1990-07-05
Fall River	Allen Bank Building and Cascade Springs Bath House-Sanitarium	Hot Springs	1984-02-23
Fall River	Archeological 39FA1638	Edgemont	2005-07-14
Fall River	Archeological Site 39FA1336	Edgemont	2005-07-14
Fall River	Archeological Site 39FA1937	Edgemont	2005-07-14
Fall River	Archeological Site No. 39FA1010	Hot Springs	1993-10-20
Fall River	Archeological Site No. 39FA1013	Hot Springs	1993-10-20
Fall River	Archeological Site No. 39FA1046	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA1049	Hot Springs	1993-08-06
Fall River	Archeological Site No. 39FA1093	Hot Springs	1993-10-20
Fall River	Archeological Site No. 39FA1152	Hot Springs	1993-10-20
Fall River	Archeological Site No. 39FA1154	Hot Springs	1993-10-20
Fall River	Archeological Site No. 39FA1155	Hot Springs	1993-10-20
Fall River	Archeological Site No. 39FA1190	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA1201	Edgemont	1993-08-06
Fall River	Archeological Site No. 39FA1204	Hot Springs	1993-10-20
Fall River	Archeological Site No. 39FA243	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA244	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA316	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA321	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA395	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA446	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA447	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA448	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA542	Edgemont	1993-10-25
Fall River	Archeological Site No. 39FA678	Edgemont	1993-08-06
Fall River	Archeological Site No. 39FA679	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA680	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA682	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA683	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA686	Edgemont	1993-10-20

Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued)

County	Resource Name	City	Date Listed YYYY-MM-DD
	South Dakota (continued)		
Fall River	Archeological Site No. 39FA688	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA690	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA691	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA767	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA788	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA806	Hot Springs	1993-08-06
Fall River	Archeological Site No. 39FA819	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA86	Edgemont	1993-08-06
Fall River	Archeological Site No. 39FA88	Edgemont	1993-10-20
Fall River	Archeological Site No. 39FA89	Edgemont	1993-08-06
Fall River	Archeological Site No. 39FA90	Hot Springs	1993-10-20
Fall River	Archeological Site No. 39FA99	Edgemont	1993-10-20
Fall River	Bartlett—Myers Building	Edgemont	2006-05-31
Fall River	Chilson Bridge	Edgemont	1993-12-09
Fall River	Flint Hill Aboriginal Quartzite Quarry	Edgemont	1978-07-14
Fall River	Hot Springs High School	Hot Springs	1980-05-07
Fall River	Hot Springs Historic District	Hot Springs	1974-06-25
Fall River	Jensen, Governor Leslie, House	Hot Spring	1987-09-25
Fall River	Log Cabin Tourist Camp	Hot Springs	2004-01-28
Fall River	Lord's Ranch Rockshelter	Edgemont	2005-07-14
Fall River	Petty House	Hot Springs	1999-02-12
Fall River	Site 39FA1303	Edgemont	2005-06-08
Fall River	Site 39FA1639	Edgemont	2005-06-09
Fall River	Site No. 39 FA 277	City Restricted	1982-05-20
Fall River	Site No. 39 FA 389	City Restricted	1982-05-20
Fall River	Site No. 39 FA 554	City Restricted	1982-05-20
Fall River	Site No. 39 FA 58	City Restricted	1982-05-20
Fall River	Site No. 39 FA 676	City Restricted	1982-05-20
Fall River	Site No. 39 FA 677	City Restricted	1982-05-20
Fall River	Site No. 39 FA 681	City Restricted	1982-05-20
Fall River	Site No. 39 FA 684	City Restricted	1982-05-20
Fall River	Site No. 39 FA 685	City Restricted	1982-05-20
Fall River	Site No. 39 FA 687	City Restricted	1982-05-20
Fall River	Site No. 39 FA 7	City Restricted	1982-05-20
Fall River	Site No. 39 FA 75	City Restricted	1982-05-20
Fall River	Site No. 39 FA 79	City Restricted	1982-05-20
Fall River	Site No. 39 FA 91	City Restricted	1982-05-20
Fall River	Site No. 39 FA 94	City Restricted	1982-05-20
Fall River	St. Martin's Catholic Church and Grotto	Oelrichs	2005-05-30
Fall River	Wesch, Phillip, House	Hot Springs	1984-02-23
Lawrence	Ainsworth, Oliver N., House	Spearfish	1990-10-25
Lawrence	Baker Bungalow	Spearfish	1996-10-24
Lawrence	Buskala, Henry Ranch	Dumont	1985-11-13
Lawrence	Cook, Fayette, House	Spearfish	1988-07-13
Lawrence	Corbin, James A., House	Spearfish	1990-10-25
Lawrence	Court, Henry, House	Spearfish	1990-10-25
Lawrence	Dakota Tin and Gold Mine	Spearfish	2005-06-08
Lawrence	Deadwood Historic District	Deadwood	1966-10-15

Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued)			
County	**Resource Name**	**City**	**Date Listed YYYY-MM-DD**
South Dakota (continued)			
Lawrence	Dickey, Eleazer C. and Gwinnie, House	Spearfish	1989-07-13
Lawrence	Dickey, Walter, House	Spearfish	1988-05-16
Lawrence	Driskill, William D., House	Spearfish	1989-07-13
Lawrence	Episcopal Church of All Angels	Spearfish	1976-04-22
Lawrence	Evans, Robert H., House	Spearfish	1991-11-01
Lawrence	Frawley Historic Ranch	Spearfish	1974-12-31
Lawrence	Halloran-Matthews-Brady House	Spearfish	1976-12-12
Lawrence	Hewes, Arthur, House	Spearfish	1990-10-25
Lawrence	Hill, John, Ranch—Keltomaki	Brownsville	1985-11-13
Lawrence	Homestake Workers House	Spearfish	1991-11-01
Lawrence	Keets, Henry, House	Spearfish	1988-07-13
Lawrence	Knight, Webb S., House	Spearfish	1989-07-13
Lawrence	Kroll Meat Market and Slaughterhouse	Spearfish	1988-05-20
Lawrence	Lead Historic District	Lead	1974-12-31
Lawrence	Lown, William Ernest, House	Spearfish	1976-05-28
Lawrence	Mail Building, The	Spearfish	1988-05-16
Lawrence	McLaughlin Ranch Barn	Spearfish	2002-02-14
Lawrence	Mount Theodore Roosevelt Monument	Deadwood	2005-12-22
Lawrence	Old Finnish Lutheran Church	Lead	1985-11-13
Lawrence	Redwater Bridge, Old	Spearfish	1993-12-09
Lawrence	Riley, Almira, House	Spearfish	1989-07-13
Lawrence	Spearfish City Hall	Spearfish	1990-10-25
Lawrence	Spearfish Filling Station	Spearfish	1988-05-16
Lawrence	Spearfish Fisheries Center	Spearfish	1978-05-19
Lawrence	Spearfish Historic Commercial District	Spearfish	1975-06-05
Lawrence	Spearfish Post Office (Old)	Spearfish	1999-02-12
Lawrence	St. Lawrence O'Toole Catholic Church	Central City	2003-02-05
Lawrence	Tomahawk Lake Country Club	Deadwood	2005-10-26
Lawrence	Toomey House	Spearfish	1997-11-07
Lawrence	Uhlig, Otto L., House	Spearfish	1989-07-13
Lawrence	Walsh Barn	Spearfish	2003-05-30
Lawrence	Walton Ranch	Spearfish	2005-05-30
Lawrence	Whitney, Mary, House	Spearfish	1990-10-25
Lawrence	Wolzmuth, John, House	Spearfish	1988-07-13
Pennington	Archeological Site No. 39PN376	Spearfish	1989-07-13
Pennington	Burlington and Quincy High Line Hill City to Keystone Branch	Spearfish	1990-10-25
Pennington	Byron, Lewis, House	Spearfish	1988-05-16
Pennington	Calumet Hotel	Spearfish	1978-05-19
Pennington	Casper Supply Company of SD	Spearfish	1975-06-05
Pennington	Cassidy House	Spearfish	1999-02-12
Pennington	Church of the Immaculate Conception	Central City	2003-02-05
Pennington	Dean Motor Company	Deadwood	2005-10-26
Pennington	Dinosaur Park	Spearfish	1997-11-07
Pennington	Emmanuel Episcopal Church	Spearfish	1989-07-13
Pennington	Fairmont Creamery Company Building	Spearfish	2003-05-30
Pennington	Feigel House	Spearfish	2005-05-30
Pennington	First Congregational Church	Spearfish	1990-10-25

Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued)

County	County	County	County
South Dakota (continued)			
Pennington	Gambrill Storage Building	Spearfish	1988-07-13
Pennington	Harney Peak Hotel	Custer	1993-10-25
Pennington	Harney Peak Tin Mining Company Buildings	Hill City	2003-02-05
Pennington	Otho Mining District	Hermosa	1999-12-17
Pennington	Pennington County Courthouse	Hill City	1977-04-11
Pennington	Quinn, Michael, House	Custer	1983-03-10
Pennington	Rapid City Carnegie Library	Hill City	1977-07-21
Pennington	Rapid City Garage	Keystone	1981-02-22
Pennington	Rapid City Historic Commercial District	Keystone	1982-06-17
Pennington	Rapid City Laundry	Hill City	1994-06-03
Pennington	Site No. 39 PN 108	City Restricted	1982-05-20
Pennington	Site No. 39 PN 438	City Restricted	1982-05-20
Pennington	Site No. 39 PN 439	City Restricted	1982-05-20
Pennington	Site No. 39 PN 57	City Restricted	1982-05-20
Pennington	Von Woehrmann Building	Hill City	1977-04-13
Nebraska			
Dawes	Army Theatre	Crawford	1988-07-07
Dawes	Bordeaux Trading Post	Chadron	1972-03-16
Dawes	Chadron Public Library	Chadron	1990-06-21
Dawes	Co-operative Block Building	Crawford	1985-09-12
Dawes	Crites Hall	Chadron	1983-09-08
Dawes	Dawes County Courthouse	Chadron	1990-07-05
Dawes	Fort Robinson and Red Cloud Agency	Crawford	1966-10-15
Dawes	Hotel Chadron	Chadron	2002-08-15
Dawes	Library	Chadron	1983-09-08
Dawes	Miller Hall	Chadron	1983-09-08
Dawes	Sparks Hall	Chadron	1983-09-08
Dawes	U.S. Post Office—Crawford	Crawford	1992-05-11
Dawes	Wohlers, Henry, Sr., Homestead	Crawford	2004-10-15
Dawes	Work, Edna, Hall	Chadron	1983-09-08
Sioux	Cook, Harold J., Homestead Cabin	Agate	1977-08-24
Sioux	Hudson-Meng Bison Kill Site	Crawford	1973-08-28
Sioux	Sioux County Courthouse	Harrison	1990-07-05

3.4.8.2.2 Historic Properties in Western Nebraska

In addition to the sites listed in Table 3.4-10, the following historic properties in western Nebraska are listed on the Nebraska state and/or the National Register of Historic Places:

Dawes County

- James Bordeaux Trading Post [DW00-002] Listed 1972/03/16
- Henry Wohlers, Sr. Homestead [DW00-043] Listed 2004/10/15
- Chadron Commercial Historic District [DW03] Listed 2007/03/27
- Chadron State College Historic Buildings [DW03] Listed 1983/09/08
- Hotel Chadron [DW03-023] Listed 2002/08/15
- Dawes County Courthouse [DW03-081] Listed 1990/07/05
- Chadron Public Library [DW03-091] Listed 1990/06/21

- Crawford United States Post Office [DW04-007] Listed 1992/05/11
- Co-Operative Block Building [DW04-024] Listed 1985/09/12
- Fort Robinson and Red Cloud Agency [DW07] Listed 1966/10/15

The historic properties listed previously are located within about 5–8 km [3–5 mi] of the existing Crow Butte ISL Facility.

Sioux County

- Hudson-Meng Bison Kill Site [25-SX-115] Listed 1973/08/28
- Harold J. Cook Homestead (Bone Cabin Complex) [SX00-028] Listed 1977/08/24
- Sandford Dugout [SX00-032] Listed 2000/03/09
- Wind Springs Ranch Historic and Archeological District [SX00-033, 25-SX-77, 25-SX-600-655] Listed 2000/11/22
- Sioux County Courthouse [SX04-002] Listed 1990/07/05

3.4.8.3 Tribal Consultations

3.4.8.3.1 South Dakota Tribal Consultation

There are 10 Native American Tribes located within or immediately adjacent to the state of South Dakota. These are the Cheyenne River Sioux, Flandreau Santee Sioux, Lower Brulé Sioux, the Crow Tribe of Montana Oglala Sioux, Rosebud Sioux, Sisseton-Whapeton Oyate, Standing Rock Sioux, Yankton Sioux, and the Ponca Tribe of Nebraska. The Siouan tribes are located throughout South and North Dakota, whereas the Ponca are located in northeastern Nebraska, but have interests in South Dakota. These and other Siouan-speaking tribes in North Dakota, Wyoming, Montana and Nebraska may have traditional land use claims in western South Dakota.

The U.S. government and the State of South Dakota recognize the sovereignty of certain Native America tribes. These tribal governments have legal authority for their respective reservations. Executive Order 13175 requires federal agencies to undertake consultation and coordination with Native Amrican tribal governments on a government-to-government basis. In addition, the NRHP provides these tribal groups with the opportunity to manage cultural resources within their own lands under the legal authority of a THPO. The THPO therefore replaces the South Dakota SHPO as the agency responsible for the oversight of all federal and state historic preservation compliance laws. To date, several tribes in South Dakota have achieved status as a THPO as provided by the NHPA (Oglala Sioux at Pine Ridge, Standing Rock Sioux, Rosebud Sioux, and the Cheyenne River Sioux). Other tribes may have applied for THPO status, but are not yet officially recognized. Projects proponents must, however, contact tribal cultural resources personnel as part of the consultation process along with the South Dakota SHPO. The National Organization of Tribal Historic Preservation Officers also maintains a list of THPOs on its website at <http://www.nathpo.org/THPO/state_list.htm>. The SHPO ensures compliance with applicable federal laws on tribal lands and consults with the tribes and the Bureau of Indian Affairs for undertakings that might occur on tribal reservation lands. Some tribes have historic and cultural preservation offices that are not recognized as THPOs, but must also be consulted where they exist.

3.4.8.3.2 Nebraska Tribal Consultation

There are six Native American tribes located within the state of Nebraska. These are the Omaha, Ponca, Winnebago, Santee Sioux, the Iowa Tribe of Kansas and Nebraska, and the Sac and Fox Nation of Missouri, Kansas, and Nebraska. These tribes are located near the Missouri River in eastern Nebraska. There are no reservation lands in western Nebraska. However, the Oglala Sioux Tribe of the Pine Ridge Reservation is located at the Nebraska-South Dakota border adjacent to the Nebraska-South Dakota-Wyoming Uranium Milling Region. These and other Siouan-speaking tribes in South Dakota, Wyoming, and Nebraska may have traditional land use claims in western Nebraska.

The U.S. government and the State of Nebraska recognize the sovereignty of certain Native America tribes. These tribal governments have legal authority for their respective reservations. Executive Order 13175 requires executive branch federal agencies to undertake consultation and coordination with Native American tribal governments on a government-to-government basis. NRC, as an independent federal agency, has agreed to voluntarily comply with Executive Order 13175.

In addition, the NHRP provides these tribal groups with the opportunity to manage cultural resources within their own lands under the legal authority of a THPO. The THPO therefore replaces the Nebraska SHPO as the agency responsible for the oversight of all federal and state historic preservation compliance laws. To date, no tribes in Nebraska have applied for status as a THPO as provided by the NHPA. In addition, some tribes in South Dakota with THPO offices may have interests in western Nebraska. Some tribes have historic and cultural preservation offices that are not recognized as THPOs, but they should be consulted where they exist. NRC, in meetings its responsibilities under the NHPA, contacts tribal cultural resources personnel as part of the consultation process, along with consulting with the Nebraska SHPO.

3.4.8.4 Places of Cultural Significance

As described in Section 3.2.8.4, traditional cultural properties are places of special heritage value to contemporary communities because of their association with cultural practices and beliefs that are rooted in the histories of those communities and are important in maintaining the cultural identity of the communities (Parker and King, 1998; King, 2003). Religious places are often associated with prominent topographic features like mountains, peaks, mesas, springs, and lakes. In addition, shrines may be present across the landscape to denote specific culturally significant locations and vision quest sites where an individual can place offerings.

Information on traditional land use and the location of culturally significant places is often protected information within the community (King, 2003). Therefore, the information presented on religious places is limited to those that are identified in the published literature and is therefore restricted to a few highly recognized places on the landscape within southwestern South Dakota.

Traditional cultural properties are ones that refer to beliefs, customs, and practices of a living community that have been passed down over the generations. Native American traditional cultural properties are often not found on the state or national registers of historic properties or described in the extant literature or in SHPO files. There is, however, a range of cultural property types of religious or traditional use that might be identified during the tribal consultation process. These might include

- Sites of ritual and ceremonial activities and related features
- Shrines
- Marked and unmarked burial grounds
- Traditional use areas
- Plant and mineral gathering areas
- Traditional hunting areas
- Caves and rock shelters
- Springs
- Trails
- Prehistoric archaeological sites

The U.S. Bureau of Indian Affairs website contains a list, current as of May 2007, of tribal leaders and contact information at <http://www.doi.gov/bia/Tribal%20Leaders-June%202007-2.pdf>. The National Organization of Tribal Historic Preservation Officers also maintains a list of THPOs on its website at <http://www.nathpo.org/THPO/state_list.htm>. These tribal groups should be contacted for consultations associated with ISL milling activities in their respective states (see Table 3.2-12). Additional tribal contact information may be obtained from the respective SHPO in Nebraska, Montana, South Dakota, and Wyoming.

3.4.8.4.1 Places of Cultural Significance in Southwestern South Dakota

There are no culturally significant historic properties listed in the NRHP or state registers in Butte, Lawrence, Pennington, Custer, or Fall River Counties. However, the Siouan tribes who once occupied portions of South Dakota (Cheyenne River Sioux, Flandreau Santee Sioux, Lower Brule Sioux, Oglala Sioux, Rosebud Sioux, Sisseton-Whapeton Oyate, Standing Rock Sioux, Yankton Sioux, and the Ponca Tribe of Nebraska) consider the Black Hills in Wyoming and South Dakota, Devil's Tower in northeastern Wyoming, Pumpkin Buttes in eastern Wyoming, and Bear Butte in southwestern South Dakota to be culturally significant.

Areas of western South Dakota once used by these tribes may contain additional, undocumented or undisclosed culturally significant places and traditional cultural properties. Mountains, peaks, buttes, prominences, and other elements of the natural and cultural environment are often considered important elements of a traditional, culturally significant landscape.

3.4.8.4.2 Places of Cultural Significance in Western Nebraska

There are no culturally significant historic properties listed in the NRHP or state register in Dawes and Sioux Counties. However, the tribes who once occupied western Nebraska (Lakota, Northern Cheyenne, Arapaho, Oglala, and Brule Sioux, among others) along the upper White and Niobrara Rivers and extending into the Black Hills of South Dakota all consider the Black Hills in Wyoming and South Dakota, Devil's Tower in northeastern Wyoming, Pumpkin Buttes in eastern Wyoming, and Bear Butte in southwestern South Dakota to be culturally significant.

Areas of western Nebraska once used by these tribes and perhaps other tribes in the region may contain additional, undocumented culturally significant sites and traditional cultural properties. Mountains, peaks, buttes, prominences, and other elements of the natural and cultural environment are often considered important elements of a traditional, culturally significant landscape.

3.4.9 Visual/Scenic Resources

Based on the BLM Visual Resource Handbook, the Nebraska-South Dakota-Wyoming Uranium Milling Region (BLM, 2007a–c) is located within the Great Plains physiographic province, adjacent to the southern end of the Black Hills. The northwestern corner of Wyoming (see Figure 3.3-17) is located within the area managed by the Newcastle BLM field office (BLM, 2000b). Most of the area is categorized as VRM Class III, but there are some Class II areas identified around Devil's Tower National Monument and the Black Hills National Forest along the Wyoming-South Dakota border (see Figure 3.4-1). One potential uranium ISL facility has been identified for development in the northeast corner of Nebraska-South Dakota-Wyoming Uranium Milling Region, about 16 km [10 mi] northeast of the Black Hills National Forest, and about 45 km [28 mi] northeast of Devils Tower. There are no Wyoming (1) Unique and Irreplaceable and (2) Rare or Uncommon designated areas within the Nebraska-South Dakota-Wyoming Uranium Milling Region (Girardin, 2006).

Uranium resources in South Dakota are being evaluated near Fall River County in the southwestern corner of the state. Although it does not assign a VRM classification to the region, the Nebraska and South Dakota BLM field offices resource management plan classifies this region as having natural vegetation of wheatgrass, grama grass, sagebrush, and pine savanna (BLM, 1992, 1985). Similar areas are identified as Class III VRM areas in Wyoming. The USFS has also performed some visual resource classification in association with its forest and grasslands management plans in the region (see text box in Section 3.2.9). The revisions to Northern Great Plains Management Plans (USFS, 2001a) indicate that for the grasslands in Fall River County, almost 95 percent of the area is categorized with a scenic integrity objective of low to moderate (moderately to heavily altered). The Black Hills National Forest land and resource management plan and subsequent amendments (USFS, 1997, 2001b, 2005) identified management plans to maintain about 85 percent of the region for low to moderate scenic integrity objectives. About 15 percent has high (13.6 percent) to very high (1.2 percent) scenic integrity objectives (USFS, 2005). In areas lacking human-caused disturbances, the landscape has attributes that potentially have a high level of scenic integrity (USFS, 2005). There is a Prevention of Significant Deterioration Class 1 area identified for the Wind Cave National Park in South Dakota as described in Section 3.4.6.2 and shown in Figure 3.4-20, but this is at least 40 km [25 mi] east of the closest potential uranium ISL facility.

Similar to South Dakota, uranium resources in Dawes County in northwestern Nebraska are located in the Great Plains physiographic province. The Crow Butte ISL facility in Dawes County is located near the Pine Ridge Unit of the Nebraska National Forest. The revisions to Northern Great Plains Management Plans (USFS, 2001a) indicate that for the Oglala National Grassland and the Pine Ridge Unit of the Nebraska National Forest, about 87 percent of the landscape is classified as having low to moderate scenic integrity objective classification, with the remaining 13 percent roughly divided between high (7.3 percent) and very high (5.4 percent).

3.4.10 Socioeconomics

For the purpose of this GEIS, the socioeconomic description for the Nebraska-South Dakota-Wyoming Region includes communities within the region of influence for potential ISL facilities in the three uranium districts in the region. These include communities that have the highest potential for socioeconomic impacts and are considered the affected environment. Communities that have the highest potential for socioeconomic impacts are defined by (1) proximity to an ISL facility {generally within 48 km [30 mi]}; (2) economic profile, such as potential for income growth or destabilization; (3) employment structure, such as potential for job placement or displacement; and (4) community profile, such as potential for growth or destabilization to local emergency services, schools, or public housing. The affected environment within the Nebraska-South Dakota-Wyoming Uranium Milling Region consists of counties and Native American communities. The affected environment is listed in Table 3.4-11.

The following subsections describe areas most likely to have implications to socioeconomics and are listed below. A CBSA, according to the U.S. Census Bureau, is a collective term for both metro and micro areas ranging from a population of 10,000 to 50,000. A Metropolitan Area has a population greater than 50,000, and a town is considered to have less than 10,000 in population (U.S. Census Bureau, 2008). Smaller communities are considered as part of the county demographics.

3.4.10.1 Demographics

Demographics for the year 2000 are based on population and racial characteristics of the affected environment and are provided in Tables 3.4-12 through 3.4-14. Figure 3.4-21 illustrates the populations of communities within the Nebraska-South Dakota-Wyoming Uranium Milling Region. Most 2006 data compiled by the U.S. Census Bureau is not yet available for the geographic areas of interest.

Based on review of Tables 3.4-12 through 3.4-14, the most populated county is Campbell County, Wyoming and the most sparsely populated county is Sioux County, Nebraska. For communities located within 48 km [30 mi] of potential ISL facilities, the most populated town is Pine Ridge, South Dakota (Pine Ridge Indian Reservation), and the smallest populated town is Oglala, South Dakota (Pine Ridge Indian Reservation). The county with the largest percentage of nonminorities is Niobrara County, Wyoming, with a white population of 98.0 percent. The town with the largest minority population is Pine Ridge, South Dakota, with a white population of 3.7 percent. The largest minority-based county is Shannon County, South Dakota, with a white population of only 4.5 percent. The largest minority-based town is Oglala, South Dakota, with a white population of only 0.7 percent.

Although not listed in Table 3.4-12, the population counts based on 2000 U.S. U.S. Census data for the Pine Ridge Indian Reservation totaled 15,521 individuals (U.S. Census Bureau, 2008), with approximately 93 percent Native American. However, recent studies suggest that the population may be larger (Housing Assistance Council, 2002).

Table 3.4-11. Summary of Affected Environment Within the Nebraska-South Dakota-Wyoming Uranium Milling Region

Counties Within Nebraska	Counties Within South Dakota	Counties Within Wyoming	Native American Communities Within South Dakota
Dawes	Butte	Campbell	Pine Ridge Indian Reservation
Sioux	Custer	Crook	
	Fall River	Niobrara	
	Shannon	Weston	

Table 3.4-12. 2000 U.S. Bureau of Census Population and Race Categories of Nebraska*

Affected Environment	Total Population	White	African American	Native American	Some Other Race	Two or More Races	Asian	Hispanic Origin†	Native Hawaiian and Other Pacific Islander
Nebraska	1,711,263	1,533,261	68,541	14,896	47,845	23,953	21,931	94,425	836
Percent of total		89.6%	4.0%	0.9%	2.8%	1.4%	1.3%	5.5%	0.0%
Dawes County	9,060	8,457	73	261	93	143	28	220	5
Percent of total		93.3%	0.8%	2.9%	1.0%	1.6%	0.3%	2.4%	0.1%
Sioux County	1,475	1,440	0	2	17	13	3	34	0
Percent of total		97.6%	0.0%	0.1%	1.2%	0.9%	0.2%	2.3%	0.0%

*U.S. Census Bureau. "American FactFinder." 2000. <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 26 February 2008).

†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100%.

Table 3.4-13. 2000 U.S. Bureau of Census Population and Race Categories of South Dakota*

Affected Environment	Total Population	White	African American	Native American	Some Other Race	Two or More Races	Asian	Hispanic Origin†	Native Hawaiian and Other Pacific Islander
South Dakota	754,854	669,404	4,685	62,283	3,677	10,156	4,378	10,903	261
Percent of total		88.7%	0.6%	8.3%	0.5%	1.3%	0.6%	1.4%	0.0%
Butte County	9,094	8,687	9	150	99	127	22	266	0
Percent of total		95.5%	0.1%	1.6%	1.1%	1.4%	0.2%	2.9%	0.0%
Custer County	7,275	6,851	20	227	26	137	13	110	1
Percent of total		94.2%	0.3%	3.1%	0.4%	1.9%	0.2%	1.5%	0.0%
Fall River County	7,453	6,746	24	451	22	189	17	130	4
Percent of total		90.5%	0.3%	6.1%	0.3%	2.5%	0.2%	1.7%	0.1%
Shannon County	12,466	562	10	11,743	28	114	3	177	6
Percent of total		4.5%	0.1%	94.2%	0.2%	0.9%	0.0%	1.4%	0.0%
Oglala (Pine Ridge Indian Reservation	1,229	9	0	1,214	1	4	1	4	0
Percent of total		0.7%	0.0%	98.8%	0.1%	0.3%	0.1%	0.3%	0.0%

Table 3.4-13. 2000 U.S. Bureau of Census Population and Race Categories of South Dakota* (continued)									
Affected Environment	**Total Population**	**White**	**African American**	**Native American**	**Some Other Race**	**Two or More Races**	**Asian**	**Hispanic Origin†**	**Native Hawaiian and Other Pacific Islander**
Pine Ridge (Pine Ridge Indian Reservation	3,171	118	3	2,987	16	43	1	57	3
Percent of total		3.7%	0.1%	94.2%	0.5%	1.4%	0.0%	1.8%	0.1%

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 26 February 2008, and 15 April 2008).
†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100%).

Table 3.4-14. 2000 U.S. Bureau of Census Population and Race Categories of Northwestern Wyoming*

Affected Environment	Total Population	White	African American	Native American	Some Other Race	Two or More Races	Asian	Hispanic Origin†	Native Hawaiian and Other Pacific Islander
Wyoming	493,782	454,670	3,722	11,133	12,301	8,883	2,771	31,669	302
Percent of total		92.1%	0.8%	2.3%	2.5%	1.8%	0.6%	6.4%	0.1%
Campbell County	33,698	32,369	51	313	378	450	108	1,191	29
Percent of total		96.1%	0.2%	0.9%	1.1%	1.3%	0.3%	3.5%	0.1%
Crook County	5,887	5,761	3	60	15	44	4	54	0
Percent of total		97.9%	0.1%	1.0%	0.3%	0.7%	0.1%	0.9%	0.0%
Niobrara County	2,407	2,360	3	12	12	17	3	36	0
Percent of total		98.0%	0.1%	0.5%	0.5%	0.7%	0.1%	1.5%	0.0%
Weston County	6,644	6,374	8	84	62	102	13	137	1
Percent of total		95.9%	0.1%	1.3%	0.9%	1.5%	0.2%	2.1%	0.0%

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 25 April 2008).

†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100%).

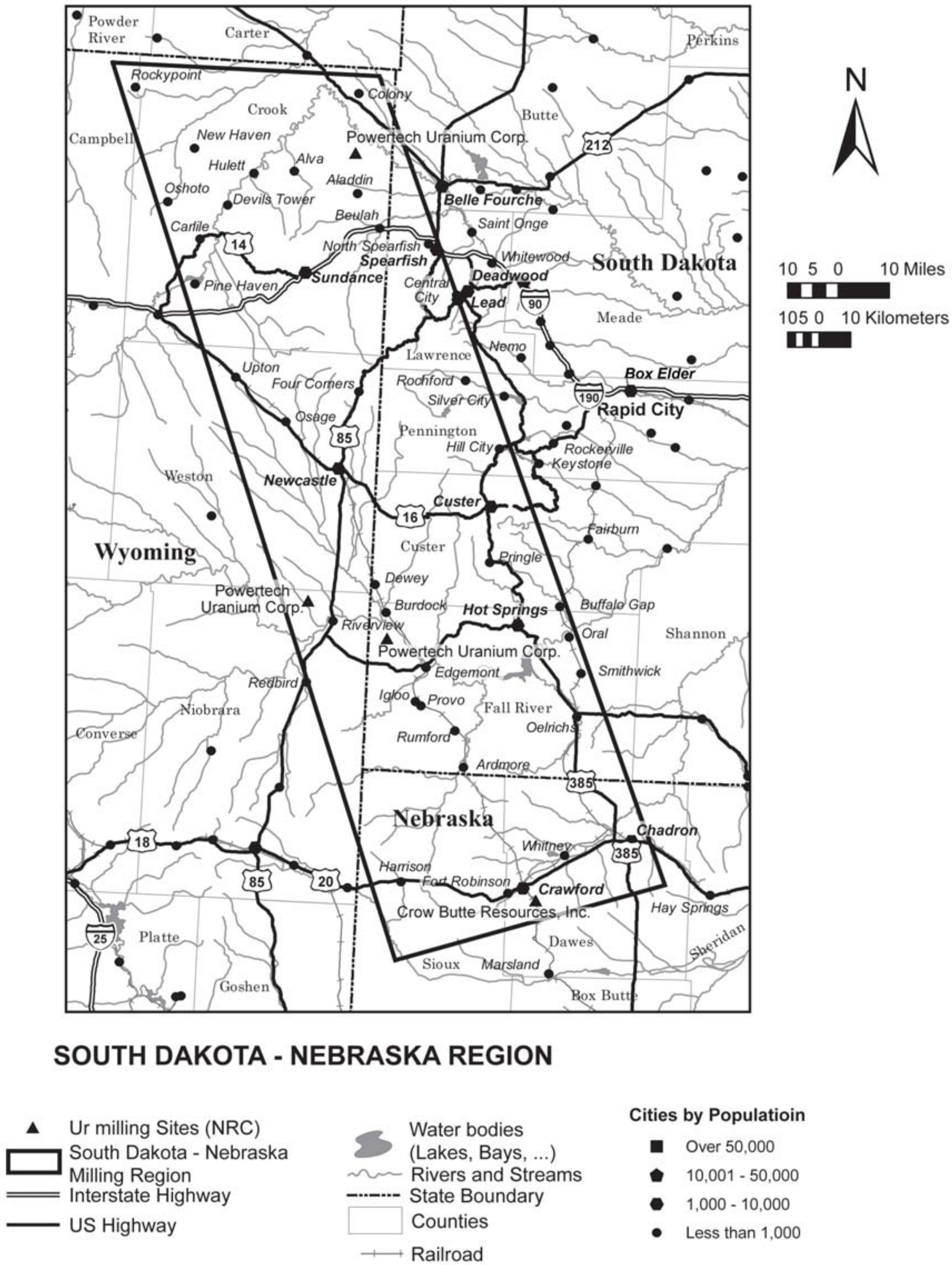


Figure 3.4-21. Nebraska-South Dakota-Wyoming Uranium Milling Region With Population

3.4.10.2 Income

Income information from the 2000 U.S. Census including labor force, income, and poverty levels for the affected environment in the Nebraska-South Dakota-Wyoming Uranium Milling Region is based on data collected at the state and county levels.

Data collected at the state level also includes information on towns, CBSAs, or Metropolitan Areas and considered an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [30 mi]} for income opportunities or may be a workforce needed to fulfill specialized positions (if a local workforce is unavailable or unspecialized). Data collected from a county level is generally for the same affected environment previously discussed in Table 3.4-11 and also includes information on Native American communities near the Nebraska-South Dakota-Wyoming Uranium Milling Region. State-level information is provided in Table 3.4-15, and county data are listed in Table 3.4-16.

For the surrounding region, the state with the largest labor force population and families and individuals below poverty level is Nebraska (Table 3.4-15). The population with the largest labor force is Rapid City, South Dakota {48 km [30 mi] from the nearest potential ISL facility}, and the smallest labor force population is Sturgis, South Dakota {32 km [20 mi] from the nearest potential ISL facility}. The population with the largest per capita income is Rapid City, South Dakota, and the smallest per capita income population is Chadron, Nebraska {16 km [10 mi] from the nearest ISL facility}. The population with the highest percentage of individuals and families below poverty levels is Scottsbluff, Nebraska {32 km [20 mi] from the nearest ISL facility).

Within the Nebraska-South Dakota-Wyoming Uranium Milling Region, the county with the largest labor force population is Campbell County, Wyoming, and the county with the smallest labor force population is Sioux County, Nebraska (Table 3.4-16). The town with the largest labor force population is Pine Ridge, South Dakota (Pine Ridge Indian Reservation), and the town with the smallest labor force population is Oglala, South Dakota (Pine Ridge Indian Reservation). The county with the largest per capita income is Campbell County, Wyoming, and the lowest per capita income county is Shannon County, South Dakota. The county with the highest percentage of individuals and families below poverty levels is Shannon County, South Dakota, and the town with the highest percentage of individuals and families below poverty levels is Pine Ridge, South Dakota.

3.4.10.3 Housing

Housing information from the 2000 U.S. Census data for the affected environment is provided in Tables 3.4-17 through 3.4-19.

The availability of housing within the immediate vicinity of the proposed ISL facilities is limited (Housing Assistance Council, 2002). The majority of housing is available in larger populated areas such as the CBSA and towns of Rapid City, South Dakota {48 km [30 mi] from the nearest ISL facility}, Spearfish, South Dakota {16 km [10 mi] to nearest potential ISL facility}, Sturgis, South Dakota {32 km [20 mi] from the nearest ISL facility}, Chadron, Nebraska {16 km [10 mi] to nearest ISL facility}, Alliance, Nebraska {16 km [10 mi] from the nearest ISL facility}, and Gillette, Wyoming {64 km [40 mi] from the nearest ISL facility}. There are approximately 10 housing units including manufactured housing (trailer homes) and residential property (neighborhoods) currently available in the region (MapQuest, 2008c).

Table 3.4-15. U.S. Bureau of Census State Income Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region*

Affected Environment	2000 Labor Force Population (16 Years and Over)	Median Household Income in 1999	Median Family Income in 1999	Per Capita Income in 1999	Families Below Poverty Level in 2000	Individuals Below Poverty Level in 2000
Nebraska	917,470	$39,250	$48,032	$19,613	29,977	161,269
South Dakota	394,945	$35,282	$43,237	$17,562	18,172	95,900
Wyoming	257,808	$37,892	$45,685	$19,134	10,585	54,777
Alliance, Nebraska	4,531	$39,408	$47,766	$18,584	255	979
Percent of total†	66.7%	NA	NA	NA	10.6%	11.2%
Chadron, Nebraska	3,228	$27,400	$44,420	$16,312	127	1,025
Percent of total†	68.26%	NA‡	NA	NA	11.0%	21.4%
Gering, Nebraska	3,927	$35,185	$42,378	$18,775	130	590
Percent of total†	64.1%	NA	NA	NA	5.9%	7.8%
Rapid City, South Dakota	31,948	$35,978	$44,818	$19,445	1,441	7,328
Percent of total†	68.8%	NA	NA	NA	9.4%	12.7%
Scottsbluff, Nebraska	7,122	$29,938	$37,778	$17,065	562	2,654
Percent of total†	62.5%	NA	NA	NA	14.5%	18.3%

Table 3.4-15. U.S. Bureau of Census State Income Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region* (continued)

Affected Environment	2000 Labor Force Population (16 Years and Over)	Median Household Income in 1999	Median Family Income in 1999	Per Capita Income in 1999	Families Below Poverty Level in 2000	Individuals Below Poverty Level in 2000
Spearfish, South Dakota	4,635	$26,887	$40,257	$16,565	189	1,362
Percent of total†	65.1%	NA	NA	NA	9.8%	17.4%
Sturgis, South Dakota	3,199	$30,253	$38,698	$16,763	187	756
Percent of total†	63.0%	NA	NA	NA	11.0%	12.0%
Casper, Wyoming	26,343	$36,567	$46,267	$19,409	1,122	5,546
Percent of total†	68.4%	NA	NA	NA	8.5%	11.4%

U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 26 February 2008, 15 April 2008, and 25 April 2008).
†Percent of total based on a population of 16 years and over.
‡NA = not applicable.

Table 3.4-16. U.S. Bureau of Census County and Native American Income Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region*

South Dakota*						
Affected Environment	**2000 Labor Force Population (16 Years and Over)**	**Median Household Income in 1999**	**Median Family Income in 1999**	**Per Capita Income in 1999**	**Families Below Poverty Level in 2000**	**Individuals Below Poverty Level in 2000**
Butte County	4,683	$29,040	$34,173	$13,997	234	1,147
Percent of total†	68.3%	NA‡	NA	NA	9.4%	12.8%
Custer County	3,535	$36,303	$43,628	$17,945	129	659
Percent of total†	59.6%	NA	NA	NA	6.2%	9.4%
Fall River County	3,408	$29,631	$37,827	$17,048	153	951
Percent of total†	59.6%	NA	NA	NA	7.8%	13.6%
Shannon County	3,884	$20,916	$20,897	$6,286	1,056	6,385
Percent of total†	52.4%	NA	NA	NA	45.1%	52.3%
Oglala (Pine Ridge Indian Reservation	339	$17,300	$19,688	$3,824	88	733
Percent of total†	49.9%	NA	NA	NA	45.1%	55.8%
Pine Ridge (Pine Ridge Indian Reservation	1,149	$21,089	$20,170	$6,067	320	2,057
Percent of total†	57.0%	NA	NA	NA	49.2%	61.0%

Table 3.4-16. U.S. Bureau of Census County and Native American Income Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued)*						
Affected Environment	**2000 Labor Force Population (16 Years and Over)**	**Median Household Income in 1999**	**Median Family Income in 1999**	**Per Capita Income in 1999**	**Families Below Poverty Level in 2000**	**Individuals Below Poverty Level in 2000**
Dawes County	4,989	$29,476	$41,092	$16,353	207	1,548
Percent of total†	66.8%	NA‡	NA	NA	9.8%	18.9%
Sioux County	749	$29,851	$31,406	$15,999	48	227
Percent of total†	64.7%	NA	NA	NA	11.1%	15.4%
Wyoming*						
Campbell County	18,805	$49,536	$53,927	$20,063	507	2,544
Percent of total†	76.6%	NA	NA	NA	5.6%	7.6%
Crook County	2,937	$35,601	$43,105	$17,379	129	529
Percent of total†	64.4%	NA	NA	NA	7.8%	9.1%
Niobrara County	1,193	$29,701	$33,714	$15,757	74	309
Percent of total†	61.5%	NA	NA	NA	10.7%	13.4%
Weston County	3,183	$32,348	$40,472	$17,366	119	628
Percent of total†	60.0%	NA	NA	NA	6.3%	9.9%

U.S. Census Bureau. “American FactFinder.” <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 26 February 2008, 15 April 2008, and 25 April 2008).
†Percent of total based on a population of 16 years and over.
‡NA = not applicable.

Table 3.4-17. U.S. Bureau of Census Housing Information for the Nebraska Uranium Milling Region*						
Affected Environment	**Single Family Owner-Occupied Homes**	**Median Value in Dollars**	**Median Monthly Costs With a Mortgage**	**Median Monthly Costs Without a Mortgage**	**Occupied Housing Units**	**Renter-Occupied Units**
Nebraska	370,495	$88,000	$895	$283	666,184	207,216
Dawes County	1,553	$55,200	$684	$262	3,512	1,211
Sioux County	140	$42,600	$600	$257	605	106
*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 26 February 2008).						

Table 3.4-18. U.S. Bureau of Census Housing Information for South Dakota*						
Affected Environment	**Single Family Owner-Occupied Homes**	**Median Value in Dollars**	**Median Monthly Costs With a Mortgage**	**Median Monthly Costs Without a Mortgage**	**Occupied Housing Units**	**Renter-Occupied Units**
South Dakota	137,531	$79,600	$828	$279	290,245	87,887
Butte County	1,360	$60,200	$706	$272	3,516	841
Custer County	1,073	$89,100	$884	$292	2,970	1,073
Fall River County	1,286	$54,300	$687	$271	3,127	901
Shannon County	631	$25,900	$515	$192	2,785	1,323
Oglala (Pine Ridge Indian Reservation)	29	$70,700	$450	$99	239	145
Pine Ridge (Pine Ridge Indian Reservation)	126	$15,000	$0	$185	709	473
*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 26 February 2008, and 15 April 2008).						

Table 3.4-19. U.S. Bureau of Census Housing Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region*						
Affected Environment	**Single Family Owner-Occupied Homes**	**Median Value in Dollars**	**Median Monthly Costs With a Mortgage**	**Median Monthly Costs Without a Mortgage**	**Occupied Housing Units**	**Renter-Occupied Units**
Wyoming	95,591	$96,600	$825	$229	193,608	55,793
Campbell County	5,344	$102,900	$879	$247	12,207	3,174
Crook County	836	$85,4000	$682	$207	2,308	411
Niobrara County	480	$60,300	$562	$200	1,011	222
Weston County	1,174	$66,700	$664	$199	2,624	549
Source: U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 25 April 2008).						

Temporary housing such as apartments, lodging, and trailer camps within the immediate vicinity of the proposed ISL facilities is not as limited. The majority of apartments is available in larger populated areas such as the CBSA and towns of Rapid City, Spearfish, and Sturgis in South Dakota; Chadron and Alliance in Nebraska; and Gillette in Wyoming, with about 25 apartment complexes currently available (MapQuest, 2008). There are also approximately 10 hotels/motels located along major highways or towns near the proposed ISL facilities. In addition to apartments and lodging, there are 20 trailer camps situated along major roads or near towns (MapQuest, 2008c).

3.4.10.4 Employment Structure

The regional employment structure from the 2000 U.S. Census data, including employment rate and type, is collected at the state and county levels. Data collected at the state level also include information on towns, CBSAs, or Metropolitan Areas and consider an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [30 mi]} for employment opportunities or may be a workforce needed to fulfill specialized positions (if a local workforce is unavailable or un-specialized). Data collected from a county level is the same for the affected environment previously discussed in Table 3.4-11 and also includes information on Native American communities.

For the region surrounding the Nebraska-South Dakota-Wyoming Uranium Milling Region, the state with the highest percentage of employment is Nebraska. The population with the highest percentage of employment is the town of Chadron, Nebraska, and the population with the highest unemployment rate is Spearfish, South Dakota.

Within the Nebraska-South Dakota-Wyoming Uranium Milling Region, the county with the highest percentage of employment is Campbell County, Wyoming, and the county with the highest unemployment rate is Shannon County, Nebraska. The towns with the highest unemployment rate are located on the Pine Ridge Indian Reservation (Table 3.4-20).

3.4.10.4.1 State Data

3.4.10.4.1.1 Nebraska

The state of Nebraska has an employment rate of 66.7 percent and unemployment rate of 2.5 percent. The largest sector of employment is management, professional, and related occupations at 33.0 percent. The largest type of industry is educational, health, and social services at 20.7 percent. The largest class of worker is private wage and salary workers at 77.1 percent (U.S. Census Bureau, 2008).

<u>Gering</u>

Gering has an employment rate of 61.6 percent and unemployment rate the same as that of the state at 2.5 percent. The largest sector of employment is management, professional, and related occupations at 34.0 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Table 3.4-20. Employment Structure of the Pine Ridge Indian Reservation Within the Affected Area*

Affected Environment	2003 Labor Force Population	Unemployed as Percent of Labor Force	Employed Below Poverty Guidelines	
Oglala Sioux Tribe of Pine Ridge	27,778	87%	716	21%

* U.S. Department of the Interior. "Affairs American Indian Population and Labor Force Report 2003." <http://www.doi.gov/bia/labor.html>. Washington, DC: U.S. Department of the Interior, Bureau of Indian Affairs, Office of Tribal Affairs. 2003.

Scottsbluff

Scottsbluff has an employment rate of 57.6 percent and unemployment rate much higher than that of the state at 4.6 percent. The largest sector of employment is management, professional, and related occupations at 29.6 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Alliance

Alliance has an employment rate of 63.1 percent and unemployment rate higher than that of the state at 3.6 percent. The largest sector of employment is production, transportation, and material-moving occupations at 25.9 percent. The largest type of industry is transportation and warehousing, and utilities. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Chadron

Chadron has an employment rate of 65.2 percent and unemployment rate lower than that of the state at 2.8 percent. The largest sector of employment is management, professional, and related occupations at 29.2 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.4.10.4.1.2 South Dakota

The state of South Dakota has an employment rate of 64.9 percent and unemployment rate of 3.0 percent. The largest sector of employment is management, professional, and related occupations at 32.6 percent. The largest type of industry is educational, health, and social services at 22.0 percent. The largest class of worker is private wage and salary workers at 72.9 percent (U.S. Census Bureau, 2008).

Rapid City

Rapid City has an employment rate of 63.7 percent and unemployment rate higher than that of the state at 3.2 percent. The largest sector of employment is management, professional, and related occupations at 32.8 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Spearfish

Spearfish has an employment rate of 53.5 percent and unemployment rate much higher than that of the state at 11.5 percent. The largest sector of employment is management, professional, and related occupations at 33.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Sturgis

Sturgis has an employment rate of 59.5 percent and unemployment rate lower than that of the state at 2.8 percent. The largest sector of employment is sales and occupations at 27.6 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.4.10.4.1.3 Wyoming

The state of Wyoming has an employment rate of 63.1 percent and unemployment rate of 3.5 percent. The largest sector of employment is sales and office occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Casper

Casper has an employment rate of 64.9 percent and an unemployment rate lower than that of the state at 3.4 percent. The largest sector of employment is sales and office occupations at 30.6 percent followed by management, professional, and related occupations at 29.7 percent. The largest type of industry is educational, health, and social services at 22.1 percent. The largest class of worker is private wage and salary workers at 76.6 percent (U.S. Census Bureau, 2008).

3.4.10.4.2 County Data

3.4.10.4.2.1 Nebraska

Dawes County

Dawes County has an employment rate of 63.8 percent and unemployment rate slightly higher than that of the state at 2.7 percent. The largest sector of employment is management, professional, and related occupations at 32.4 percent. The largest type of industry is educational, health, and social services at 28.9 percent. The largest class of worker is private wage and salary workers at 58.8 percent (U.S. Census Bureau, 2008).

Sioux County

Sioux County has an employment rate of 62.1 percent and unemployment rate slightly higher than that of the state at 2.7 percent. The largest sector of employment is management, professional, and related occupations at 50.3 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 40.5 percent. The largest class of worker is private wage and salary workers at 52.8 percent (U.S. Census Bureau, 2008).

3.4.10.4.2.2 South Dakota

Butte County

Butte County has an employment rate of 64.3 percent and unemployment rate higher than that of the state at 3.9 percent. The largest sector of employment is management, professional, and related occupations at 27.0 percent. The largest type of industry is agriculture, forestry, fishing, and hunting, and mining at 19.4 percent. The largest class of worker is private wage and salary workers at 66.8 percent (U.S. Census Bureau, 2008).

Custer County

Custer County has an employment rate of 57.5 percent and unemployment rate lower than that of the state at 2.0 percent. The largest sector of employment is management, professional, and related occupations at 34.6 percent. The largest type of industry is educational, health, and social services at 20.6 percent. The largest class of worker is private wage and salary workers at 58.5 percent (U.S. Census Bureau, 2008).

Fall River County

Custer County has an employment rate of 52.9 percent and unemployment rate higher than that of the state at 3.9 percent. The largest sector of employment is management, professional, and related occupations at 34.7 percent. The largest type of industry is educational, health, and social services at 31.1 percent. The largest class of worker is private wage and salary workers at 58.2 percent (U.S. Census Bureau, 2008).

Shannon County

Shannon County has an employment rate of 35.1 percent and unemployment rate considerably higher than that of the state at 17.3 percent. The largest sector of employment is management, professional, and related occupations at 37.8 percent. The largest type of industry is educational, health and social services. The largest class of worker is government workers (U.S. Census Bureau, 2008).

3.4.10.4.2.3 Wyoming

Campbell County

Campbell County has an employment rate of 73.2 percent and an unemployment rate lower than that of the state at 3.4 percent. The largest sector of employment is management, professional, and related occupations at 23.9 percent followed by construction, extraction, and maintenance occupations at 23.7 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 23.3 percent followed by educational, health, and social services at 16.7 percent. The largest class of worker is private wage and salary workers at 78.4 percent (U.S. Census Bureau, 2008).

Crook County

Crook County has an employment rate of 62.2 percent and an unemployment rate lower than that of the state at 2.1 percent. The largest sector of employment is management, professional, and related occupations at 29.9 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 24.7 percent. The largest class of worker is private wage and salary workers at 59.5 percent (U.S. Census Bureau, 2008).

Niobrara County

Niobrara County has an employment rate of 59.4 percent and an unemployment rate lower than that of the state at 2.1 percent. The largest sector of employment is management, professional, and related occupations at 34.4 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 24.7 percent. The largest class of worker is private wage and salary workers at 62.6 percent (U.S. Census Bureau, 2008).

Weston County

Weston County has an employment rate of 56.6 percent and an unemployment rate lower than that of the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 24.3 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 22.4 percent. The largest class of worker is private wage and salary workers at 68.9 percent (U.S. Census Bureau, 2008).

3.4.10.4.3 Native American Communities

Information on labor force and poverty levels for the Pine Ridge Indian Reservation is based on 2003 Bureau of Indian Affairs data and is provided in Table 3.4-20. The Oglala Sioux Tribe reports unemployment rates of more than 80 percent, much higher than the statewide levels that range from 2.5 percent for Nebraska to 3.5 percent for Wyoming (U.S. Census Bureau, 2008; U.S. Department of the Interior, 2003).

3.4.10.5 Local Finance

Local finance information such as revenue and tax information for the affected environment is provided in the following sections.

3.4.10.5.1 Nebraska

Sources of revenue for the State of Nebraska come from income, sales, cigarette, motor, and lodging taxes. Personal income tax rates for Nebraska range from 2.56 percent to 6.84 percent. The sales and use tax rate is 5.5 percent. Information on ad valorem taxes or mineral taxes such as that from uranium extraction is not available (Nebraska Department of Revenue, 2007). Information on local finance for the affected communities within the region of influence is presented next.

Dawes County

Sources of revenue for Dawes County come from real estate and property taxes. The net property taxes levied in 2003 were $1,634,113 with a state aid of $634,793 (Nebraska Department of Revenue, 2007).

Sioux County

Sources of revenue for Sioux County come from real estate and property taxes (Nebraska Department of Revenue, 2007).

3.4.10.5.2 South Dakota

Sources of revenue for the State of South Dakota come from 36 different state taxes. These taxes are grouped into four main categories: sales, use, and contractors' excise taxes; motor fuel taxes; motor vehicle fees and taxes; and special taxes. Once collected, these tax revenues are distributed into the state's general fund, local units of government, and the state highway fund. In 2006, 72 percent came from sales, use, and contractors' excise taxes; 11 percent from motor fuel taxes; 9 percent from special taxes; and 8 percent from vehicle taxes. South Dakota also imposes an energy minerals tax on owners of energy minerals (such as uranium). In 2006, the tax rate base was 4.5 percent of the taxable value and approximately 50 percent was disbursed to local government (South Dakota Department of Revenue and Regulation, 2007). Information on local finance for the affected communities within the region of influence is presented next.

Butte County

The majority of revenue for Butte County comes from sales, use, and property taxes. In 2004, a total revenue of $1,578,000 was collected from property taxes (City-Data.com, 2008).

Custer County

The majority of revenue for Custer County is from property taxes. In 2006, there were approximately 13,000 parcels of land in Custer County and $9.3 million was collected in real estate taxes. Other sources of revenue come from motor vehicle fees (Custer County South Dakota, 2007).

Fall River County

In 2004, the majority of revenue for Fall River County was from property taxes ($2,101,000) and motor vehicle fees ($482,000) (City-Data.com, 2007).

Shannon County

The majority of revenue for Shannon County comes from retail sales at $30,594 as of 2002 and federal grants at $197,565 as of 2004 (U.S. Census Bureau, 2008).

3.4.10.5.3 Wyoming

The State of Wyoming does not have an income tax nor does it assess tax on retirement income received from another state. Wyoming has a 4 percent state sales tax, 2 percent to 5 percent county lodging tax, and 5 percent use tax. Counties have the option of collecting an additional 1 percent tax for general revenue and 2 percent tax for specific purposes. Wyoming also imposes “ad valorem” taxes on mineral extraction properties. Taxes levied for uranium production were 10.0 percent in 2007 (6.0 percent “ad valorem” and 4 percent severance) totaling $1.7 million dollars (Wyoming Department of Revenue, 2007). None of this uranium tax revenue was generated in the Nebraska-South Dakota-Wyoming Uranium Milling Region. Annual sales and use tax distribution information for affected counties (including cities and towns) is presented in Table 3.4-21.

Table 3.4-21. 2007 State and Local Annual Sales and Use Tax Distribution of Affected Counties Within Wyoming (Through September 28, 2007*)

Affected Counties	Use Tax		Sales Tax		Gross Revenue
	State	Local	State	Local	
Campbell County	9,104,434	8,130,984	72,443,855	64,724,530	155,316,435
Crook County	542,748	630,596	2,305,618	2,677,933	6,266,869
Niobrara County	156,916	182,363	1,091,293	1,268,288	2,745,320
Weston County	630,016	506,201	2,572,484	2,066,940	5,886,521

*Wyoming Department of Revenue. "State of Wyoming Department of Revenue 2007 Annual Report." 2007. <http://revenue.state.wy.us/PortalVBVS//uploads/2007%20DOR%20Annual%20Report.pdf> (7 April 2009).

3.4.10.5.4 Native American Communities

The Pine Ridge Indian Reservation is the poorest reservation in the United States. The majority of revenue for Pine Ridge comes from employment by the Oglala Sioux Tribe, Oglala Lakota College, Bureau of Indian Affairs, and the Indian Health Service. Some revenue also comes from agricultural production, gaming, hunting, and ranching (Housing Assistance Council, 2002)).

3.4.10.6 Education

Information on education for the affected communities is presented in the following paragraphs.

Based on review of the affected environment, the county with the largest number of schools is Campbell County, Wyoming, and the county with the smallest number of schools is Niobrara, Wyoming. The towns with the smallest number of schools or smaller schools are located on the Pine Ridge Indian Reservation.

3.4.10.6.1 Nebraska

Dawes County

Dawes County has a total of 17 schools including public schools, elementary schools, middle schools, high schools, and 1 academy. There are a total of approximately 5,500 students. The majority of schools provides bus services (Schoolbug.org, 2007a).

Sioux County

Sioux County has a total of 6 schools including 5 public schools and 1 high school, with a total of approximately 565 students. Information as to whether these schools provide bus services is not available (Publicschoolsreport.com, 2008).

3.4.10.6.2 South Dakota

Butte County

Butte County has three elementary schools, two middle schools, and two high schools. There are a total of approximately 1,789 students. Information as to whether these schools provide bus services is not available (Schoolbug.org, 2008).

Custer County

Custer County has five elementary schools, one middle school, one high school, and one alternative school for a total of nine schools. There are a total of approximately 1,207 students. Information as to whether these schools provide bus services is not available (Schoolbug.org, 2007b).

Fall River County

Fall River County has 4 elementary schools, 2 middle schools, 1 junior high school, and 3 high schools for a total of 10 schools. There are a total of approximately 1,200 students. Information as to whether these schools provide bus services is not available (Schoolbug.org, 2007c).

Shannon County

Shannon County has one school district, which consists of four elementary and junior high schools. There are approximately 991 students. Information as to whether these schools provide bus services is not available (Greatschools.net, 2008).

Native American Communities

The Pine Ridge Indian Reservation has the Pine Ridge School and the Oglala elementary school (Housing Assistance Council, 2002; Pine Ridge School, 2008). Specific information pertaining to school population or bus services is not available.

3.4.10.6.3 Wyoming

Campbell County

Campbell County has 1 school district with 24 schools consisting of 15 elementary schools, 2 junior high schools, 1 junior/senior high school, 1 high school, 1 alternative school, and 1 aquatic center. There are a total of approximately 7,441 students. The majority of schools provides bus services (Campbell County School District No. 1, 2007).

Crook County

Crook County has 1 school district with 2 elementary schools, 2 secondary schools, and 1 high school, with a total of approximately 1,142 students. Information as to whether these schools provide bus services is not available (Crook County School District, 2008).

<u>Niobrara County</u>

Niobrara County has one school district, Niobrara County School District No. 1, with a total of approximately 422 students. There is one elementary and middle school, one high school, and one private school. Information as to whether these schools provide bus services is not available (Niobrara County School District No. 1, 2008).

<u>Weston County</u>

Weston County has one school district, Weston County School District No. 1, with a total of approximately 1,134 students. There are two elementary schools, one middle school, and one high school. Information as to whether these schools provide bus services is not available (Weston County School District No. 1, 2008).

3.4.10.7 Health and Social Services

The majority of health care facilities is located within populated areas of the affected environment. The closest health care facilities within the vicinity of the potential ISL facilities are located in Spearfish, Edgemont, Rapid City, and Sturgis, South Dakota; Alliance, Gordon, and Chadron, Nebraska; and Gillette, Sundance, and Torrington, Wyoming, and have a total of at least 18 facilities (MapQuest, 2008b). These consist of hospitals, clinics, emergency centers, and medical services. The following hospitals are located proximate to the Nebraska-South Dakota-Wyoming Uranium Milling Region: Spearfish, South Dakota (one); Rapid City, South Dakota (two); Alliance, Nebraska (one); Gordon, Nebraska (one); Chadron, Nebraska (two); Gillette, Wyoming (two); and Torrington, Wyoming (one).

Local police within the Nebraska-South Dakota-Wyoming Uranium Milling Region are under the jurisdiction of each county. There are 20 police, sheriff, or marshals offices within the region: Butte County, South Dakota (2); Custer County, South Dakota (1); Fall River County, South Dakota (2); Shannon County, South Dakota (1); Dawes County, Nebraska (3); Sioux County, Nebraska (1); Campbell County, Wyoming (2); Crook County, Wyoming (3); Niobrara County, Wyoming (2); and Weston County, Wyoming (3) (Usacops, 2008).

Fire departments within the affected area are comprised at the county, town or CBSA level. There are 45 fire departments within the milling region: Rapid City, South Dakota (16); Sturgis, South Dakota (14); Spearfish, South Dakota (5); Alliance, Nebraska (1); Campbell County, Wyoming (2); Crook County, Wyoming (1); and Gillette, Wyoming (2) (50states, 2008).

3.4.11 Public and Occupational Health

3.4.11.1 Background Radiological Conditions

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 3 mSv/yr [300 mrem/yr] but varies by location and elevation (National Council on Radiation Protection and Measurements, 1987). In addition, the average American receives 0.6 mSv/yr [60 mrem/yr] from man-made sources including medical diagnostic tests and consumer products (National Council of Radiation Protection and Measurements, 1987). Therefore, the total from natural background and man-made sources for the average U.S. resident is 3.6 mSv/yr [360 mrem/yr]. For a breakdown of the sources of this radiation, see Figure 3.2-22.

The total effective dose equivalent is the total dose from external sources and internal material released from licensed operations. Doses from sources in the general environment (such as terrestrial radiation, cosmic radiation, and naturally occurring radon) are not included in the dose calculation for compliance with 10 CFR Part 20, even if these sources are from technologically enhanced naturally occurring radioactive material, such as preexisting radioactive residues from prior mining (Atomic Safety and Licensing Board, 2006).

Background dose varies by location primarily because of elevation changes and variations in the dose from radon. As elevation increases so does the dose from cosmic radiation and hence the total dose. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. The amount of radon in the soil/bedrock depends on the type, porosity, and moisture content. Areas that have types of soils/bedrock like granite and limestone have higher radon levels that those with other types of soils/bedrock (EPA, 2006). Radiological background for Wyoming is provided in Section 3.2.11.1. For the states of South Dakota and Nebraska, the average background rate including natural and man-made sources is 6.0 and 3.5 mSv/yr [600 and 350 mrem/yr], respectively (EPA, 2006). The average background rate for South Dakota is significantly higher than the U.S. average background rate of 3.6 mSv/yr [360 mSv/yr], and for Nebraska it is very similar.

For South Dakota, the radon dose is 4.4 mSv/yr [440 mrem/yr] compared to the U.S. average radon dose of 2.0 mSv/yr [200 mrem/yr]. For South Dakota, the indoor average radon rate is significantly higher than the U.S. average due to geological reasons and poor ventilation within homes (EPA, 2006). For the western region of South Dakota of interest here, the radon levels are half as much when compared to the state average (South Dakota Department of Environmental and Natural Resources, 2008), and therefore, background dose is expected to be closer to the national average for this region.

3.4.11.2 Public Health and Safety

Public health and safety standards are the same regardless of a facility's location. Therefore, see Section 3.2.11.2 for further discussion of these standards.

3.4.11.3 Occupational Health and Safety

Occupational health and safety standards are the same regardless of facility's location. Therefore, see Section 3.2.11.3 for further discussion of these standards.

3.4.12 References

Atomic Safety and Licensing Board. "Atomic Safety and Licensing Board Transcript in the Matter of Hydro Resources Inc." Docket No. 40–8968–ML. Washington, DC: Atomic Safety and Licensing Board. May 16, 2006.

BLM. "Visual Resource Management." Manual 8400. Washington, DC: BLM. 2007a. <http://www.blm.gov/nstc/VRM/8400.html> (17 October 2007).

BLM. "Visual Resource Inventory." Manual H–8410–1. Washington, DC: BLM. 2007b. <http://www.blm.gov/nstc/VRM/8410.html> (17 October 2007).

BLM. "Visual Resource Contrast Rating." Manual 8431. Washington, DC: BLM. 2007c. <http://www.blm.gov/nstc/VRM/8431.html> (17 October 2007).

BLM. “Record of Decision and Approved Resource management Plan for Public Lands Administered by the Newcastle Field Office.” BLM/WY/PL–00/027+1610. Newcastle, Wyoming: BLM. September 2000a.

BLM. “Newcastle Resource Management Plan.” Newcastle, Wyoming: BLM, Newcastle Field Office. 2000b. <http://www.blm.gov/rmp/WY/application/rmp_browse.cfm?hlevel=1&rmpid=89&idref=28910> (17 October 2007).

BLM. “Nebraska Record of Decision and Approved Resource Management Plan.” Casper, Wyoming: BLM, Casper District Office. 1992. <http://www.blm.gov/pgdata/etc/medialib/blm/wy/programs/planning/rmps.Par.13877.File.dat/nebraska-rmp.pdf?bcsi_scan_B6C3A1920618BACA=0&bcsi_scan_filename=nebraska-rmp.pdf> (17 October 2007).

BLM. “Final Resource Management Plan, South Dakota Resource Area, Miles City District.” Miles City, Montana: BLM, South Dakota Resource Area, Miles City District. 1985. <http://www.blm.gov/mt/st/en/prog/planning/south_dakota.html> (17 October 2007).

Bryce, S.A., J.M. Omernik, D.A. Pater, M. Ulmer, J. Schaar, J. Freeouf, R. Johnson, P. Kuck, and S.H. Azevedo. “Ecoregions of North Dakota and South Dakota.” U.S. Geological Survey Map. Scale 1:1,500,000. 1996.

Campbell County School District No. 1. “Campbell County School District No. 1, Educational Services Center.” Gillette, Wyoming. 2007. <www.esc.ccsd.k12.wy.us> (15 October 2007).

Chapman, S.S., S.A. Bryce, J.M. Omernik, D.G. Despain, J. ZumBerge, and M. Conrad. “Ecoregions of Wyoming.” U.S. Geological Survey Map. Scale 1:1,400,000. 2004.

Chapman, S.S., J.M. Omernik, J.A. Freeouf, D.G. Huggins, J.R. McCauley, C.C. Freeman, G. Steinauer, R.T. Angelo, and R.L. Schlepp. “Ecoregions of Nebraska and Kansas.” U.S. Geological Survey Map. Scale 1:1,950,000. 2001.

Chenoweth, W.L. “Geology and Production History of the Uranium Deposits in the Northern Black Hills, Wyoming—South Dakota.” Eastern Powder River Basin, Wyoming Geological Association, 39th Annual Field Conference Guidebook. Casper, Wyoming: Wyoming Geological Association. pp. 263–270. 1988.

City-Data.com. “Butte County, South Dakota.” 2008. <www.city-data.com> (28 February 2008).

City-Data.com. “Fall River County, South Dakota.” 2007. <www.city-data.com> (14 October 2007).

Collings, S.F. and R.H. Knode. “Geology and Discovery of the Crow Butte Uranium Deposit, Dawes County, Nebraska.” Practical Hydromet ’83, 7th Annual Symposium on Uranium and Precious Metals. Littleton, Colorado: American Institute of Mining, Metallurgical, and Petroleum Engineering. 1984.

Crook County School District. “Crook County, Wyoming.” 2008. <www.crooknet.k12.wy.us> (25 April 2008).

Custer County South Dakota. “Custer County.” 2007. <www.custercountysd.com/> (15 October 2007).

DeGraw, H.M. “Subsurface Relations of the Cretaceous and Tertiary in Western Nebraska.” MS Thesis. University of Nebraska. Lincoln, Nebraska. 1969.

DOE. DOE/EA–1535, “Uranium Leasing Program Final Programmatic Environmental Assessment.” Washington, DC: DOE, Office of Legacy Management. 2007. <http://www.eh.doe.gov/nepa/ea/EA1535/ulm_ea2007.pdf> (12 October 2007).

Dondanville, R.F. “The Fall River Formation, Northwestern Black Hills; Lithology and Geology History.” Joint Field Conference Guidebook. Northern Powder River Basin, Wyoming: Wyoming Geological Association, Billings Geological Society. pp. 87–99. 1963.

Driscoll, F.G. “Groundwater and Wells.” 2nd Edition. St. Paul, Minnesota: Johnson Filtration Systems Inc. 1986.

Driscoll, D.G., J.M. Carter, J.E. Williamson, and L.D. Putnam. “Hydrology of the Black Hills Area, South Dakota.” U.S. Geological Survey Water Resources Investigation Report 02-4094. 2002.

EPA. “Counties Designate Nonattainment or Maintenance for Clean Air Act’s National Ambient Air Quality Standards (NAAQS).” 2007. <http://www.epa.gov/oar/oaqps/greenbk/mapnmpoll.html> (29 September 2007).

EPA. “Prevention of Significant Deterioration (PSD) Permit Program Status: May 2007.” 2007b. <http://www.epa.gov/nsr/where.html> (26 September 2007).

EPA. “Assessment of Variations in Radiation Exposure in the United States (Revision 1).” Contract Number EP–D–05–02. Washington, DC: EPA. 2006.

Federal Highway Administration. “Synthesis of Noise Effects on Wildlife Populations.” FHWA–HEP–06–016. Washington, DC: Federal Highway Administration, Department of Transportation. 2004.

Girardin, J. “A List of Areas Designated Unique and Irreplaceable or Designated Rate or Uncommon by the Council.” Letter (November 29) to T. Lorenzon, Director, Environmental Quality Council. Cheyenne, Wyoming: Environmental Quality Council. 2006.

Gjelsteen, T.W. and S.P. Collings. “Relationship Between Groundwater Flow and Uranium Mineralization in the Chadron Formation, Northwest Nebraska.” Eastern Powder River Basin, Wyoming Geological Association, 39th Annual Field Conference Guidebook. Casper, Wyoming: Wyoming Geological Association. pp. 271–284. 1988.

Gott, G.B, D.E. Wolcott, and C.G. Bowles. “Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota and Wyoming.” U.S. Geological Survey Professional Paper 763. 1974.

Greatschools.net. “Shannon County, South Dakota.” 2008. <http//www.greatschools.net> (16 April 2008).

Harshman, E.N. “Uranium Deposits of Wyoming and South Dakota.” *Ore Deposits in the United States 1933–1967*. New York City, New York: American Institute of Mining, Metallurgical, and Petroleum Engineers. pp. 815–831. 1968.

Hart, O.M. “Uranium in the Black Hills.” *Ore Deposits of the United States, 1933–1967*. J.D. Ridge, ed. New York City, New York: American Institute of Mining, Metallurgical, and Petroleum Engineers. pp. 832–837. 1968.

Henebry, G.M., B.C. Putz, M.R. Vaitkus, and J.W. Merchant. “The Nebraska Gap Analysis Project Final Report.” Lincoln, Nebraska: University of Nebraska, School of Natural Resources. 2005.

Housing Assistance Council. “Taking Stock: Rural People, Poverty, and Housing at the Turn of the 21st Century.” Washington, DC: Housing Assistance Council. December 2002.

Kansas Geological Survey. “The Dakota Aquifer Program: Annual Report, FY119.” Open-File Report. 91-1. 1991. <http://www.kgs.ku.edu/Dakota/vol3/fy91/rep06.htm> (29 April 2008).

King, T. *Places That Count: Traditional Cultural Properties in Cultural Resources Management*. Walnut Creek, California: Altamira Press. 2003.

MapQuest. “Nebraska, South Dakota, and Wyoming.” 2008. <http://mapquest.com> (16 April 2008).

Maxwell, C.H. “Map and Stratigraphic Sections Showing Distribution of Some Channel Sandstones in the Lakota Formation, Northwestern Black Hills, Wyoming. U.S. Geological Survey Miscellaneous Field Studies Map MF–632. 1974.

Miller, J.A. and C.L. Appel. “Groundwater Atlas of the United States, Kansas, Missouri, and Nebraska.” U.S. Geological Survey Report HA 730–D. Denver, Colorado: U.S. Geological Survey. 1997. <http://pubs.usgs.gov/ha/ha730/ch_d/> (29 January 2009).

Munn, L.C. and C.S. Arneson. “Soils of Wyoming—A Digital Statewide Map at 1:500,000-Scale.” B–1069. Laramie, Wyoming: University of Wyoming Agricultural Experiment Station, College of Agriculture. 1998.

National Climatic Data Center. “NCDC U.S. Storm Events Database.” 2007. <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms> (14 April 2008).

National Climatic Data Center. “Climates of the States, Climatology of the United States No. 60 (New Mexico, Nebraska, South Dakota, and Wyoming).” Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2005. <http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl?directive=prod_select2&prodtype=CLIM60&subrnum=> (30 January 2005).

National Climatic Data Center. “Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000.” Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

National Council on Radiation Protection and Measurements. “Report No. 094—Exposure of the Population in the United States and Canada From Natural Background Radiation.” Bethesda, Maryland: National Council on Radiation Protection and Measurements. 1987.

National Weather Service. “NOAA Technical Report NWS 33: Evaporation Atlas for the Contiguous 48 United States.” Washington, DC: National Oceanic and Atmospheric Administration. 1982.

Nebraska Department of Environmental Quality. “2008 Surface Water Quality Integrated Report.” Lincoln, Nebraska: Nebraska Department of Environmental Quality. 2008.

Nebraska Department of Environmental Quality. “Total Maximum Daily Loads for the White River Hat Creek Basin.” Lincoln, Nebraska: Nebraska Department of Environmental Quality. December 2005a.

Nebraska Department of Environmental Quality. “Total Maximum Daily Loads for the Niobrara River Basin.” Lincoln, Nebraska: Nebraska Department of Environmental Quality. December 2005b.

Nebraska Department of Environmental Quality. “Ambient Air Quality Regulations.” 2002. <http://www.deq.state.ne.us/> (23 October 2007).

Nebraska Department of Revenue. “Nebraska Individual Income Tax Rates for Tax Year 2007.” 2007. <www.revenue.ne.gov/> (15 October 2007).

Nebraska Game and Parks Commission. “Park Areas in the Panhandle Region.” Lincoln, Nebraska: Nebraska Game and Parks Commission. 2008. <http://www.ngpc.state.ne.us/parks/guides/parksearch/getregion.asp?District=1> (29 February 2008).

Niobrara County School District No. 1. 2008. <www.lusk.k12.wy.us/> (27 February 2008).

NRC. “Environmental Assessment for Renewal of Source Material License No. SUA–1534: Crow Butte Resources, Incorporated Crow Butte Uranium Project Dawes County, Nebraska.” Docket No. 40-8943. Washington, DC: NRC. 1998

NRCS. “United States Department of Agriculture, National Resources Conservation Service. Dawes County, Nebraska.” October 2007. <http://soildatamart.nrcs.usda.gov/survey.aspx?County=NE045> (29 January 2009).

Parker, P. and T. King. “Guidelines for Evaluating and Documenting Traditional Cultural Properties.” National Register Bulletin 38. Washington, DC: National Park Service. 1998.

Pine Ridge School. “Pine Ridge School, Pine Ridge, South Dakota.” 2008. <www.prs.bia.edu> (29 April 2008).

Publicschoolsreport.com. “Sioux County, Nebraska.” 2008. <publicschoolsreport.com> (27 February 2008).

Renfro, A.R. “Uranium Deposits in the Lower Cretaceous of the Black Hills.” *Contributions to Geology*. Laramie, Wyoming: University of Wyoming. Vol. 8, No. 2-1. pp. 87–92. 1969.

Robinson, C.S., W.J. Mapel, and M.H. Bergendahl. "Stratigraphy and Structure of the Northern and Western Flank of the Black Hills Uplift, Wyoming, Montana, and South Dakota." U.S. Geological Survey Professional Paper 404. 1964.

Schoolbug.org. "Butte County, South Dakota." 2008. <www.schoolbug.org> (27 February 2008).

Schoolbug.org. "Custer County, South Dakota." 2007a. <www.schoolbug.org> (13 October 2007).

Schoolbug.org. "Fall River County, South Dakota." 2007b. <www.schoolbug.org> (13 October 2007).

Schoolbug.org. "Dawes County, Nebraska." 2007c. <www.schoolbug.org> (13 October 2007).

South Dakota Birds and Birding. "American Dipper." 2008. <http://sdakotabirds.com/species/american_dipper_info.htm> (12 February 2008).

South Dakota Department of Environmental and Natural Resources. "Radon." <http://www.state.sd.us/denr/DES/AirQuality/radon1.htm> 2008. (15 April 2008).

South Dakota Department of Environment and Natural Resources. "Air Quality Program." 2007. <http://www.state.sd.us/denr/DES/AirQuality/airprogr.htm> (23 October 2007).

South Dakota Department of Revenue and Regulation. "South Dakota Department of Revenue and Regulation." 2007. <www.state.sd.us/drr2/revenue.html> (18 October 2007).

South Dakota Division of Wildlife. "South Dakota Statewide Fisheries Survey." Angostura Reservoir County: Fall River, No. 2102–/F21–R–37. 2004. <http://www.sdgfp.info/wildlife/Fishing/WesternLakes/Angostura04.pdf> (04 April 2008).

South Dakota Game, Fish, and Parks. "Fishing in South Dakota." Pierre, South Dakota: South Dakota Game, Fish, and Parks. 2008. <http://www.sdgfp.info/Wildlife/fishing/> (15 February 2008).

South Dakota State University. "South Dakota GAP Analysis Project." Brookings, South Dakota: South Dakota State University, Department of Wildlife and Fisheries Sciences. 2007. <http://wfs.sdstate.edu/sdgap/sdgap.htm> (29 November 2007).

South Dakota State University. "South Dakota GAP Analysis Project." Brookings, South Dakota: South Dakota State University, Department of Wildlife and Fisheries Sciences. 2001. <http://wfs.sdstate.edu/sdgap/sdgap.htm> (29 February 2008).

University of Nebraska. "Gap Analysis Project." Lincoln, Nebraska: University of Nebraska. 2007.

Usacops. "South Dakota, Nebraska, and Wyoming." 2008. <http://www.usacops.com> (16 April 2008).

U.S. Census Bureau. "American FactFinder 2000 Census Data." 2008. <http://factfinder.census.gov> (25 February 2008).

U.S. Department of the Interior. “American Indian Population and Labor Force Report.” Washington, DC: U.S. Department of the Interior, Bureau of Indian Affairs. 2003.

USFS. “Medicine Bow-Routt National Forests, Thunder Basin National Grassland.” Laramie, Wyoming: USFS. 2008a. <http://www.fs.fed.us/r2/mbr/index.shtml> (27 February 2008).

USFS. “Nebraska and Samuel R. McKelvie National Forests Buffalo Gap, Fort Pierre, and Oglala National Grasslands.” Chadron, Nebraska: USDA Forest Service Nebraska, Samuel R. McKelvie National Forests Buffalo Gap, Fort Pierre, and Oglala National Grasslands. 2008b.

USFS. “Black Hills National Forest, Phase II Amendment: 1997 Land and Resource Management Plan Final Environmental Impact Statement.” Custer, South Dakota: USFS, Black Hills National Forest. 2005. <http://www.fs.fed.us/r2/blackhills/projects/planning/amendments/phase_II/index.shtml> (17 October 2007).

USFS. “Land and Resource Management Plan for the Nebraska National Forest and Associated Units (Rocky Mountain Region).” Chadron, Nebraska: USFS, Nebraska National Forest. 2001a. <http://www.fs.fed.us/ngp/plan/feis_plan_nebraska.htm> (17 October 2007).

USFS. “Black Hills National Forest, Phase I Amendment: 1997 Land and Resource Management Plan Environmental Assessment.” Custer, South Dakota: USFS, Black Hills National Forest. 2001b. <http://www.fs.fed.us/r2/blackhills/projects/planning/amendments/phase_I/index.shtml> (17 October 2007).

USFS. “Revised Land and Resource Management Plan for the Black Hills National Forest.” Custer, South Dakota: USFS, Black Hills National Forest. 1997. <http://www.fs.fed.us/r2/blackhills/projects/planning/97Revision/fp/index.shtml> (17 October 2007).

U.S. Geological Survey. “Water Watch.” 2008a. <http://water.usgs.gov/waterwatch> (28 February 2008).

U.S. Geological Survey. “Fragile Legacy Endangered, Threatened and Rare Animals of South Dakota.” 2008b. <http://www.npwrc.usgs.gov/resource/wildlife/sdrare/index.htm#contents> (1 March 2008).

U.S. Geological Survey. “A Tapestry of Time and Terrain.” Denver, Colorado: U.S. Geological Survey. 2004. <http://tapestry.usgs.gov/Default.html> (25 February 2008).

Vondra, C.F. “The Stratigraphy of the Chadron Formation in Northwestern Nebraska.” MS Thesis. University of Nebraska. Laramie, Wyoming. 1958.

Washington State Department of Transportation. “WSDOT's Guidance for Addressing Noise Impacts in Biological Assessments—Noise Impacts.” Seattle, Washington: Washington State Department of Transportation. 2006. <http://www.wsdot.wa.gov/TA/Operations/Environmental/NoiseChapter011906.pdf> (12 October 2007).

WDEQ. "Wyoming's 2008 305(b) Integrated State Water Quality Assessment Report and 2008 303(d) List of Waters Requiring TMDLs. WDEQ, Water Quality Divisions." 2008. http://deq.state.wy.us/wqd/watershed/Downloads/305b/2008/2008%20Integrated%20Report.pdf> (27 January 2009).

WDEQ. "Wyoming Surface Water Classification List." Cheyenne, Wyoming: WDEQ, Water Quality Division, Surface Water Standards. 2001.

Weston County School District No. 1. 2008. <www.weston1.k12.wy.us/> (27 February 2008).

Whitehead, R.L. "Groundwater Atlas of the United States, Montana, North Dakota, South Dakota, Wyoming." U.S. Geological Survey Report HA 730–I. Denver, Colorado: U.S. Geological Survey. <http://capp.water.usgs.gov/gwa/ch_i/index.html> 1996.

Williamson, J.E. and J.M. Carter. "Water-Quality Characteristics in the Black Hills Area, South Dakota." U.S. Geological Survey Water Resources Investigation Report 01-4194. 2001.

Wyoming Department of Transportation. "WYDOT Traffic Analysis." Cheyenne, Wyoming: Wyoming Department of Transportation. 2005. <http://www.dot.state.wy.us/Default.jsp?sCode=hwyta> (25 February 2008).

Wyoming Game and Fish Department. "Comprehensive Wildlife Conservation Strategy." Cheyenne, Wyoming: Wyoming Game and Fish. 2008. <http://gf.state.wy.us/wildlife/CompConvStrategy/Species> (19 February 2008).

Wyoming Game and Fish Department. "Terrestrial Habitat/Aquatic Habitat/Habitat Management." Cheyenne, Wyoming: Wyoming Game and Fish. 2007. <http://gf.state.wy.us/habitat/aquatic/index.asp> (13 September 2007).