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3.5.3 Groundwater

As discussed in the GEIS (Section 3.3.4.3.1), the Northern Great Plains aquifer system is the major regional aquifer system in the Wyoming East Uranium Milling Region. Whitehead (1966) grouped the Northern Great Plains aquifer system into five major aquifers. These aquifers, from the shallowest to the deepest, are the Lower Tertiary, Upper Cretaceous, Lower Cretaceous, Upper Paleozoic, and Lower Paleozoic aquifers. The Lower Tertiary aquifers consist of the sandstone beds with the Wasatch Formation and the Fort Union Formation. Both formations consist of alternating sandstone, siltstone, and claystone beds and 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 report to be as thick as 1,095 and 305 m (3,600 and 1,000 ft), respectively. In the lower Tertiary aquifers, the regional flow direction is northward and northeastward from recharge area in northeastern Wyoming.

The Upper Cretaceous aquifer consists of sandstone beds interbedded with siltstone and claystone in the Lance and Hell Creek Formation and the Fox Hill Sandstone. The Fox Hills Sandstone is one of the most continuous water-yielding formations in the Northern Great Plains aquifer system. The Upper Cretaceous aquifers are separated from the Lower 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. The lower Cretaceous aquifers are the most widespread aquifers in the Northern Great Plain aquifer system and contain several sandstones. However, the lower Cretaceous aquifers contain little freshwater. The water becomes saline in the deep parts of the Powder River Basin. The Paleozoic aquifers cover a larger area, but they are deeply buried in most places and contain little freshwater.

As previously discussed in Section 3.4.1 of this EA, the Wasatch Formation outcrops in the study area and represents the most superficial deposits in the area except for limited Quaternary deposits within surface drainages. Extensive alluvial deposits are present in the project area along Cottonwood Creek. The sandstone beds within the Wasatch Formation comprise the shallowest aquifers within the project area. There are commonly multiple water-bearing sands within the Wasatch Formation. Due to their higher permeability, these water bearing sands provide the primary sources for groundwater withdrawal. Groundwater within the Wasatch aquifers is typically under confined (artesian) conditions, although locally unconfined conditions exist. Well yields from the Wasatch in the southern part of the Powder River Basin where the site is located are reported to be as high as 1,900 Lpm (500 gpm). In the vicinity of the Pumpkin Buttes, the Wasatch Formation is known to be 480 m (1,575 ft) thick (Sharp and Gibbons, 1964).

As discussed in Section 3.4.1, the applicant has identified a series of sand layers in the upper portion of Wasatch Formation present in the project area and have labeled these layers from the shallowest to the deepest as the H, G, F, C, B, A, and 1 Sands. The sands are considered aquifers in the project area. The intervening shales that separate these sands have been identified as aquitards and have been identified by the overlying and underlying sands. For example the shale separating the H and G Sands has been labeled the HG Aquitard (see Section 3.5.3 of this EA). A schematic of the typical aquifer and aquitard sequence in the project area is shown in Figure 3-6. While generally present throughout the project area, the nature and extent of these sands differ somewhat across the project area from the Nichols Ranch Unit to the Hank Unit. In addition, depth and expression of these sands at the ground surface is influenced by

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the topographical relief of the project area. The production aquifer at the Nichols Ranch Unit is the A Sand, while the production aquifer at the Hank Unit is the F Sand. The nature and extent of the specific sands and aquitards identified in the project area is discussed further in Section 3.4.1 of this EA.

The depth at which groundwater is first encountered across the site varies and depends on surface topography. The specific sand that acts as the surficial aquifer similarly varies across the project area depending on the outcropping of these sands and the surface topography. Limited groundwater level data is available to define depth to shallow groundwater across the Nichols Ranch Unit area, and additional wells are planned to better define shallow groundwater levels in this area. However, based on available data and extrapolation of sand units across the site, the applicant has depicted the depth to shallow groundwater and the sand layer acting as the surficial aquifer in the Nichols Ranch Unit area on Figure 2-21a of the TR. In the southern portion of the Nichols Ranch Unit area, shallow groundwater is first encountered in the Cottonwood alluvium and has been shown to within 3 m (10 ft) of the ground surface. Moving north from the Cottonwood alluvium, shallow groundwater is first encountered in the F aquifer at depths ranging from 15 to 30 m (50 to 100 ft). However, in the northernmost portion of the Nichols Ranch Unit area, the G sand is likely to be the shallow aquifer, with depth to groundwater ranging between 30 to 60 m (100 and 200 ft). Groundwater flow in the F and G Sands is projected to be in a westerly direction.

Depth to shallow groundwater at the Hank Unit Area is similarly uncertain, and the installation of additional wells are planned to identify shallow water levels in the Hank Unit area. However, the applicant has indicated that the H Sand should be the surficial aquifer in this area, with depth to groundwater ranging between 15 m (50 ft) in the low lying areas to the west of the Hank Unit area to 61 m (200 ft) along the eastern border of the Hank Unit area (Figure 2-21b of the TR). Groundwater flow in the H Sand at the Hank Unit is expected to flow in a westerly direction. The Willow and Dry Willow Creek alluvial materials in the Hank Unit area are not expected to contain water except during short periods of time after runoff events.

Groundwater in the surficial aquifers is likely unconfined, although there maybe portions of these aquifers that are locally confined. Those sands that underlie the surficial aquifer, particularly at that depth, are generally confined.

3.5.3.1 Uranium Bearing Aquifer

The principle uranium bearing aquifer at the Nichols Ranch Unit is the A Sand (Figure 3-6). As indicated in Section 3.4.1, the A Sand is 18 to 30 m (60 to 100 ft) thick and is located 91 m to 213 m (300 to 700 ft) below the surface at the Nichols Ranch Unit. The A Sand is thickest to the northeast and thins to the southwest and is fine to coarse grained. Groundwater in the A Sand is confined. The A Sand is underlain by the A1 Aquitard and the 1 Sand. The 1 Sand has been identified as the aquifer production aquifer. The A1 Aquitard is comprised of mudstones and carbonaceous shale with occasional thin lenses of poorly developed coal. This unit ranges in thickness from 6 to 11 m (20 to 35 ft). The underlying 1 Sand is variable in thickness, ranging from 3 to 26 m (10 to 85 ft) in thickness, and occurs at depths of 171 to 216 m (560 to 710 ft) bgs. The sand is very fine to coarse grained.

The A Sand is overlain by the BA Aquitard and the B Sand. The B Sand has been identified as the aquifer overlying the production aquifer. The BA aquitard varies from 7.6 to 27 m (25 to 90 ft) in this area, thickening to the northwest and thinning to the southeast. This unit consists of mudstones and thin discontinuous light gray siltstones. The BA Aquitard has been shown to extend across the site from the Nichols Ranch Unit to the Hank Unit, where it is 24 m (80 ft) thick and is composed mainly of mudstones. The B Sand ranges in thickness from 30 to 183 m (100 to 600 ft) at the Nichols Ranch Unit. This unit is fine to coarse grained. The body of the B sand is occasionally separated by lenses of mudstone, siltstone, and carbonaceous shale. Some of these mudstone splits exceed 8 m (25 ft) in thickness and may extend for thousands of feet. The B Sand is very extensive and has been correlated across the gap between the Nichols Ranch and Hank Units.

The principle uranium ore zone sand member at the Hank Unit is the F Sand, which is approximately 23 m (75 ft) thick and 61 to 183 m (200 to 600 ft) bgs in this portion of the project area. Groundwater is unconfined in the F Sand at the Hank Unit. The F Sand is underlain by the FC Aquitard and the C Sand. The C Sand has been designated the aquifer underlying the production zone in areas where it is present. The C Sand at the Hank Unit is 1.5 to 6.1 m (5 to 20 ft) thick, discontinuous, and is composed of fine and very fine grained sand. The C sand is not always present below the F Sand at the Hank Unit. At these locations the B Sand is the sand unit underlying the production sand. The FC aquitard is composed of mudstones, siltstones, gray carbonaceous shales, and poorly developed coal. The aquitard ranges in thickness from 14 to 24 m (45 to 110 ft), depending on the presence of the C Sand. Where the C Sand is not present, it merges with the CB aquitard overlying the B Sand.

Water levels have been measured in wells installed in the project area to define the direction and gradient of groundwater movement. The location of wells installed at the Nichols Ranch and Hank Unit are shown in Figures 3-7 and 3-8, respectively. While wells have been installed in many of the identified sand aquifers, these wells have been concentrated in the production zones at the Nichols Ranch and Hank Units. Based on these water level measurements, a potentiometric map has been presented for the A Sand at the Nichols Ranch Unit (Figure 2-19 of the TR). This potentiometric map indicates that groundwater in the A Sand is flowing to the northwest with an average gradient of 0.0033. Based on this gradient, and effective porosity of 0.05, and an average hydraulic conductivity of 0.15 m/day (0.5 ft/day), the average rate of groundwater flow is estimated to be 0.01 m/day (0.033 ft/day). A similar potentiometric map has been presented for the F Sand across both the Nichols Ranch and Hank units (Figure 2-20 of the TR). This map indicates that water in the F Sand is flowing west with an average gradient of 0.005. Based on this gradient, an effective porosity of 0.005, and an average hydraulic conductivity of 0.18 m/day (0.6 ft/day), the average rate of groundwater flow in the F aquifer across the project area is estimated to be 0.018 m/day (0.06 ft/day). Similar gradients and flow directions have been observed in the B and C Sand aquifers as in the A and F Sand aquifers. The shallow sands in the Hank Unit Area are more likely to be affected by local topographical changes than the deeper sands. Water level data for the G Sand in the Hank area show a much steeper groundwater gradient.

INSERT FIGURE 3-7

INSERT FIGURE 3-8

3.5.3.1.1 Hydrogeologic Characteristics

The hydraulic properties of the production aquifers as well as the associated underlying and overlying aquifers have been evaluated in the project area using both multi-well pumping tests and single tests. Aquifer testing was previously conducted between 1978 and 1979 by Cleveland-Cliffs and Uranerz. In preparation for the current application, additional aquifer testing was conducted by Uranerz in 2006 and 2007. A summary of the aquifer properties estimated for the Nichols Ranch Unit using the results of these aquifer tests is presented in Table 2-12 of the TR. The hydraulic conductivity of the A Sand at the Nichols Ranch Units was found to vary from 0.55 to slightly more than 21.3 cm/day (0.018 to slightly greater than 0.7 ft/day). A value of 15.2 cm/day (0.5 ft/day) was thought by the applicant to best represent the A Sand. A single-well test for the B Sand aquifer indicated that the hydraulic conductivity of 11.3 cm/day (0.37 ft/day) for this sand. Two single-well tests for the 1 Sand resulted in hydraulic conductivities of 5.5 and 7.9 cm/day (0.18 and 0.26 ft/day) for this sand. A single-well test in the F sand yielded a higher hydraulic conductivity of 110 cm/day (3.6 ft/day).

A summary of the aquifer properties estimated for the Hank Unit using the results of the multi-well pumping test and single-well tests in this area is presented in Table 2-13 of the TR. The hydraulic properties of the F Sand at the Hank Unit were found to vary greatly. The hydraulic conductivities of this unit were found to vary from a low of 4.3 cm/day to a high of 287 cm/day (0.14 to 9.4 ft/day). A hydraulic conductivity of 18.3 cm/day (0.6 ft/day) is thought by the applicant to best represent the majority of the F sand. The water-level in the ore zone at the Hank unit is near the top of the sand and therefore the F Sand is not fully saturated. Accordingly, the F Sand aquifer is an unconfined aquifer. The primary storage property for an unconfined aquifer is specific yield. The applicant has estimated that a specific yield of 0.05 best represents the F Sand in this area. Test results from two G Sand wells yielded hydraulic conductivity measurements for this sand of 0.15 and 0.67 cm/day (0.005 and 0.022 ft/day). A single measurement in the C Sand indicated a hydraulic conductivity value of 0.76 cm/day (0.025 ft/day). Two single well tests in the B Sand yielded hydraulic conductivity measurements of 11.6 and 67.1 cm/day (0.38 and 2.2 ft/day).

3.5.3.1.2 Level of Confinement

Vertical permeabilities of the aquitards in the Powder River Basin have been defined at numerous locations, including just north of the Hank Unit during the permitting of the PRI North Butte. These permeabilities have been measured using multi-well pumping tests and a variety of analytical methods. These permeabilities have also been determined using laboratory measurements. The applicant reports that data and analysis presented in the PRI North Butte application indicated that the vertical permeability for the aquitard separating the F and C sands was 0.004 cm/day (1.1×10^{-4} ft/day). A second multi-well test at the North Butte site indicated that the aquitard permeability between the A Sand and the 1 Sand was 0.004 cm/day (1.2×10^{-4} ft/day). Laboratory measurements of permeabilities of samples from two aquitards were submitted for the North Butte site. These permeabilities varied from 54.9 to 0.001 cm/day (1.8 ft/day to 3.7×10^{-5} ft/day). These data were considered sufficient to demonstrate the confinement of the uranium-bearing sands at the project area. Aquifer confinement would be further verified at each of the wellfields during the required wellfield multi-well pumping tests. These data would be submitted as part of the Wellfield data packages and would be reviewed and approved by the NRC before each wellfield would begin operation.

3.5.3.1.3 Groundwater Quality

Groundwater quality at the project area has been defined by sampling numerous wells in many of the aquifers indentified in the area. The resulting groundwater quality data has been summarized in Table 2-14 of the TR. The data in this summary has been grouped for the A Sand, the F Sand, the B and C Sands, the G and H Sands, and the 1 Sand. These data indicate that the A Sand water typically has very low TDS (less than 500 mg/L), with major components being sodium, sulfate, and bicarbonate. Uranium concentrations in A Sand groundwater varied between detection and 0.027 mg/L. Radium-226 concentrations varied between detection and 36.3 picocuries (pCi) per liter. These concentrations are low for a ore-bearing aquifer, but are the result of the A Sand well screens extending over the entire sand and not limited to the ore zone.

Groundwater quality data for the F Sand indicated that average TDS concentrations were greater than 1,000 mg/L. Sodium, calcium, bicarbonate, and sulfate are the major dissolved constituents in this water. Uranium concentrations as high as 5.25 mg/L were measured in this ore bearing sand. Radium concentrations as high as 562 pCi/L were also measured.

Water quality for the B and C Sands were grouped together by the applicant. This sands lie between the two production zones and are connected in some areas. TDS in these aquifers are typically above 600 mg/L with the major constituents being sodium, bicarbonate, and sulfate. Uranium concentrations in these aquifers were generally low, averaging 0.059 mg/L but with a maximum of 2.16 mg/L. Radium concentrations in the B and C aquifers average 1.71 pCi/L. with a maximum measured concentration of 9 pCi/L. Groundwater quality data from the G and H Sands indicates that TDS averaged 427.8 mg/L. Average uranium and radium concentrations in these aquifers were 0.004 mg/L and 0.044 pCi/L, respectively.

3.5.3.1.4 Current Groundwater Uses

The applicant has contacted the WSEO to identify all permitted wells within the project unit area and within a 4.8-km (3-mi) radius of each unit. Numerous wells have been identified in these surveys, including wells associated with mining and aquifer monitoring, stock watering wells, and domestic wells. The survey indicates that excluding the monitoring and mining related wells, most wells are used for livestock watering through the use of windmills or electric well pumps. The depth of these wells generally ranges between 30 and 305 m (100 and 1,000 ft). A number of the identified wells are noted to have sufficient hydraulic heads to allow the wells to discharge to the surface without pumping (flowing wells). A limited number of domestic wells have also been identified.

All the permitted wells identified within the Nichols Ranch Unit and within a three-mile radius of the unit are presented in Tables D6G.1-1 and D6G.1-2 of the TR, respectively. All of the permitted wells identified within the Hank Unit and within a three-mile radius are presented in Tables D6G.2-1 and D6G.2-2 of the TR, respectively. The survey has identified nine existing wells within the Nichols Ranch Unit excluding aquifer testing or monitoring wells. All of these wells are used for stock watering. The review of these wells conducted by the applicant indicates that several of these wells are completed in the ore-bearing sands and would need to be abandoned or converted to monitoring wells. The applicant indicates that arrangements have been made to address these impacts with the owners of these wells through confidential agreements.

Six permitted wells were identified within 0.8 km (0.5 mi) of the Hank Unit area. All of these are used for stock watering. Several of these wells appear to be completed in the F Sand, while other wells are screened through multiple sands including the C, B, and A Sands. Several of these wells would need to be abandoned or converted to monitoring wells. The applicant indicates that arrangements have also been made to address these impacts with the owners of these wells through confidential agreements. A domestic well was identified 1 km (0.6 mi) north of the northern boundary of the Hank Unit. This well is reported to be completed in the B Sand below the production zone (F Sand) at the Hank Unit.

Excluding mining and monitoring wells, more than forty-five wells have been identified within a 4.8-km (3-mi) radius of both the Nichols Ranch Unit and the Hank Unit. Most of these wells have been identified as stock watering wells, although several domestic wells have been identified within three miles of the proposed mining units.

3.5.3.2 Surrounding Aquifers

As indicated in the GEIS (Section 3.3.4.3.4), the Wasatch Formation and the Fort Union Formation are important aquifers for water supplies on a regional scale. The Fox Hill Sandstone is one of the most continuous water-yielding formations in the Northern Great Plans 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.

Based on the survey of water wells within a 4.8-km (3-mi) radius of the site, water supply wells are generally completed within a 305 m (1,000 ft) of the ground surface in the sands of the Wasatch Formation. The Fort Union Formation is not extensively used because sufficient yields of groundwater are available from the overlying Wasatch.

4.5.2 Groundwater Impacts

Potential environmental impacts to groundwater resources in the Nichol Ranch ISR Project can occur during each phase of the ISR facility's lifecycle. ISR activities can impact aquifers at varying depths (separated by aquitards) above and below the uranium-bearing aquifer as well as adjacent surrounding aquifers in the vicinity of the uranium-bearing aquifer. Surface activities that can introduce contaminants into soils are more likely to impact shallow (near-surface) aquifers while ISR operations and aquifer restoration are more likely to impact the deeper uranium-bearing aquifer, any aquifers above and below, and adjacent surrounding aquifers.

ISR facility impacts to groundwater resources can occur from surface spills and leaks, consumptive water use, horizontal and vertical excursions of leaching solutions from production aquifers, degradation of water quality from changes in the production aquifer's chemistry, and waste management practices involving land application, evaporation ponds, or deep well injection. Detailed discussion of the potential impacts to groundwater resources from construction, operations, aquifer restoration, and decommissioning are provided in the following sections.

According to the CEQ, the significance of impacts is determined by examining both context and intensity (40 CFR 1508.27). Context is related to the affected region, the affected interests, and the locality, while intensity refers to the severity of the impact, which is based on a number of considerations. In describing the significance of potential impacts in this EA, the following significance levels for groundwater impacts have been identified:

SMALL: Impacts (chemical, radiological, and/or hydraulic) on groundwater would not be detectable or so minor as not to alter groundwater quality or water levels in any meaningful way.

MODERATE: Impacts (chemical, radiological, and/or hydraulic) would be detectable but would not adversely impact the current or potential future uses of groundwater in the area.

LARGE: Chemical, radiological, and/or hydraulic impacts would be readily detectable and would result in potentially significant adverse impacts on the current or potential future uses of groundwater in the area.

4.5.3.1 Alternative A (No-Action)

The No-Action Alternative would result in no construction or operational activities on site that might impact shallow groundwater. This alternative also would not require the injection of lixiviant into the production aquifer or the consumptive use of groundwater. The disposal of waste liquids and solids would no longer be necessary and therefore would pose no threat to groundwater quality. Consequently, Alternative A would result in no impacts to groundwater.

4.5.3.2 Alternative B (Proposed Action)

4.5.3.2.1 Construction Impacts to Groundwater

As indicated in the GEIS (Section 4.3.4.2.1; NRC, 2009a), during construction of ISR facilities, the potential for groundwater impacts is primarily from consumptive groundwater use, introduction of drilling fluids and muds from well drilling, and spills of fuels and lubricants from construction equipment.

Groundwater use during construction is limited to routine activities such as dust suppression, mixing cements, and drilling support. The amounts of groundwater used in these activities are small relative to available water and potentially could have a SMALL adverse and temporary impact to groundwater supplies within the Nichols Ranch ISR Project. Groundwater quality of near-surface aquifers during construction would be protected by BMPs such as implementation of a spill prevention and cleanup plan to minimize soil contamination. Additionally, the amount of drilling fluids and muds introduced into aquifers during well construction would be limited and have a SMALL adverse impact to the water quality of those aquifers. Thus, construction impacts to groundwater resources would be SMALL based on the limited nature of construction activities and implementation of management practices to protect shallow groundwater.

4.5.3.2.2 Operation Impacts to Groundwater

As indicated in Section 4.3.4.2.2 of the GEIS, during ISR operations, potential environmental impacts to shallow (near-surface) aquifers are related to leaks of lixiviant from pipelines, wells, or header houses and to waste management practices such as the use of evaporation ponds and disposal of treated wastewater by land application. In Alternative B, deep well injection is proposed as the liquid waste disposal method; therefore, impacts associated with this action should be minimal. Potential environmental impacts to groundwater resources in the production and surrounding aquifers also include consumptive water use and changes to water quality. Water quality changes would result from normal operations in the production aquifer and from possible horizontal and vertical lixiviant excursions beyond the production zone. Disposal of processing wastes by deep well injection during ISR operations also can potentially impact groundwater resources (NRC, 2009a).

4.5.3.2.2.1 Operation Impacts to Shallow (Near-Surface) Aquifers

The GEIS (Section 4.3.4.2.2.1; NRC, 2009a) discusses the potential impacts to shallow aquifers during ISR operations. A network of buried pipelines is used during ISR operations for transporting lixiviant between the pump house and the satellite or main processing facility and also to connect injection and extraction wells to manifolds inside the pumping header houses. The failure of pipeline fittings or valves, or failures of well mechanical integrity in shallow aquifers could result in leaks and spills of pregnant and barren lixiviant which could impact water quality in shallow aquifers. The potential environmental impact of such pipeline, valve, well integrity failure, or pond leakage depends on a number of factors, including the depth to shallow groundwater, the use of shallow groundwater, and the degree of hydraulic connection of shallow aquifers to regionally important aquifers. As indicated in the GEIS, potential environment impacts could be MODERATE to LARGE if 1) the groundwater in shallow aquifers is close to the ground surface, 2) the shallow aquifers are important sources for local domestic or agricultural water supplies, or 3) shallow aquifers are hydraulically connected to other locally or regionally important aquifers.

As previously discussed in Section 3.4.1 and 3.5.3, the Wasatch Formation outcrops in the project area and is characterized by a series of sand layers separated by mudstones and siltstones. The more permeable sand layers serve as aquifers in this area. The applicant has identified a series of sand layers in the upper portion of Wasatch Formation present in the project area and have labeled these layers from the shallowest to the deepest as the H, G, F, C, B, A, and 1 Sands. While generally present throughout the project area, the nature and extent of these sands differ somewhat across the project area from the Nichols Ranch Unit to the Hank Unit. In addition, depth and expression of these sands at the ground surface is influenced by the topographical relief of the project area.

The depth at which groundwater is first encountered across the site varies and depends on surface topography. The specific sand that acts as the surficial aquifer similarly varies across the project area depending on the outcropping of these sands and the surface topography. Limited groundwater level data is available to define depth to shallow groundwater across the Nichols Ranch Unit area, and additional wells are planned to better define shallow groundwater levels in this area. However, based on available data and extrapolation of sand units across the site, the applicant has estimated the depth to shallow groundwater and the sand layer acting as the surficial aquifer across the Nichols Ranch Unit area. In the southern portion of the Nichols Unit area, shallow groundwater is first encountered in the Cottonwood alluvium and has been shown to within 3 m (10 ft) of the ground surface. Moving north from the Cottonwood alluvium, shallow groundwater is first encountered in the F aquifer at depths ranging from 15 to 30 m (50 to 100 ft). However, in the northernmost portion of the Nichols Ranch Unit area, the G sand is likely to be the shallow aquifer, with depth to groundwater ranging between 30 to 60 m (100 to 200 ft). Groundwater flow in the F and G Sands is projected to be in a westerly direction.

Thus, the depth to shallow groundwater in the southern portion of the Nichols Ranch Unit is limited. Data indicate that the depth to groundwater in the general area of the proposed processing plant is only 15 m (50 ft) and portions of the projected production zone extend to the area adjacent to the Cottonwood Creek alluvium, where groundwater may be as shallow as 3 m (10 ft). This limited unsaturated zone offers a limited buffer to absorbed and attenuate any releases at the ground surface. Moreover, shallow groundwater likely flows to Cottonwood Creek alluvium, and if left unchecked, shallow groundwater contamination could migrate into and along this alluvial material to the west. The groundwater quality data for the F Sand indicate that groundwater in this unit has relatively high TDS, but appears suitable for stock watering in many areas. The well survey provided by the applicant indicates that there are a number of stock watering well within a half-mile radius of the project area. While it is uncertain how many of these wells are screened in the shallow aquifer, some of these wells may be potentially impacted by releases at the ground surface that migrate downgradient to the west. Thus, potential environmental impact to shallow groundwater during operation at the Nichols Ranch Unit appears to be MODERATE to LARGE.

Depth to shallow groundwater at the Hank Unit Area is similarly uncertain, and the installation of additional wells are planned to identify shallow water levels in the Hank Unit area. However, the applicant has indicated that the H Sand should be the surficial aquifer in this area, with depth to groundwater ranging between 15m (50 ft) in the low lying areas to the west of the Hank Unit area to 61 m (200 ft) along the eastern border of the Hank Unit area. Groundwater flow in the H Sand at the Hank Unit is expected to flow in a westerly direction. The Willow and Dry Willow Creek alluvial materials in the Hank Unit area are not expected to contain water except during short periods of time after runoff events.

Thus, the depth to shallow groundwater appears somewhat greater at the Hank Unit than the Nichols Ranch Unit. There is generally a 30 m (100 ft) or more separation from the ground surface to shallow water beneath most of the production zone and planned processing facility. However, the southern portion of the ore body extends into an area where shallow water is projected to be within 15 m (50 ft) of the surface. Water quality data from the H sand indicates that the groundwater quality in this unit is relatively good and suitable for multiple purposes. The well survey provided by the applicant indicates that there are a number of stock watering wells within a half-mile radius of the project area. It is uncertain how many of these wells are screened in the shallow aquifer. However, the H Sand lies over the shallow F Sand which is the production zone in the Hank Unit. Those wells in close vicinity to the site that are screened in the H Sand are also likely screened in the F Sand as well. The applicant has indicated that wells screened across the F Sand in the vicinity of the Hank will be abandoned. Thus, wells using shallow groundwater from the H Sand will likely be abandoned and will not be directly impacted by releases at the surface. Regardless, due to the shallow depth to groundwater in the southern portion of the Hank Unit area and relatively good groundwater quality in the shallow aquifer, the potential impact to shallow groundwater at the Hank Unit appears to be MODERATE.

As indicated by the GEIS, any potential impact of releases at or near the ground surface on shallow groundwater can be greatly reduced by leak detection programs required by the NRC. The applicant plans an aggressive leak detection and spill cleanup program. In addition, preventative measures such as well mechanical integrity testing would limit the likelihood of well integrity failure during operations.

4.5.3.2.2.2 Operation Impacts to Production and Surrounding Aquifers

The potential environmental impacts to groundwater supplies in the production and other surrounding aquifers are related to consumptive water use and groundwater quality.

Water Consumptive Use: As discussed in the GEIS (Section 4.2.4.2.2.2), groundwater is withdrawn and reinjected into the production zone during ISR operations. Most of the water withdrawn from the aquifer is returned to the aquifer. The portion that is not returned to the aquifer is referred to as consumptive use. The consumptive use is due primarily to production bleed and also includes other smaller losses. The production bleed is the net withdrawal maintained to ensure groundwater gradients toward the production network. This net withdrawal ensures there is an inflow of groundwater into the well field to minimize the potential movement of lixiviant and its associated contaminants out of the well field.

Consumptive water use during ISR operations could impact a local water user who use water from the production aquifer is outside the exempted zone. This potential impact would result from lowering the water levels in nearby wells and reducing the yield of these wells. In addition, if the production zone is hydraulically connected to other aquifers above and/or below the water zone, consumptive use may impact the water levels in these overlying and underlying aquifers and reduce the yield in any nearby wells withdrawing water from these aquifers.

The applicant has provided predictions drawdowns created by production bleed during mine operation (Addendum 7A of the TR, Uranerz, 2008b). These predictions are based on a simple analytical model and relied on aquifer properties determined during aquifer testing or assumed based on local conditions. Based on an assumed production rate of 13,250 Lpm (3,500 gpm) and a 1 percent bleed rate, a groundwater withdrawal rate of 133 Lpm (35 gpm) was used to predict drawdowns at the Nichols Ranch Unit. The drawdowns resulting from at this pumping rate were predicting using the aquifer properties of 4,350 L/day/m (350 gal/day/ft) for transmissivity and a storage coefficient of 1.8×10^{-4}. Simulations were conducted to evaluate the drawdowns resulting from concentrated drawdowns distributed at various locations in the projected wellfields. These predictions show that 9 m (30 ft) of the drawdown will extend 2,134 m (7,000 ft) outward from the center of the wellfields. The 1.5 m (5 ft) contour is projected to extend out 6,858 m (22,500 ft) or approximately 6.4 km (4 mi) from the Nichols Ranch ISR Project area.

The applicant has indicated that the primary effect of the drawdowns caused by the Nichols Ranch bleed should be limited to those wells that are located in the ore zone (A Sand) Unit (May 8, 2009 Response to Environmental RAIs, LU-1 ER Section 3.1.2). This conclusion based on the assumption that the A Sand is well-confined and there would be little leakage from the underlying or overlying sands into the A Sand. The applicant has further indicated that the predicted drawdowns should not greatly impact production from pumping wells since, in the confined A Sand, there is a large amount of potential drawdown available. The applicant has indicated that flowing wells in the area may cease flowing due to the predicted drawdowns. The applicant has indicated that flowing wells within the 3 m (10 ft) drawdown contour may be impacted. A pump may have to be installed in a flowing well if the drawdowns cause it to cease flowing. The applicant has identified a total of 10 wells within an 8 km (5 mi) radius that are flowing wells and screened within the A Sand. While the applicant has limited the impact to those wells screened in the A Sand, there may be some leakage from the overlying and/or underlying aquifers. Such leakage may occur in areas where the intervening aquitards are not extensive or where they are compromised by wells screened over multiple aquifers or inadequately sealed wells or boreholes are present. The result of such leakage across confining beds would be drawdowns in these adjacent beds.

Thus, the potential short-term impact due to consumptive use at the Nichols Ranch Unit is LARGE. After production and restoration are complete and groundwater withdrawals are terminated at the Nichols Ranch Unit, groundwater levels will tend to recover with time. However, the recharge in this area is limited and recovery may be slow. Thus, the potential long-term (approximately 10 years) environmental impact from consumptive use during the operational phase at Nichols Ranch Unit remains MODERATE to LARGE.

The applicant has similarly provided predictions drawdowns created by production bleed in the F Sand at the Hank Unit. Based on an assumed production rate of 9,470 Lpm (2,500 gpm) and a 3 percent bleed rate, a groundwater withdrawal rate of 284 Lpm (75 gpm) was used to predict drawdowns at the Hank Unit. The drawdowns resulting from this pumping rate were predicted using the aquifer properties of 400 gal/day/ft for transmissivity and a storage value of 0.05 for the unconfined F Sand. Simulations were conducted by assuming 284 Lpm (75 gpm) distributed over 6 locations in the northern well field for 1.5 years followed by a second set of six withdrawals in the southern wellfield for the remaining 1.5 years. The predictions indicate that drawdowns of 3 m (10 ft) will extend out only to area immediately adjacent to the southern wellfield, while the drawdowns of 1.5 m (5 ft) will extent out approximately 274 m (900 ft) from the well field. The reduced drawdowns observed in the F Sand at the Hank unit are due to the unconfined nature of the aquifer. No flowing wells have been identified in the F Sand in this area. In addition, any wells screened in the F Sand in the area immediately adjacent to the Hank unit area will need to be abandoned due to their close proximity to the production zone. Thus, the potential environmental impact due to consumptive use of groundwater at the Hank Unit is likely to be SMALL.

Excursions and Groundwater Quality: As discussed in the GEIS, groundwater quality in the production zone is degraded as part of ISR operations. The portion of the production aquifer used for production must be exempted as an underground source of drinking water though the Wyoming UIC program. After production is completed, the licensee is required to initiate aquifer restoration activities to restore the production zone to baseline or pre-operational class-of-use conditions, if possible. If the aquifer cannot be returned to preoperational conditions, NRC requires that the production aquifer be returned to the maximum contaminant levels (MCLs) provided in Table 5C of 10 CFR 40 Appendix A or to Alternate Concentrations Limits (ACL) approved by NRC. For these reasons, potential impacts to the water quality of the uranium-bearing production zone aquifer as a result of ISR operations would generally be expected to be SMALL and temporary.

To prevent horizontal excursions, inward hydraulic gradients are expected to be maintained in the production aquifer during ISR operations. These inward hydraulic gradients are created by the net groundwater withdrawals (production bleeds) maintained through continued pumping during ISR operations. Groundwater flows in response to these inward hydraulic gradients, thus ensuring that groundwater flow is toward the production zone. This inward groundwater flow toward the extraction wells prevents horizontal excursions of leaching solutions away from the production zone.

The NRC also requires the licensee to take preventive measures to reduce the likelihood and consequences of potential excursions. A ring of monitoring wells within and encircling the production zone is required for early detection of horizontal excursions. If excursions are detected, corrective actions are required outside of the exempted portion of the production aquifer.

Vertical excursions may also potentially occur into aquifers overlying or underlying the production zone aquifer. As analysis presented in the GEIS indicates, the potential for migration of leaching solution into an overlying or underlying aquifer is small if the thickness of the aquitard separating the production zone from the overlying and underlying is sufficient and the permeability of the aquitard is low. Hydraulic gradient between the production zone and overlying or underlying aquifers also help to determine the potential for vertical excursions. Vertical excursions can also occur due to improperly sealed boreholes, to poorly completed wells, or to a loss of mechanical integrity of ISL injection and extraction wells. To ensure the detection of vertical excursions, the NRC also requires monitoring in the overlying and underlying aquifers. A program of mechanical integrity testing of all ISL well is also required. Corrective action is required if any vertical excursions are detected.

The hydrogeologic conditions found in the A Sand at the Nichols Ranch Unit are generally similarly to those found at other successful ISR facilities. Groundwater in the A Sand is confined and there is sufficient hydraulic conductivity to allow ISR mining. The drawdown created by pumping in the production zone should facilitate containment of the lixiviant in the mining zone and allow the recovery of any horizontal or vertical excursions, should they occur. The overlying BA Aquitard and underlying A1 Aquitard appear thick and extensive and should confine the lixiviant to the A Sand. Pumping tests conducted to date indicate no potential hydraulic connection between the A Sand and the overlying or underlying sands. Each mine unit will undergo further extensive testing during the Mine Unit Test required before initiating solution mine in each mine unit. The results of this further testing will be provided in the Mine Unit Data Packages, which will be reviewed and approved by the NRC. Therefore, the potential environmental impact to groundwater quality is SMALL at the Nichols Ranch Unit.

The occurrence of an unconfined aquifer in the production zone at the Hank Unit presents special considerations when evaluating the maintenance of the necessary inward hydraulic gradient, the reliability of monitoring around the periphery of the well field, and the capability of the pulling back any potential horizontal excursion. These issues result primarily from the limited drawdown that occurs in an unconfined aquifer. Aquifer testing involving multiple wells distributed throughout the production zone is generally necessary to verify that hydraulic control of the production zone can be maintained with the planned production bleed. These tests must also demonstrate that hydraulic control reaches out to the proposed monitoring ring and that sufficient drawdown is available to pull back any horizontal or vertical excursion that might occur. The unsaturated conditions overlying the ore-bearing deposits also present special concerns. Normally, the production zone in an ISR project remains fully saturated and under pressure. However, in unconfined conditions such as those found at the Hank Unit, there is the potential that the oxidants injected into the production zone may volatilize and create a vapor lock. These issues are still being evaluated as part of the concurrent safety review and are the subject of ongoing discussions with the applicant. Pending the resolution of these issues, potential environmental impact due to changes in water quality and potential horizontal or vertical excursions at the Hank Unit cannot be evaluated.

4.5.3.2.2.3 Operation Impacts to Deep Aquifers Below the Production Aquifers

Potential environmental impacts to confined deep aquifers below the production aquifers could be due to deep well injection of processing wastes into deep aquifers. Under different environmental laws such as the Clean Water Act, the SDWA, and the Clean Air Act, EPA has statutory authority to regulate activities that may affect the environment. Underground injection of fluid requires a permit from EPA or from an authorized state UIC program. The WDEQ has been authorized to administer the UIC program in Wyoming and is responsible for issuing any permits for deep well disposal at the Nichols Ranch site.

The GEIS also indicates that the potential environmental impact of injection of leaching solution into deep aquifers below ore-bearing aquifers would be expected to be SMALL, if water production from deep aquifers is not economically feasible or the groundwater quality from these aquifers is not suitable for domestic or agricultural uses (e.g., high salinity), and they are confined above by sufficiently thick and continuous low permeability layers.

The GEIS (Section 4.3.4.2.2.3) indicates that in the Wyoming East Uranium Milling Region, where the Nichols Ranch ISR Project is located, the Paleozoic aquifers are hydraulically separated from the aquifer sequence that includes, from the shallowest to the deepest, the Wasatch Formation, the Fort Union Formation, the Lance Formation, and the Fox Hills Formation by thick low permeability confining layers that include the Pierre Shale, the Lewis Shale, and the Steele Shale (Whitehead, 1996). Hence, nonkarstic Paleozoic aquifers (e.g., Tensleep Sandstone) can be investigated further for suitability of disposal of leaching solutions. The GEIS has concluded that in the Wyoming West Uranium Milling Region, considering the relatively low water quality in and the reduced water yields from nonkarstic Paleozoic Aquifers and the presence of thick and regionally continuous aquitards confining them from above, the potential environmental impacts due to deep injection of leaching solution into nonkarstic Paleozoic aquifers could be small. The Pierre Shale was reported be be fracture in some places at the regional scale (Whitehead, 1996). Considering potential heterogeneities in the hydrogeologic properties of the Pierre Shale, the potential impacts could be SMALL to MODERATE where the Pierre Shale might be locally fractured.

Nichols Ranch plans to dispose of waste fluids using deep well injection and is seeking a permit for a Class 1 injection well from the WDEQ. The WDEQ will evaluate the suitability of the proposed deep injection wells. The WDEQ will only grant such a permit if the waste fluids can be suitably isolated in a deep aquifer. Consequently, it is assumed that the potential environmental impact to deep aquifers below the production aquifers of deep well injection of waste will be SMALL.

4.5.3.2.3 Aquifer Restoration Impacts to Groundwater

As indicated in GEIS (Section 4.2.4.2.3), the potential environmental impacts to groundwater resources during aquifer restoration are related to groundwater consumptive use and waste management practices, including discharge of wastes storage ponds, and potential deep disposal of brine slurries resulting from reverse osmosis. In addition, aquifer restoration directly affects groundwater quality in the vicinity of the wellfield being restored.

Nichols Ranch is planning three phases of restoration: groundwater sweep, groundwater transfer, and groundwater treatment. The sequence of the restoration methods used will be determined based on operating conditions. Depending on the progress of restoration, it is possible that not all phases of restoration will be utilized. A reductant may be added anytime to the fluids circulated during restoration to lower the oxidation potential of the production zone. During groundwater sweep, water is pumped from the mine unit, without re-injection, resulting in an influx of baseline quality water from the perimeter of the mine unit. This baseline quality water effectively sweeps the affected portion of the aquifer. During the groundwater transfer phase, water may be transferred between a production area beginning restoration and a production area beginning mining operations. Also a groundwater transfer may occur within the same production area, if one section of the production area is in a more advanced state of restoration than another. The direct transfer of water will act to lower the TDS in the production aquifer being restored by displacing affected groundwater with pre-mining baseline quality. This water can then be used in other restoration or production areas without withdrawing additional groundwater from the production aquifer. During the treatment phase water from the restoration zone is sent for treatment by ion exchange and reverse osmosis. After treatment the water can be reinjected into the restoration zone to continue flushing of the production zone.

Regardless of the process, hydraulic control of the former production zone must be maintained during restoration. This is accomplished by maintaining an inward hydraulic gradient through a production bleed (see Section 4.5.3.2.2.2). As discussed in the GEIS, the impacts of consumptive use during aquifer restoration are generally greater than during ISR operations. This is particularly true during the sweep phase when a greater amount of groundwater is generally withdrawn from the production aquifer. During the sweep phase groundwater is not reinjected into the production aquifer and all withdrawals should be considered consumptive.

As discussed in Section 4.5.3.2.2.2 of this EA, the applicant has presented predictions of drawdown during production at both the Nichols Ranch Unit and the Hank Unit. Based on an assumed production rate of 13,250 Lpm (3,500 gpm) and a 1 percent bleed rate, the applicant has provided predictions of drawdown at the Nichols Ranch Unit based on a bleed of 133 Lpm (35 gpm). Based on an assumed production rate of 9,470 Lpm (2,500 gpm) and a 3 percent bleed rate, the applicant has provided predictions of drawdown at the Hank Unit based on a bleed of 284 Lpm (75 gpm).

The applicant has indicated that restoration will be sequenced with production at the facility. Thus, initially only production will occur at each mine unit. However, as production moves from one wellfield to another, restoration and production will occur simultaneously. Eventually, after production is complete, only restoration will be undertaken. The applicant has indicated that restoration will consumed additional water, particularly during the groundwater sweep phase. Also, during restoration, approximately 20 to 25 percent of the groundwater treatment flow through the reverse osmosis unit is disposed of as brine that is sent to the deep well disposal. Based on liquid disposal rates predicted for the deep injection wells, net withdrawals may approach 379 Lpm (100 gpm) at both the Nichols Ranch and Hank Units during the combined production and restoration phase and during the restoration phase alone. The applicant has not, as yet, provided predictions of the drawdowns that such withdrawals would create or an evaluation of the impact of these drawdowns.

The analysis of the predictions of drawdown during production (see Section 4.5.3.2.2.2) has already indicated that at 133 Lpm (35 gpm), production withdrawals from the Nichols Ranch Unit will likely impact the groundwater levels in wells within a 8 km (5 mi) radius of the unit, particularly those wells screened within the A Sand and are flowing. The additional consumptive used of groundwater that will accompany aquifer restoration will only accentuate these impacts. Thus, the potential temporary environmental impact due to consumptive use during restoration at the Nichols Ranch Unit is LARGE. After production and restoration are complete and groundwater withdrawals are terminated at the Nichols Ranch Unit, groundwater levels will tend to recover with time. However, the recharge in this area is limited and recovery may be slow. Thus, the potential long-term environmental impact from consumptive use during the restoration phase at Nichols Ranch Unit remains LARGE.

The analysis of the predictions of drawdown during production (see Section 4.5.3.2.2.2) has indicated that at 284 Lpm (75 gpm), production withdrawals from the Hank Unit should result in limited, localized drawdowns. The limited drawdowns were due to the unconfined nature of the production aquifer (F-Sand) at the Hank Unit. The additional pumping amounts that may occur during restoration are not likely to increase these drawdowns significantly. Thus, the potential environmental impact due to consumptive use of groundwater during aquifer restoration at the Hank Unit is likely to be SMALL.

A network of buried pipelines is used during ISR restoration for transporting restoration fluids between the pump house and the satellite or main processing facility and also to connect injection and extraction wells to manifolds inside the pumping header houses. However, the fluids transported in these pipes during restoration are generally less potent than during production. The failure of pipeline fittings or valves, or failures of well mechanical integrity in shallow aquifers could result in leaks and spills of these fluids which could impact water quality in shallow aquifers. These potential impacts to shallow groundwater during production have previously been evaluated in Section 4.5.3.2.2.1. Although, the fluids transported in through the piping system during restoration are generally less potent than during production, the potential environmental impact to shallow groundwater during restoration is similar to that during production. Thus, the potential impact to shallow groundwater during restoration at the Nichols Ranch Unit appears to be MODERATE to LARGE. The potential impact to shallow groundwater during restoration at the Hank Unit appears to be MODERATE.

The disposal of waste fluids via deep well injection of waste is planned during mine restoration in much the same manner as during mine operation. As previously indicated in Section 4.5.3.2.2.3, it is assumed that the potential environmental impact to deep aquifers below the production aquifers of deep well injection of waste will be SMALL.

4.5.3.2.4 Decommissioning Impacts to Groundwater

The environmental impacts to groundwater during dismantling and decommissioning ISR facilities are primarily associated with consumptive use of groundwater, potential spills of fuels and lubricants, and well abandonment. The consumptive groundwater use could include water use for dust suppression, re-vegetation, and reclaiming disturbed areas. The potential environmental impacts during the decommissioning phase are expected to be similar to potential impacts during the construction phase. Groundwater consumptive use during the decommissioning activities would be less than groundwater consumptive use during ISR operation and groundwater restoration activities. Spills of fuels and lubricants during decommissioning activities could impact shallow aquifers. Implementation of BMPs during decommissioning can help to reduce the likelihood and magnitude of such spills and facilitate cleanup. Based on consideration of BMPs to minimize water use and spills, the potential environmental impacts to the groundwater resources in shallow aquifers from decommissioning would be expected to be SMALL.

After ISR operations are completed, improperly abandoned wells could impact aquifers above the production aquifer by providing hydrologic connections between aquifers. As part of the restoration and reclamation activities, all monitoring, injection, and production wells will be plugged and abandoned in accordance with the Wyoming UIC program requirements. The wells would be filled with cement and clay and then cut off below plough depth to ensure that groundwater does not flow through the abandoned wells (Stout and Stover, 1997). If this process is properly implemented and the abandoned wells are properly isolated from the flow domain, the potential environmental impacts would be expected to be SMALL (NRC, 2009a).

4.5.3.3 Alternative C (No Hank Unit)

Alternative C would include issuing Uranerz a license for the construction, operation, aquifer restoration, and decommissioning of facilities for ISR uranium milling and processing as proposed by Uranerz, but only for the Nichols Ranch Unit and not the Hank Unit. This would result in the same environmental impact as identified for the Nichols Ranch Unit for Alternative B (see Section 4.5.3.3), while removing those impacts identified for the Hank Unit.

4.5.3.3.1 Construction Impacts to Groundwater

As indicated during the evaluation of the potential environmental impacts at the Nichols Ranch Unit, the potential environmental impacts to groundwater resources during construction of the Nichols Unit would be SMALL based on the limited nature of construction activities and implementation of management practices to protect shallow groundwater.

4.5.3.3.2 Operation Impacts to Groundwater

During operation, the potential environmental impact to shallow groundwater at the Nichols Ranch Unit appears to be MODERATE to LARGE. Thus, the potential short-term environmental impact due to consumptive use during operation at the Nichols Ranch Unit is LARGE. After production and restoration are complete and groundwater withdrawals are terminated at the Nichols Ranch Unit, groundwater levels will tend to recover with time. However, the recharge in this area is limited and recovery may be slow. Thus, the potential long-term impact from consumptive use during the operational phase at Nichols Ranch Unit remains MODERATE to LARGE. The potential environmental impact to groundwater quality during operations is likely to SMALL at the Nichols Ranch Unit. During operations, the potential environmental impact to deep aquifers below the production aquifers of deep well injection of waste is assumed to be SMALL.

4.5.3.3.3 Aquifer Restoration Impacts to Groundwater

During aquifer restoration, the potential short-term environmental impact due to consumptive use during restoration at the Nichols Ranch Unit is LARGE. After production and restoration are complete and groundwater withdrawals are terminated at the Nichols Ranch Unit, groundwater levels will tend to recover with time. However, the recharge in this area is limited and recovery may be slow. Thus, the potential long-term environmental impact from consumptive use during the restoration phase at Nichols Ranch Unit remains MODERATE to LARGE. The potential impact to shallow groundwater during restoration at the Nichols Ranch Unit appears to be MODERATE to LARGE. During aquifer restoration, the potential environmental impact to deep aquifers below the production aquifers of deep well injection of waste will be SMALL.

4.5.3.3.4 Decommissioning Impacts to Groundwater

During decommissioning, the potential environmental impacts to the groundwater resources in shallow aquifers at the Nichols Ranch Unit would be expected to be SMALL. The potential environmental impacts due to well abandonment at the Nichols Ranch Unit would also be expected to be SMALL (NRC, 2008).

4.5.3.4 Alternative D (Alternate Liquid Waste Disposal Method)

Alternative D would include issuing Uranerz a license for the construction, operation, aquifer restoration, and decommissioning of facilities for ISR uranium milling and processing as proposed by Uranerz, but using evaporation ponds rather than deep well injection as an alternative liquid waste disposal method. The primary potential environmental impact of evaporation ponds to groundwater would be through leakage from the ponds to shallow (near surface) groundwater. All other potential environmental impacts to groundwater identified in the evaluation of Alternative B would remain the same.

As indicated in the GEIS (Section 2.7.2), evaporation ponds would be constructed, operated, and monitored for leakage in accordance with NRC regulations at 10 CFR Part 40, Appendix A. Evaporation ponds at NRC-licensed ISR facilities are designed with leak detection systems to detect liner failures. The licensee also must maintain sufficient reserve capacity in the retention pond system so the contents of a pond can be transferred to other ponds in the event of a leak and the subsequent corrective action and liner repair. Licensees can minimize the likelihood of impoundment failure by designing the pond embankments in accordance with the criteria found in NRC Regulatory Guide 3.11. Sufficient freeboard height above the liquid level ensures containment during wind and rain events. As indicated in the GEIS (Section 4.3.12.2), leaks may occur over the operational life of a pond; however, the pond design helps to contain leaks and the monitoring would detect leaks before a significant release of material to the environment occurs. Based on these considerations, the potential environmental impact from the use of a pond is generally considered to be SMALL.

The potential environmental impact at the Nichlols Ranch ISR Project to shallow groundwater due to releases at the surface from piping or value failures has already been evaluated for Alternative B (Section 4.5.3.2.2.1). As indicated in that evaluation, the potential environmental impacts to shallow water due to leaks from pipeline, valve, well integrity failure, or pond leakage depends on a number of factors, including the depth to shallow groundwater, the use of shallow groundwater, and the degree of hydraulic connection of shallow aquifers to regionally important aquifers. The evaluation of Alternative B indicates that the depth to shallow groundwater in the southern portion of the Nichols Ranch Unit is limited. Data indicate that the depth to groundwater in the general area of the proposed processing plant is only 15.2 m (50 ft) and portions of the projected production zone extend to the area adjacent to the Cottonwood Creek alluvium, where groundwater may be as shallow as 3 m (10 ft). This limited unsaturated zone offers a limited buffer to absorb and attenuate any releases at the ground surface. Moreover, shallow groundwater likely flows to Cottonwood Creek alluvium, and if left unchecked, shallow groundwater contamination could migrate into and along this alluvial material to the west. The groundwater quality data for the F Sand indicate that groundwater in this unit has relatively high TDS, but appears suitable for stock watering in many areas. The well survey provided by the applicant indicates that there are a number of stock watering wells within a half-mile radius of the project area. While it is uncertain how many of these wells are screened in the shallow aquifer, some of these wells may be potentially impacted by releases at the ground surface that migrate downgradient to the west. Thus, potential impact to shallow groundwater during operation at the Nichols Ranch Unit was found to be MODERATE to LARGE under Alternative B. The addition of an evaporation pond will only add to this potential environmental impact to shallow groundwater.

The evaluation of Alternative B indicates that the depth to shallow groundwater appears somewhat greater at the Hank Unit than the Nichols Ranch Unit. There is generally a 30.5 m (100 ft) or more separation from the ground surface to shallow water beneath most of the production zone and planned processing facility. However, the southern portion of the ore body extends into an area where shallow water is projected to be within 15.2 m (50 ft) of the surface. Water quality data from the H Sand (the shallow aquifer) indicates that groundwater quality in this unit is relatively good and suitable for multiple purposes. The well survey provided by the applicant indicates that there are a number of stock watering wells within a half-mile radius of the project area. It is uncertain how many of these wells are screened in the shallow aquifer. However, the H Sand lies over the shallow F Sand which is the production zone in the Hank Unit. Those wells in close vicinity to the site that are screened in the H Sand are also likely screened in the F Sand as well. The applicant has indicated that wells screened across the F Sand in the vicinity of the Hank will be abandoned. Thus, wells using shallow groundwater from the H Sand will likely be abandoned and will not be directly impacted by releases at the surface. Regardless, due to the shallow depth to groundwater in the southern portion of the Hank Unit area and relatively good groundwater quality in the shallow aquifer, the potential impact to shallow groundwater at the Hank Unit is likely MODERATE under Alternative B. The addition of evaporation ponds under Alternative D would not likely change this potential impact. Consequently, potential environmental impact to shallow groundwater under Alternative D is likely MODERATE.