Smoky Canyon Mine
Panels F & G Final EIS

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Chapter 3
Affected Environment

3.1 Geology, Minerals and Topography

3.1.1 Regional Geologic Setting

The Study Area is within the middle Rocky Mountain and Basin and Range physiographic provinces and is in the central part of the Over-Thrust Belt, a major orogenic zone extending through the North American continent in a general north-south trend. **Figure 3.1-1** shows the general geology map of the Project Area (**Figures 3.1-2** and **3.1-3** are east-west cross sections through the Panels F and G areas).

Rocks present in the Study Area are marine sediments deposited during Mississippian, Pennsylvanian, Permian, and Triassic time in a basin that extended across much of eastern Idaho, northern Utah, western Wyoming, and southwestern Montana. Carbonate deposition gave way to deposition of fine-grained clastic material in a deep-water setting, which included deposition of reduced sulfide and organic rich, black shales. The Middle Permian Phosphoria formation is present over a wide area of this basin and comprises one of the largest resources of phosphate rock in the world with the richest phosphorite accumulations being found in the Meade Peak member in southern Idaho and western Wyoming (Perkins and Piper 2004).

Compressional forces during the Cretaceous Period resulted in major folding and faulting of the Paleozoic and Mesozoic sediments throughout the Rocky Mountain region. These sediments were folded on a regional scale into north-south trending anticlines and synclines that expose the phosphate resources within the Meade Peak member of the Phosphoria formation along steeply dipping fold limbs. Rocks outcropping in the Study Area lie within the Meade thrust plate, one of several thrust plates developed as part of the Rocky Mountain Overthrust Belt (Evans 2004). Sedimentary rocks were thrust an estimated 18 to 20 miles along bedding planes during early compression associated with the Laramide orogeny, with subsequent folding late in the single compressive event (Cressman 1964). A number of thrust fault traces are present east of the proposed mine panels. Block faulting began as part of the Basin and Range Province about 17 million years ago and continues to affect the region today.

3.1.2 Stratigraphy

A generalized stratigraphic section for the area is presented on **Figure 3.1-4**. Detailed stratigraphic descriptions are provided by Cressman (1964), Montgomery and Cheney (1967), McKelvey et al. (1959), Lowell (1952), and Deiss (1949). The following are brief descriptions of primary sedimentary units in the Study Area, from oldest to youngest (Maxim 2004a).

Brazer Limestone
The Mississippian Brazer Limestone is about 1,300 feet thick and consists of massively-bedded, cliff-forming, limestone with interbeds of sandstone and siltstone. Some 150 to 250 feet below the top of the Brazer Limestone is a 50-foot thick softer, swale-forming siliceous shale bed. The Brazer Limestone outcrops at the base of the mountain slope east of Panel G (Boulder Creek Anticline) and along Freeman Ridge and Snowdrift Mountain to the west of Panels F and G (Snowdrift Anticline).

Wells Formation

The Pennsylvanian and Permian Wells formation is divided into two members. The upper member is approximately 1,000 feet thick and consists of fine-grained sandstone with interbeds of limestone and dolomite. The 100-feet thick Grandeur Limestone member of the Park City formation is present at the top of this member and is locally mapped as part of the Wells formation. The lower member of the Wells formation is a 500-feet thick medium-bedded, gray cherty limestone with interbeds of sandstone. The Wells formation forms ridges that crop out along the east side of Panels F and G on the east side of the Webster Syncline, and also along the west flank of the Webster Syncline forming Freeman Ridge and Snowdrift Mountain (**Figure 3.1-2**). This thick formation of sandstone and limestone contains the primary regional aquifer in the Study Area with recharge occurring on the mountain slopes and discharge occurring at lower elevations on the east margin of the Webster Range (**Figures 3.1-2** and **3.1-3**). The West Sage Valley Branch and Meade thrust faults shown on **Figures 3.1-1** to **3.1-3** form the eastern boundary of the Wells formation and Brazer Limestone outcrops in the Study Area. The fault planes extend miles to the west in the subsurface beneath the entire Study Area.

Phosphoria Formation – Lower Meade Peak Member

The Permian Phosphoria formation is divided into two members, the Meade Peak member and the overlying Rex Chert. Rocks in the Meade Peak member locally consist of about 75 to 120 feet of dark, carbonaceous, argillaceous and phosphatic shale and mudstone, which host phosphate ore beds. The phosphatic ore is generally found in the Upper Ore and Lower Ore zones, which are separated by the Center Waste Shale. The Upper Ore is overlain by the Hanging Wall Mudstone and the Lower Ore is underlain by the Footwall Mudstone. The Phosphoria formation outcrops on both flanks of the Webster Syncline (**Figures 3.1-1** to **3.1-3**). The overall package of units that comprise the Meade Peak member has low permeability and is not typically water-bearing, except where faulted and fractured. The Meade Peak member generally is considered a barrier (aquitard) to groundwater movement between more permeable units above (Rex Chert) and below (Wells formation). Some zones within the Meade Peak member are known to contain selenium and metals that can be mobilized when exposed to water and oxygen. The contact between the Lower Meade Peak and the underlying Grandeur Limestone is marked by the thin (typically less than 1 foot thick), fossiliferous, gray-black chert known as the ‘Fishscale’ bed.

The Meade Peak member has been altered in some locations of the Project Area, especially within the Panel F deposit where rocks have been offset along transverse fault structures. Unaltered rock is “hard, carbonaceous, calcareous to dolomitic, and lower in phosphorite than altered phosphorite, whereas the altered rock is partially consolidated, low in organic matter and carbonate, and 3-10 percent higher in phosphate content” (Derkey et al. 1984). Studies by Derkey et al. (1984) and Grauch et al. (2004) suggest that alteration within the Meade Peak member is highly variable and locally gradational. This variation is especially evident within the Center Waste Shale of the Panel F deposit.

Phosphoria Formation – Upper Rex Chert Member

The upper Rex Chert member of the Phosphoria formation consists of about 150 feet of medium-bedded resistant chert and cherty limestone, interbedded with non-resistant cherty shale and mudstone. The resistant Rex Chert forms ridges whereas the Meade Peak Member forms covered swales and slopes. Locally, the Rex Chert is water-bearing and forms part of a local groundwater flow system. In the northern part of Panel F, the Rex Chert is locally replaced by the Franson Limestone member of the Park City formation.

Figure 3.1-1 Surface Geology and Faults

Figure 3.1-2 Panel F Area Cross Section

Figure 3.1-3 Panel G Area Cross Section

Figure 3.1-4 Stratigraphic Section

Dinwoody Formation
The Triassic Dinwoody formation is divided into upper and lower members that together are as much as 1,600 feet thick. It is composed of interbedded, calcareous siltstone, limestone, shale, and clay. The lower member contains more clay and shale beds than the upper member where limestone is more common. The Dinwoody formation outcrops along the western side of Panel F within the Webster Syncline (**Figure 3.1-2**).

Alluvium
Unconsolidated alluvium and colluvium of Quaternary age are present on slopes and along drainages. These deposits consist of gravel, sand, silt, and clay, with widely varying dimensions. In the drainages, thickness of alluvium typically is less than 10 to 20 feet. Greatest thickness of alluvium is assumed to be in portions of Crow Creek Valley.

3.1.3 Structural Setting

Two major thrust plates, the Absaroka and Meade plates, are recognized in the region. Six major thrust faults associated with these plates have been identified to the east of the Webster Range (**Figure 3.1-1)**. The Boulder Creek Anticline and the Webster Syncline are major north-south trending folds existing across the Project Area and were probably formed contemporaneously with thrusting (Cressman 1964; Montgomery and Cheney 1967).

East-west trending tear faults and normal faults, which probably occurred during Cenozoic-age Basin and Range faulting, offset the thrust faults, fold axes, and individual rock units. Three major normal faults have been mapped in the Study Area: Deer Creek Fault, Wells Canyon Fault, and Sand Wash Fault (**Figure 3.1-1**). These three normal faults extend deep into the sedimentary section. Other normal faults shown on **Figure 3.1-1** have shorter lateral extent. Panel F has experienced greater faulting in the northern part of the deposit. As a result, considerably more alteration is observed in the Meade Peak sediments of Panel F.

Surface outcrop areas of the Wells formation and Meade Peak member of the Phosphoria formation are shown on **Figure 3.1-1**. Panels F and G are located along the outcrop of Meade Peak rocks, with the Wells formation outcropping immediately east of the mine panels. Younger rocks of the Rex Chert member (Phosphoria formation) and Dinwoody formation crop out along the west side of Panels F and G. As shown on **Figure 3.1-1**, the outcrop of units along the Webster Syncline is narrower (i.e., steeper dip of beds) in the Panel G area compared to the broader width of outcrop along the syncline limb west of Panel F.

3.1.4 Seismicity and Geotechnical Stability

Seismicity
The Project Area lies within a Zone III seismic region (UBC 1991) extending from northern Arizona through the Wasatch Front in Utah to the Yellowstone and Hebgen Lake regions in Wyoming and Montana. The Idaho Geological Survey has mapped the southeastern part of Idaho, east of the Snake River Plain as having the highest of three seismic shaking rankings (IGS 2004). About 20 earthquakes capable of damaging structures (greater than 5.0 on the Richter Scale) have occurred within this seismic region from 1880 through 1994 (USGS, BLM, and USFS 1975; UISS 2000).

Although several earthquakes have occurred in recent years, there is no reported evidence they have caused surface features such as scarps, displacement of streams, or creation of sagponds

(USFS 1981; Mariah Associates 1990). USGS (2004a) and Idaho Geological Survey (2004) maps of Quaternary faults do not indicate any such faults being present in the Project Area. The closest earthquake recorded between 1880 and 1994 occurred approximately three miles north of the Smoky Canyon Mine near Draney Peak and had a Richter Scale magnitude of 5.9 (Schuster and Murphy 1996). Other significant earthquakes in the vicinity of the Project Area include one that occurred in 1930 near Grover, Wyoming about 12 miles to the southeast of Smoky Canyon, and two along the Utah/Idaho border in 1914 and 1963. These three earthquakes were assigned intensities (Modified Mercali Scale) of 6, 7, and 7, respectively. An earthquake in the area occurred April 21, 2001 centered about 27 miles northwest of Afton, Wyoming. The preliminary magnitude of this earthquake was 5.3. Within a 100-kilometer radius of the mine site, two additional seismic events that exceed 4 on the Richter scale have been reported since 2001. These include an event of magnitude of 5.4 in 2001 and another registering 4.2 in 2002 (Maxim 2004a).

Geotechnical Stability

Factors related to geotechnical stability of highwalls and overburden disposal site slopes have been identified through past operations at the Smoky Canyon Mine. Factors related to stability of highwalls include the type and strength of rock, degree of rock alteration, steepness of the final highwall slope, presence of any groundwater, spacing and orientation of fractures and faults, and blasting practices. Stronger rock, which is less fractured and altered, will produce more stable highwalls than weaker or more altered or fractured rock. Groundwater discharges from a highwall can also destabilize it. In general, highwalls at Smoky Canyon have proven to be stable over the duration of the mining operations. Mine designs are adapted as needed to respond to indications of highwall instability.

Factors related to stability of overburden fill slopes include the topography of the surface underlying the overburden pile, stress such as shock loading or overloading, slope heights, reduction of material strength by introduction of water, and the scheduling of reclamation contouring. Past instability of overburden fill slopes at the Smoky Canyon Mine has been related to high fill heights and excess water content due to excess incorporation of snow or snow melt into the material. Mine practices have been modified based on experience to preclude future slope failures.

In addition to the geotechnical stability of the mine facilities themselves, the haul/access roads outside the mine panels that are included in the Proposed Action and Action Alternatives have their own slope stability considerations. Landslide prone soil areas have been mapped in the Soil Survey of the CNF (USDA 1990). Cutslope stability hazard ratings for road construction have been assigned to soil families assuming roads are built on uniform slopes with cuts greater than 5 feet high, a 1H:1v final cut grade, and revegetation following construction. Additional discussion of these soils, and the soils map are found in **Section 3.4** of this document.

3.1.5 Overburden Characterization

Mineralogical and chemical characterization of overburden expected to be produced from the Panels F and G operations has been completed to help anticipate potential environmental effects from handling and disposing of this material (Maxim 2004b and 2004l). Baseline geochemistry analyses of whole rock metal content, acid generation potential, paste chemistry, and total organic carbon content were completed for 225 samples from 52 drillholes, for the purpose of characterizing geochemistry of overburden lithologies and spatial variability in chemistry as a function of geology. The relative volumes of different overburden lithologies are shown in **Table 3.1-1**.

TABLE 3.1-1 PANELS F AND G OVERBURDEN DESCRIPTION

GEOLOGIC UNIT	RUN OF MINE PERCENTAGE
PANEL F	
Chert	37.7
Franson Limestone	3.6
Hanging Wall Mud	5.8
Center Waste Shale	52.9
Total	100
PANEL G	
Chert	37.6
Hanging Wall Mud	10.2
Center Waste Shale	52.2
Total	100

Potential for Acid Rock Drainage (ARD)

ARD is produced when sulfide minerals contained in rock chemically react with oxygen and water to produce sulfuric acid and other reaction products. This acidic condition can lead to the dissolution of metals that are more soluble in water at low pHs. Other minerals in rock (primarily carbonates) can neutralize acid and cause the precipitation or co-precipitation of dissolved constituents. The potential for generation of ARD is a function of the amount of sulfide minerals present in mine waste and the amount of available minerals to neutralize any generated acid (Lapakko 1993). To assess the potential for acid rock generation, the amount of oxidizable sulfide minerals, or Acid Generation Potential (AGP), and the amount of neutralizing materials, or Acid Neutralizing Potential (ANP), in the material being assessed are typically measured. A ratio of these measurements (ANP:AGP) determined by the acid base accounting (ABA) test indicates the potential for acid to be generated. Although any material with an ANP:AGP ratio above 1.0 could be considered non-acid generating, the BLM ARD risk threshold is based on an ANP:AGP ratio of 3:1 (BLM and USFS 2000).

Representative samples of cuttings from rotary drill holes completed in 2001 and 2003 by Simplot were collected to test ANP:AGP of the major stratigraphic potential overburden units proposed to be mined. One of the Panel G Center Waste Shale samples had an ANP:AGP value less than 1 while seven had values between 1 and 3. The remaining 16 samples (67 percent) had ANP:AGP values greater than 3. One of the 16 Panel G Footwall Mud samples had ANP:AGP values between 1 and 3. All other Panel G overburden samples had ANP:AGP values greater than 3. Only 5 of 20 altered and 7 of 20 unaltered Center Waste Shale samples from Panel F had ANP:AGP values between 1 and 3. All other Panel F samples had ANP:AGP values greater than 3. ABA data for both Panels F and G were similar and indicated that overburden would not present a significant risk of ARD. These data indicate that local oxidation of sulfide minerals may occur, but the overall ABA value for all overburden indicates it is unlikely to promote ARD. This is in line with conditions at the existing Smoky Canyon Mine and other phosphate operations in Southeastern Idaho.

Trace Elements and Sources

Selenium and other metals and metalloids occur in the Phosphoria formation in elevated concentrations relative to average crustal abundances (USFS et al. 1976; Desborough et al. 1999; Herring et al. 1999; Munkers et al. 2000).

Assay Data on Selenium

Herring et al. (2000) sampled measured sections in the Phosphoria formation at the Smoky Canyon Mine and assayed these samples for various metals and selenium. They showed selenium occurs in the Meade Peak Phosphatic Shale member of the Phosphoria formation primarily in the Hanging Wall Mudstone, Center Waste Shale, and Footwall Mudstone beds where selenium concentrations ranged from 6 to 708 mg/Kg. The selenium concentration in the Rex Chert member was 1 mg/Kg. They also noted that selenium concentrations varied greatly between samples. This variability is due to different degrees of alteration and weathering based on depth below the ground surface and structural features such as fractures and faults.

Munkers (2000) discussed drill core assays of the Phosphoria formation obtained from the Smoky Canyon Mine. These data showed that the largest concentrations of selenium occurred in the Center Waste Shale. Most of these concentrations were below 150 mg/Kg, but three zones in this unit had concentrations as high as 250 to 300 mg/Kg.

Selenium in the Phosphoria formation occurs in several forms. The USGS has identified selenium associated with organic matter (kerogen) in carbon-rich rocks and also with the mineral pyrite (Desborough et al. 1999). Munkers et al. (2000) noted that most of the selenium in the Smoky Canyon Mine rocks occurs as selenide (Se^{-2}) in ionic substitution for sulfur in pyrite; however, native selenium (Se^{0}) has also been identified (Munkers et al. 2000). These forms of selenium are insoluble; however, upon exposure to surface conditions and weathering, selenide and elemental selenium can be oxidized to more soluble forms. In the overburden in the vicinity of Pole Creek north of the Project Area, Möller (1997) found that approximately two percent of the selenium in samples analyzed from the overburden disposal facility occurred as the more soluble form, selenite (Se^{+4}), although its chemical or mineralogical occurrence was not described. The most soluble forms of selenium, selenate (Se^{+6}), and certain organo-selenium compounds are not found in the undisturbed overburden material.

Cadmium commonly occurs in ionic substitution for zinc in the sulfide mineral sphalerite (ZnS). Desborough (1977) found cadmium to occur in sphalerite in the Meade Peak Member in Coal Canyon, Wyoming. Munkers et al. (2000) reported that sphalerite is common in siltstones in overburden samples from the Meade Peak Member collected at the Smoky Canyon Mine. Accordingly, and by extension, it is probable that cadmium occurs in sphalerite in the Middle Waste Shale; however, concentration in organic compounds is also probable.

The mineralogical occurrence of other metals in the Middle Waste Shale has not been well documented; however, Desborough (1977) studied metal occurrences in vanadium-rich zones in the Meade Peak member in eastern Idaho and western Wyoming. He determined that trace elements and metals occurred in sulfide minerals (zinc in sphalerite), oxides (molybdenum, titanium, and vanadium), silicates (chromium), and organic compounds (chromium, silver, vanadium), as well as an indeterminate occurrence for nickel. Lead, arsenic, and other metals and metalloids were not studied. A similar diversity of mineralogical and organic-compound occurrences can be assumed, although it has not been documented, for the occurrence of metals in the Center Waste Shale at the Smoky Canyon Mine. The absence of low pH conditions in the overburden, and waters that pass through it, substantially inhibits the leaching and mobilization of most metals and metalloids, other than selenium.

The USGS (Perkins and Foster 2004) studied affinities and distribution of selenium and other elements in the Meade Peak member and determined that, in unweathered rocks, sulfides (mainly pyrite and sphalerite) host the majority of the cadmium, copper, selenium, and zinc and a large proportion of the nickel and vanadium. Most of the non-sulfide fraction of these elements in unweathered rocks is associated with organic matter and oxyhydroxides, and a small amount of the selenium is present in elemental form. Silicates and oxides host the majority of the chromium and vanadium in unweathered rocks. In weathered rocks, acid-soluble oxyhydroxides are the primary hosts for all these elements except chromium and uranium, which are associated with relatively stable minerals.

Cadmium, manganese, nickel, and selenium were measured in whole rock assays from Panels F and G samples. Samples of potential overburden were collected as previously described, and assayed to assess the total content of metals and metalloids present in the overburden. A total of 114 samples from drill holes in the proposed Panel F were tested along with 102 samples from Panel G, representing the stratigraphic units that would comprise overburden to be mined under the Proposed Action and Action Alternatives.

Lithology-related trends in selenium concentration are similar at both Panels F and G with the greatest selenium concentrations observed in Center Waste Shale (**Table 3.1-2**). A greater mean selenium concentration was calculated for unaltered Center Waste Shale compared to altered Center Waste Shale from Panel F. Selenium concentrations decrease in the following order at each lease area; Center Waste Shale has values greater than Footwall Mudstone (Panel G), which has values greater than Hanging Wall Mudstone. Wells formation, Rex Chert, and Franson Limestone (Panel F) had mean selenium concentrations ranging from 1.5 to 3.6 mg/Kg and were considerably lower than the other lithologies (Maxim 2004b).

In **Table 3.1-2**, Franson Limestone is described only for Panel F because it does not occur in the overburden of Panel G. Likewise, Center Waste Shale is present in distinctly different alteration states in Panel F, which is not present to a significant degree in Panel G.

TABLE 3.1-2 WHOLE ROCK SELENIUM CONCENTRATIONS (MG/KG)

	FRANSON LIMESTONE	REX CHERT	HANGING WALL MUD	CENTER WASTE SHALE	CENTER WASTE SHALE (ALTERED)	CENTER WASTE SHALE (UNALTERED)	FOOTWALL MUD	WELLS FORMATION
PANEL F								
Number of Samples	15	20	20	0	20	20	0	19
Minimum	0.7	1.3	2.1		3.4	3.9		0.7
Mean	2.2	3.3	20.7		56.3	87.3		2.6
Maximum	10	5.9	76.5		370	400		7.2
Standard Deviation	2.6	1.3	21.1		82.9	99.5		1.7
PANEL G								
Number of Samples	0	23	18	24	0	0	16	21
Minimum		0.6	2.9	6.4			4.9	0.5
Mean		1.5	12.7	68.3			14.9	3.6
Maximum		3.5	74.5	177			24.9	11.2
Standard Deviation		0.8	16.6	51.2			6.3	3.5

From: Maxim 2004b

Paste Extract Test Data

Electrical conductivity (EC), pH, cadmium, manganese, nickel, and selenium were measured from saturated paste extracts. Samples of potential overburden from Panels F and G were collected as previously described and analyzed to assess which metals and metalloids would be expected to be leachable from overburden. A total of 114 samples from drill holes in Panel F were tested along with 102 samples from Panel G, representing the stratigraphic units that would comprise overburden to be mined under the Proposed Action and Action Alternatives.

Metal concentrations measured in saturated paste extracts were generally low, with many samples having concentrations that were at or below detection limit levels. Cadmium was not detected in paste extracts from any sample (**Table 3.1-3**). Detections of nickel were limited, with only Panel G Center Waste Shale samples registering detections for more than 3 samples.

TABLE 3.1-3 METAL DETECTIONS IN PANELS F AND G SATURATED PASTE EXTRACTS

	FRANSON LIMESTONE	REX CHERT	HANGING WALL MUD	CENTER WASTE SHALE	CENTER WASTE SHALE (ALTERED)	CENTER WASTE SHALE (UNALTERED)	FOOTWALL MUD	WELLS FORMATION
PANEL G								
Number of Samples Analyzed	0	23	18	24	0	0	16	21
NUMBER OF DETECTIONS								
Cadmium (DL = 0.1[1])		0	0	0			0	0
Manganese (DL = 0.1)		13	1	9			0	0
Nickel (DL = 0.1)		0	2	11			1	1
Selenium (DL = 0.01)		0[2]	7	22			6	1
PANEL F								
Number of Samples Analyzed	15	20	20	0	20	20	0	19
NUMBER OF DETECTIONS								
Cadmium (DL = 0.1)	0	0	0		0	0		0
Manganese (DL = 0.1)	0	8	6		0	5		0
Nickel (DL = 0.1)	0	0	0		1	3		1
Selenium (DL = 0.01)	0	0	10		15	19		2

[1] Detection limits reported in mg/Kg.
[2] Selenium was reported at the detection limit in one Deer Creek chert sample.
From: Maxim 2004b

Manganese was not detected in paste extracts from any Footwall Mudstone, Wells formation, or Franson Limestone sample. Mean manganese concentrations for Panel G were the greatest in paste extracts from Rex Chert and Center Waste Shale (0.2 mg/Kg for both rock types). For Panel F samples, Rex Chert had the greatest mean manganese concentration (0.2 mg/Kg).

Selenium was detected most frequently in paste extracts of Center Waste Shale, including altered and unaltered Panel F samples. Selenium was not measured above the detection limit in Rex Chert or Franson Limestone samples. Saturated paste selenium concentrations

(**Table 3.1-4**) generally followed the same trend as whole rock total selenium concentrations (i.e., Center Waste Shale has concentrations greater than Hanging Wall Mudstone which has concentrations greater than Footwall Mudstone which has concentrations greater than Wells formation ≈ Rex Chert ≈ Franson Limestone). However, for Panel F samples, altered Center Waste Shale produced paste extracts with selenium concentrations that were considerably lower than those of unaltered Center Waste Shale and Panel G Hanging Wall Mudstone (Maxim 2004b).

The USGS (Herring 2004) conducted leaching experiments with Meade Peak rock samples obtained from a number of locations in southeastern Idaho and also noted that less-altered rock tended to produce higher leachate concentrations of selenium and other elements compared to altered rock, which typically had much lower leachate concentrations.

TABLE 3.1-4 SATURATED PASTE EXTRACTABLE SELENIUM CONCENTRATIONS (MG/KG)

	FRANSON LIMESTONE	CHERT	HANGING WALL MUD	CENTER WASTE SHALE	CENTER WASTE SHALE (ALTERED)	CENTER WASTE SHALE (UNALTERED)	FOOTWALL MUD	WELLS LIMESTONE
PANEL G								
Number of Samples	0	23	18	24	0	0	16	21
Minimum		< 0.01	< 0.01	< 0.01			< 0.01	< 0.01
Mean[1]		0.01	0.05	0.31			0.02	0.01
Maximum		0.01	0.44	1.23			0.17	0.01
Standard Deviation		0	0.10	0.39			0.04	0
PANEL F								
Number of Samples	15	20	20	0	20	20	0	19
Minimum	All samples below detection		< 0.01		< 0.01	< 0.01		< 0.01
Mean			0.06		0.11	0.38		0.01
Maximum			0.26		0.71	1.3		0.02
Standard Deviation			0.08		0.17	0.45		0.002

[1] Mean values were calculated using the detection limit (0.01 mg/Kg) for samples with selenium concentrations that were below detection.

From: Maxim 2004b

EC measurements provide an indication of total solute release from rock samples. Saturated paste EC data indicate that solute release from Panels F and G samples was greatest from Center Waste Shale followed by Hanging Wall Mudstone and Footwall Mudstone. EC was greater in unaltered Center Waste Shale than in altered Center Waste Shale.

Saturated paste pH measurements ranged from 4.9 to 8.7 with mean values for individual lithologies ranging from 6.8 to 8.3. For each lease area, Center Waste Shale samples registered the lowest pH values, and Wells formation limestone registered the greatest, which is in agreement with ABA data.

3.1.6 Applicable Regional and Site-Specific Studies for COPCs

Selenium is a naturally occurring element that is widely distributed in the earth's crust and is naturally present in most rocks and soils. In some parts of the United States, especially in the western states, some soils naturally have higher levels of selenium compounds. Weathering of rocks and soils may result in soluble forms of selenium being present in runoff water and soil moisture, which may be taken up by plants and animals exposed to this water. Weathering can also release selenium compounds in fine dust particles. Other sources of airborne selenium include volcanic eruptions and burning of fossil fuels.

Selenium and its compounds are used in some photographic devices, gun bluing, plastics, paints, anti-dandruff shampoos (Selsun Blue), vitamin and mineral supplements, fungicides, and certain types of glass. Selenium is used to prepare drugs and nutritional supplements for humans and is included in feed supplements for poultry and livestock.

The following description of the human health aspects of selenium is largely paraphrased from the "Toxicological Profile for Selenium" (ATSDR 2003).

People are exposed to low levels of selenium daily through food, water, and air. Selenium is an essential nutrient for humans and animals and is an important constituent in a number of proteins; particularly enzymes involved in antioxidant defense mechanisms, thyroid hormone metabolism, and redox control of intracellular reactions in the body. The U.S. government has established a Recommended Dietary Allowance for selenium and it is present in most multi-vitamin supplements. People receive the majority of their daily intake of selenium from eating food, and to a lesser extent, from water intake. Estimates of the average intake of selenium from food for the U.S. population range from 71 to 152 milligrams of selenium per person per day. Low levels of selenium can also be found in drinking water. The U.S. EPA has established the maximum allowable concentration of selenium in public drinking water sources at 0.050 mg/L.

The human body easily absorbs the selenium compounds in food and water when ingested. Most of the selenium that enters the body quickly leaves it, usually within 24 hours. Beyond what the body needs, selenium leaves mainly in the urine, but also in feces and breath. Selenium can build up in the human body if exposure levels are high and if such exposure occurs over a long time. It builds up mostly in the liver and kidneys but also in the blood, lungs, heart, testes, nails, and hair.

Selenium has both beneficial and harmful effects. Low doses of selenium are needed to maintain good health. However, exposure to high levels can cause adverse health effects. Short-term oral exposure to high concentrations of selenium may cause nausea, vomiting, and diarrhea. Chronic oral exposure to high concentrations of selenium compounds can produce a disease called selenosis. The major signs of selenosis are hair loss, nail brittleness, and neurological abnormalities (such as numbness and other odd sensations in the extremities). Studies of laboratory animals and people show that most selenium compounds probably do not cause cancer. In fact, studies in humans suggest that lower-than-normal selenium levels in the diet might increase the risk of cancer. The EPA has determined that one specific form of selenium, selenium sulfide, is a probable human carcinogen. Selenium sulfide is insoluble in water, is not present in foods, and is a very different chemical from the organic and inorganic selenium compounds found in foods and in the environment.

A summary of selenium effects in livestock and wildlife was included in Appendix H of the Final EIS for the FMC, Dry Valley Mine – South Extension Project (BLM and USFS 2000) and is summarized in the following paragraphs.

Selenium is considered a micronutrient in animal diets and may also be required in small amounts for plant health. Animals reportedly require from 0.05 to 0.1 mg/Kg of body weight selenium in their diets to prevent selenium deficiency. There is a relatively small margin between the necessary dose for health and the toxic dose for selenium. A variety of toxic effects have been associated with exposure of fish, birds, wildlife, and livestock to elevated selenium levels in diet and water.

Reproductive toxicity is reported to be one of the most sensitive endpoints for vertebrates exposed to selenium (Lemly 1997). In fish, selenium is transferred from parents to offspring through the eggs and levels of selenium that may cause teratogenic effects in offspring do not generally affect the health or survival of parents (Skorupa 1998). Teratogenesis, an expression of selenium toxicity, is considered a subtle but important cause of reproductive failure in fish (Lemly 1997).

Selenium and sulfur are biochemically similar. Plants adsorb, reduce, and incorporate selenium into growing tissue. Certain plants are selenium accumulators (ex. Astragalus); grow in soil with high selenium levels and accumulate high selenium concentrations (400 to 800 ppm). However, these plants are relatively unpalatable to grazing and foraging animals. Secondary accumulator plants (ex. Aster, Atriplex) accumulate selenium to concentrations of 50 to 100 ppm. Grasses and other shallow rooted plants usually accumulate small amounts of selenium (less than 50 ppm).

Acute and chronic selenium poisoning has been documented in the general literature for foraging animals. Acute selenium poisoning can result from ingestion of excessive amounts of seleniferous primary or secondary accumulator plants. Most chronic selenosis occurs from ingesting seleniferous grasses and small grains.

Bioaccumulation of selenium occurs by concentrating selenium from soils or aquatic sediment by vegetation then passing this selenium up through animals. A significant concern regarding selenium exposure is that bioaccumulation can occur and can concentrate selenium to toxic levels from starting concentrations that are lower.

In addition to generally applicable literature for selenium and other COPCs relative to this Project, there are directly applicable, regional, and site-specific studies that are summarized in this section. Taken together, these regional and site-specific studies provide a broad understanding of the sources, release mechanisms, transportation pathways, potential receptors, and known and potential effects of selenium and other COPCs in the phosphate production area of Southeastern Idaho. This existing understanding, combined with applicable site-specific data, is the basis for the evaluation of potential environmental effects from selenium and other COPCs for the Panels F and G Proposed Action and Alternatives.

U.S. Geological Survey Regional Studies

In response to a request from the BLM, the USGS initiated in 1997 a series of geologic, geo-environmental, and resource studies in the Western Phosphate Field. The results of these studies have been released in a series of individual publications available from the USGS along with a book that discusses the history, geology, geochemistry, economics, and environmental aspects of the Western Phosphate Field (Hein ed. 2004). The USGS book contains a number of chapters that provide selenium-related information that is generally applicable throughout the phosphate production area of Southeastern Idaho.

The occurrence of various COPCs in the Meade Peak member are discussed in Chapter 8 (Grauch et al. 2004) of the USGS book. Cadmium, nickel, selenium, and zinc were found to be most abundant in sulfide mineralization and in oxyhydroxide minerals in more weathered rock. Selenium also appeared to be associated with natural organic materials in the rock. The significance of these findings are that: 1) the COPCs can be transported from the rocks into the environment as dissolved and adsorbed species; and 2) release of these elements from rocks will be strongly dependent on pH, Eh, and exchangeable ion contents in the water pathway.

Presser et al. (2004) described a number of sites in Southeastern Idaho that have been impacted by selenium released from phosphate mines. Temporal analysis of water quality monitoring at phosphate mines indicated that selenium concentrations at overburden seeps typically varied during the year with peak selenium concentrations often occurring during the spring. This leads to varying selenium concentrations in receiving streams. Selenium concentrations in macrophytes and forage fish from certain locations in Southeastern Idaho were shown to exceed published risk thresholds for higher trophic levels species (USDI 1998). They referred to dietary exposure of selenium leading to the deaths of sheep and horses at six sites since 1996. Selenium concentrations in forage plants on some phosphate mine overburden fills were found to exceed published thresholds for dietary toxicity for horses and sheep with concentrations in alfalfa being greater than grasses.

Presser et al. (2004) described selenium loading during 2001 and 2002 in the Blackfoot River watershed, which contains most of the phosphate mines in Southeastern Idaho. There was typically little difference between total and dissolved selenium in the water samples, indicating selenium was being transported largely in dissolved species. Selenite represented less than 10 percent of the dissolved selenium, which was typically a mixture of selenate and organic selenide. Over 70 percent of the selenium load in the watershed occurred during the high-flow season, mostly as selenate. During low flow, the organic selenide concentration increased, suggesting elevated biotic productivity and enhanced selenium uptake in food webs. They referred to 1998 risk assessment findings by the IDEQ indicating some stream segments in the Blackfoot River watershed were being impacted by selenium contamination exceeding the EPA Ambient Water Quality Criteria, Freshwater Continuous Criterion Concentration (0.005 mg/L, 40 CFR 131.36).

Stillings and Amacher (2004) presented data collected from a natural wetland formed from phosphate mine drainage. Selenium concentrations at the overburden seep were higher in the spring of 1999 following a winter with heavy snowfall than the following year after a winter with less snowfall. Selenium concentrations in the water decreased with distance from the source while selenium concentrations in wetland sediments were greatest near the source and decreased with distance. This suggests that selenium sequestration in wetland sediments is an important factor for selenium attenuation. Most of the selenium in the sediment was adsorbed and/or coprecipitated with iron oxides, although organic matter also sequestered selenium. Selenium concentrations in wetland vegetation showed a trend similar to the sediment with higher concentrations closest to the source, indicating plant uptake as another factor in attenuation of selenium in the wetland environment.

Hamilton et al. (2004) discussed occurrences of selenium and other trace elements in water, sediment, aquatic plants, aquatic invertebrates, and fish from nine stream sites in the Blackfoot River watershed in 2000. Selenium concentrations in water were below the limit of detection for all sites except East Mill Creek where both the upper and lower sites had selenium concentrations above the 0.005 mg/L water quality criterion. Stream sediment selenium concentrations were also highest in East Mill Creek. Selenium concentrations in aquatic plants correlated well (0.97, P less than 0.0001) with sediment concentrations and indicated selenium transfer from the streams to the local food webs. Selenium concentrations in aquatic invertebrates showed a strong correlation (0.94, P less than 0.002) with concentrations in aquatic plants. Comparison of the invertebrate data with hazard assessment protocols by Lemly (1995) indicated probable adverse effects to larval fish in certain streams. Fish tissue selenium concentrations were highest in speckled dace and lowest in redside shiners. The selenium concentrations in fish tissue followed the same pattern of accumulation as in surficial sediments, aquatic plants, and aquatic invertebrates. The speckled dace is a bottom browser that feeds on invertebrates and plant material. They discussed the importance of collecting data from a variety of ecosystem components (water, sediment, vegetation, invertebrates, and fish) and considering the synergistic effects of all these components when trying to determine if certain aquatic ecosystems are at risk from selenium contamination. They concluded that the available data support the premise that selenium concentrations in several aquatic ecosystem components were sufficiently elevated to cause adverse effects to aquatic resources in the Blackfoot River watershed.

Mackowiak et al. (2004), presented information on uptake of selenium and other COPCs into plants and the implications of this for grazing animals in Southeastern Idaho. Data were presented from samples of vegetation taken at a phosphate mine overburden site, a wetland below an overburden fill, and also from samples taken at undisturbed sites both on and off the outcrop pattern of the Meade Peak member. Plants at the undisturbed sites all had selenium concentrations less than 2 mg/Kg, within the maximum tolerable dietary content (2 mg/Kg, National Research Council 1980) for most classes of livestock, and well below the 5 mg/Kg critical threshold value for animal forage diet (National Research Council 1980). Mean vegetation selenium content from the overburden fill site was 38 mg/Kg. Alfalfa contained nearly 80 mg/Kg, which was about four times more than grasses at the same site. Mean selenium values for legumes, grass, and tree species growing on the overburden were all greater than the 5 mg/Kg threshold. In contrast, forb and shrub species had lower mean selenium values close to the threshold. From the data collected, they concluded that forage selenium concentrations from the overburden site were a concern with regard to toxicity effects in grazing animals. Acute or chronic poisoning was predicted for grazing animals selectively ingesting certain high-concentration forage species from several sites at the overburden fill. The delay in onset of acute poisoning post-ingestion (12 to 36 hours) might result in these animals becoming ill or dying in areas that are away from the primary vegetation contamination areas. They indicated covering seleniferous overburden with non-seleniferous material has merit for long-term mitigation, but studies demonstrating the optimal covering thickness that prevents root penetration into the seleniferous material have not yet been done. Attenuating mobile selenium with iron materials was suggested as being potentially useful for remediation of contaminated sites. They indicated that the lowest-cost method for mitigating accumulation of selenium in forage plants growing on overburden fills was selective control of plant species used in revegetation. Good candidates for low selenium uptake species include certain grasses and native forbs and shrubs. Existing reclamation revegetation on overburden sites can be manipulated with herbicides and physical treatments to change the existing species mix to ones that are more favorable.

University of Idaho Studies

University of Idaho researchers have conducted studies supported by the Idaho Mining Association (IMA) to investigate potential effects of selenium on wildlife and livestock. The results of these studies were not peer reviewed or approved by the BLM, USFS, or IDEQ.

Hardy (2005) studied the effects of dietary selenium on cutthroat trout obtained from the Blackfoot River and the Henry's Lake Fish Hatchery. These fish were studied over a 2 to 2.5 year period at the Hagerman Fish Culture Experiment Station where the fish were raised in a clean environment and fed a diet containing elevated selenium levels.

Fessler (2003) researched selenium toxicity in sheep on reclaimed phosphate mine areas in Southeastern Idaho. The sheep were first all exposed to normal (low) levels of selenium. Then the low and high selenium groups were exposed to selenium forage concentrations on reclaimed phosphate mines that would fall within various published "toxic" levels for four weeks after which they were again grazed on normal selenium forage and water for two weeks (depuration phase). During the study, one of the test groups escaped the enclosure, so the selenium exposure of these animals was uncertain.

Dr. John Ratti collected over 500 bird eggs in 1999 and 2000 from reference sites and drainages affected by phosphate mining sites in Southeastern Idaho (Garton et al. 2002a, 2002b).

Regional Studies by Idaho Mining Association and Idaho Department of Environmental Quality

Following livestock losses associated with excessive selenium uptake in 1996, the five active phosphate mining companies in Southeastern Idaho joined together with the IMA to form the IMA Selenium Subcommittee. An Interagency/Phosphate Industry Selenium Working Group was subsequently established to facilitate cooperation between the mining industry, tribal entities, and state, federal, and local agencies. The IMA Subcommittee retained the services of Montgomery Watson, a consulting firm, to conduct a series of regional studies throughout the phosphate mining area of Southeastern Idaho with the intent of characterizing the extent and magnitude of selenium and other COPC releases to a variety of environmental media. These investigations included sampling of surface waters, groundwater, sediments, soil, vegetation, aquatic biota, and wildlife for a range of constituents of concern including: cadmium, manganese, nickel, selenium, vanadium, and zinc. The results of these investigations are documented in the following reports:

- Fall 1997 Interim Surface Water Survey Report, Montgomery Watson (MW 1997).
- 1998 Regional Investigation Report, Sampling and Analysis Plan, Southeast Idaho, Phosphate Resource Area, Montgomery Watson (MW 1998).
- Final 1998 Regional Investigation Report, Southeast Idaho Phosphate Resource Area Selenium Project, Montgomery Watson (MW 1999).
- Draft 1999 Interim Investigation Data Report, Southeast Idaho Phosphate Resource Area Selenium Project, Montgomery Watson (MW 2000).
- Draft 1999-2000 Regional Investigation Data Report for Surface Water, Sediment, and Aquatic Biota Sampling Activities, September 1999. Southeast Idaho Phosphate Resource Area Selenium Project, Montgomery Watson (MW 2001a).
- Draft 1999-2000 Regional Investigation Data Report for Surface Water, Sediment, and Aquatic Biota Sampling Activities, May – June 2000. Southeast Idaho Phosphate Resource Area Selenium Project, Montgomery Watson (MW 2001b).

The agencies disagreed with some of the content in the last three reports related to the 1999 and 2000 investigations, and these reports were not finalized or approved by the agencies.

The 1997 results from these studies showed that surface water samples collected from or near phosphate mine facilities contained elevated concentrations of selenium with about half the samples exceeding the water quality criterion (0.005 mg/L).

The 1998 studies were expanded to include surface water, groundwater, stream sediments, soils, vegetation, and trout fillets. Over 70 percent of the surface water samples collected at mine sites exceeded the EPA selenium ambient water quality criterion, and 20 percent of the stream samples outside of mine areas exceeded the criterion. Seeps emanating from overburden fills and French drains had the highest concentrations of selenium. In general, sediment, soil, and vegetation sample analyses indicated elevated levels of the COPCs at mine facilities compared to sample locations remote from mines.

In 1999, additional investigations were conducted to collect surface waters at select stream locations and to characterize selenium and cadmium concentrations. Ten of the 12 surface water samples collected in May 1999 exceeded the EPA criterion. Investigations of selenium concentrations in elk and cattle tissue were also conducted. The elk liver and skeletal muscle sampling program found that elk harvested by hunters near phosphate mines typically had higher tissue selenium concentrations than those taken away from mines. Of the 160 elk livers analyzed, 156 had liver selenium concentrations less than the maximum concentration observed by IDFG in other parts of Idaho (6 – 7 mg/Kg ww). The four livers with higher concentrations exhibited selenium concentrations ranging from 7.4 to 13 mg/Kg. A screening human health risk assessment indicated there was not a human health concern with consumption of elk liver containing 13 mg/Kg selenium (MW 2000).

In August 2000, the IDEQ took over coordination of future area-wide investigations, for regulatory purposes, to establish agency oversight of investigations and to formulate regional cleanup guidelines to assist lead agencies in implementing future site-specific remedial efforts. The IDEQ subsequently retained Tetra Tech, Inc. to conduct additional area-wide investigations as necessary, conduct an area-wide human health and ecological risk assessment, and prepare an area-wide risk management plan. Tetra Tech first evaluated the existing data to identify data gaps (Tetra Tech 2001a). Another early product of this work was completion of the conceptual site model for the project (Tetra Tech 2001b). All the existing information and risk assessment prepared by the IMA was reviewed for applicability in preparing a human health and ecological risk assessment (Tetra Tech 2001c).

The IDEQ ecological conceptual site model is reproduced here as **Figure 3.1-5**. A separate conceptual site model was prepared for the human health risk assessment. The source of the COPCs was identified as phosphate mine overburden. Potential transport media and pathways were described as:

- Wind erosion and dust transportation to eventual deposition on surfaces downwind.
- Percolation of precipitation recharge through overburden to seeps, drains, groundwater, and potentially surface water.
- Storm water runoff transporting dissolved COPCs and particles eroded from exposed overburden surfaces to surface streams and places of sedimentation. COPCs can subsequently be exchanged between surface water and sediments downstream of the sources.

Terrestrial and aquatic plants can uptake COPCs from contaminated water, soil, and sediments. In the case of selenium, its concentration in plants can be greater than its concentration in the water, soil, or sediment. For ecological receptors, the most important exposure pathways (greatest ecological risk) include: ingestion of particles (dust, soil, sediment), surface water, and ingestion of contaminated plants or prey.

Three potentially exposed human populations were identified as recreational hunters and fishers, Native Americans, and subsistence lifestyle receptors. The complete exposure pathways included ingestion of wildlife and cattle that graze on contaminated forage, ingestion of fish taken from contaminated aquatic habitats (water, vegetation, and/or sediment), ingestion of contaminated terrestrial or aquatic plants by Native Americans, and ingestion of contaminated homegrown produce by subsistence lifestyle receptors.

Following evaluation of all data, including that from additional area-wide investigations conducted during 2001, a draft Human Health and Ecological Risk Assessment was released by IDEQ in July 2002 for a formal 45-day public review and comment period. The Final Human Health and Ecological Risk Assessment was released by IDEQ in December 2002 (IDEQ 2002c). The 165-page document is a detailed analysis of the area-wide data including nine extensive appendices of technical information and responses to public comments. The Area Wide Risk Management Plan (February 2004) states "Localized groundwater studies to characterize and delineate conditions in the vicinity of the subject mine sites were appropriately deferred to site-specific investigations due to the scale and complexity of conducting hydrogeologic evaluations on an area wide basis. DEQ continues to support this decision, and believes site-specific efforts will result in more detailed and cost-effective characterizations of flowpaths, local geology, and potential ground water release sources than a comprehensive regional effort could have achieved." The major conclusions of the risk assessment were:

- There is a low probability of significant human health effects based on current conditions. Potentially significant human health risks were indicated only in the case of subsistence use of resources in a limited number of highly impacted areas, which was considered highly unlikely.

- There is a low probability of population level impacts to regional wildlife based on current conditions and the low percentage of impacted areas in comparison to unaffected surrounding habitat.

- There is a high probability of subpopulation and/or individual effects occurring for ecological receptors residing in the vicinity of highly impacted areas. For example, small animals such as rodents, with home ranges of only a few acres, have a higher probability of adverse effects if they live in impacted areas.

- There is a potential for risks to aquatic and riparian ecological receptors residing in highly impacted areas as indicated by significant exceedances of conservative benchmarks for surface water, sediment, and fish tissue concentrations (groundwater was not included in this conclusion).

Figure 3.1-5 Ecological Conceptual Site Model

The COPCs for future site-specific CERCLA studies are: cadmium, chromium, nickel, selenium, vanadium, and zinc. The IDEQ recommended that chromium, nickel, and vanadium be excluded from mine-specific surface water and vegetation analyte lists but remain on soil and sediment lists. Selenium and cadmium are considered to be the primary hazard drivers on a regional basis.

The IDEQ then prepared a draft Area-Wide Risk Management Plan that was released for public review between May through July 2003. The Final Area-Wide Risk Management Plan was released by IDEQ in February 2004 (IDEQ 2004a). The Area Wide Risk Management Plan is intended to provide discretionary guidance to agencies responsible for site-specific, non-time critical removal actions at phosphate mines under the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA). This removal action process for any one site includes site-specific inspection/investigations (SI), engineering evaluation/cost analysis (EE/CA), removal action implementation, and removal closeout to include post-removal controls and monitoring. Each EE/CA and corresponding Agency Recommended Alternative will be subject to formal public comment to solicit input from stakeholders and interested parties.

Based on the results of the detailed risk management evaluation, the IDEQ recommended removing copper from the list of COPCs for all environmental media, since the observed concentrations are well below the risk-based action levels. Because of low media-specific concentrations observed in previous sampling events, IDEQ also recommended removal of chromium, nickel, and vanadium from future mine-specific surface water and vegetation analyte lists, but suggested these remain on soil and sediment analyte lists. These constituents exhibit relatively low concentrations in the regional water data and do not appear to present measurable risks associated with plant uptake. The Risk Management Plan contains four regional removal action goals with associated removal action objectives. In addition, the Plan includes Area Wide Action Levels for the COPCs in a variety of environmental media.

In June 2001, the Idaho Division of Health, Bureau of Environmental Health and Safety (BEHS), issued a Health Consultation report on selenium in beef, elk, sheep, and fish in the phosphate production area of Southeastern Idaho (BEHS 2001). The health consultation only addressed public health significance of exposure to selenium in wild game and livestock and did not address health implications to Native Americans. The BEHS concluded that sheep or cattle taken directly off seleniferous pasture to slaughter, and the liver of elk grazing on pasture with elevated selenium, could present an indeterminate public health hazard but more information is needed to evaluate the risk. Elk muscle and cattle subjected to depuration before slaughter were not considered a public health hazard. Cutthroat trout from East Mill Creek did not appear to present a public health hazard.

The same agency released another Health Consultation in May 2003 on selenium in fish from the upper Blackfoot River watershed (BEHS 2003). The BEHS advised in this report that children under the age of seven should not eat more than four meals per month of Yellowstone Cutthroat and Brook Trout from East Mill Creek. No rainbow trout were captured in this stream. Idaho fishing regulations designate the upper Blackfoot River watershed as a catch and release fishery and keeping Yellowstone Cutthroat Trout from the river, or its tributaries, is illegal.

Smoky Canyon Mine Studies

The Simplot Smoky Canyon Mine conducted sampling of vegetation and growth medium in 2000 at reclaimed areas of the mine to identify any relationships between selenium concentrations in the growth medium and the reclamation vegetation (JBR 2001a). Statistically designed soil and vegetation sampling was conducted in six areas of the mine having different reclamation treatments. Samples were analyzed for selenium and other COPCs. Good correlation was found between selenium concentrations in vegetation and extractable selenium concentrations in the growth medium (correlation coefficient = 0.92 with α less than 0.01). Selenium concentrations were lowest to highest in samples of Timothy, smooth brome grass, wheat grass, clover, alfalfa, and Sanfoin. Grass typically had low (less than 5 mg/Kg) selenium concentrations even when total selenium in the growth medium was greater than 5 mg/Kg. Legumes and other forbs were responsible for most of the elevated average selenium concentrations in vegetation. Selenium concentrations in vegetation were elevated where the growth medium was seleniferous shale and were at baseline levels where seleniferous overburden had been covered with chert and salvaged topsoil. Where vegetation was rooted in ROM overburden with no topsoil, average selenium concentrations in vegetation ranged from 5.8 to 31.7 mg/Kg. Where vegetation was growing in topsoil over ROM overburden, average selenium concentrations ranged from 4.8 to 7.1 mg/Kg. Where vegetation was growing in topsoil over chert, the average selenium concentration was 0.36 mg/Kg. The IDEQ removal action level for selenium in vegetation is 5 mg/Kg (IDEQ 2004a). None of the removal action levels for other COPCs were exceeded in the vegetation samples from this study.

Simplot conducted Site Investigations at the Smoky Canyon Mine during 2003 and 2004 under a CERCLA Administrative Order on Consent (AOC) with the USFS and other state and federal agencies (NewFields 2005b). These investigations documented sources of COPCs at the mine, the contaminant migration pathways, and apparent impacts by comparing the concentrations of COPCs with removal action levels developed by the IDEQ in the Area-Wide Risk Management Plan (IDEQ 2004a).

The results of these investigations for vegetation indicated that selenium was the only COPC that exceeded any IDEQ removal action level. Mean selenium concentrations of forage (grass and forbs) samples collected from two overburden disposal areas at the mine with thin or no topsoil exceeded the removal action level, whereas concentrations from more extensively reclaimed (thicker topsoil or chert cover) areas were at or below the removal action level. None of the browse (woody plants) samples exceeded the removal action level.

Selenium concentrations in two overburden seeps and three runoff retention ponds during parts of the year were greater than the removal action level intended to protect livestock water use (0.05 mg/L). Concentrations in the same two seeps and one retention pond were greater than the removal action level intended to protect transient wildlife that may use the water for drinking (0.2 mg/L).

The Site Investigations found that exceedances of the selenium standard in surface water (0.005 mg/L) were primarily focused to Pole Canyon Creek below the Pole Canyon overburden disposal fill, Hoopes Spring, and lower Sage Creek below the confluence with Hoopes Spring. The creek below the Pole Canyon overburden fill is affected by its being routed beneath the fill in a French drain, a former design practice no longer followed. Elevated selenium in Hoopes Spring was attributed to groundwater infiltration originating from the base of the Pole Canyon overburden fill. Water from Hoopes Spring contributes more than one-half the flow in lower Sage Creek, thus lower Sage Creek has also been affected by seepage from the Pole Canyon overburden fill. Selenium concentrations in Crow Creek below the confluence with Sage Creek did not exceed the selenium standard.

COPC concentrations in sediments were less than removal action levels at all locations, except lower Pole Canyon Creek, which contained sediments that exceeded removal action levels for all COPCs except copper.

Selenium concentrations in fish were at or below background concentrations (8.3 mg/Kg dry weight (dw)) as reported in the Area-Wide Risk Assessment in all locations except Hoopes Spring and lower Sage Valley where the fish concentrations ranged from 14.1 to 31.8 mg/Kg dw and 13.5 to 19.3 mg/Kg dw, respectively. According to the Site Investigation Report (NewFields 2005b), EPA has identified protective concentrations ranging from 9.5 to 15 mg/Kg dw for salmonid species including rainbow and cutthroat trout. Based on measured selenium concentrations, risk to aquatic invertebrates appeared to be acceptable in all areas except lower Pole Canyon Creek.

The Engineering Evaluation/Cost Analysis (EE/CA) prepared for the Smoky Canyon Mine Area A presented and evaluated a range of removal action alternatives to address the environmental conditions identified in the SI (NewFields 2006a). The EE/CA report contained: a review of the screening criteria and provided goals and objectives for removal actions; summary of SI findings; technical information supporting identification and development of removal action alternatives; identification of removal action alternatives including options that were screened out of consideration; detailed analyses of the removal action alternatives under consideration; comparative analysis of alternatives; and, recommendations for removal actions that are applicable at the site.

The USFS' preferred Removal Action Alternative, as identified in the EE/CA, was to respond to releases of hazardous substances from the Pole Canyon Cross Valley Overburden Fill. This was shown in the SI to be responsible for surface water contamination of Pole Creek and groundwater contamination discharged at Hoopes Spring. The preferred response for this source included: 1) diversion of Pole Creek around the overburden fill to reduce production of contaminated leachate, 2) an infiltration gallery upstream of the overburden fill to capture overflow clean water and infiltrate it into the groundwater, 3) run-on control structures, and 4) return of water to Sage Valley that has been unaffected by contact with the overburden. This response was designed to clean up the existing contamination of Pole Creek downstream of the overburden fill and significantly reduce existing groundwater contamination downgradient of the overburden fill, including contaminated water discharging from Hoopes Spring. More information on this removal action, the schedule for its implementation, and its anticipated effectiveness for reducing existing contamination is contained in **Appendix 2A**.

A public comment period was held to obtain public input on the Smoky Canyon Mine SI and EE/CA. This included a number of public meetings and the opportunity for the public to review the documents and submit written comments. This public comment period closed on July 24, 2006. Approval to commence Removal Actions at the Pole Canyon ODA was given to Simplot on October 2, 2006. Since then, Simplot has commenced construction of the approved removal action.

In October 2006, ongoing monitoring activities at the Smoky Canyon Mine discovered that selenium concentrations in South Fork Sage Creek downstream of the existing Smoky Canyon Mine operations were in excess of the surface water standard, ranging from 0.0056 mg/L in October 2006 to 0.0081 mg/L in January 2007 (NewFields 2007a). The source of this selenium was described as primarily being increased recharge of precipitation runoff through disturbed areas at Panel E along with some contribution from the same source as Hoopes Spring

(NewFields 2007b and **Appendix 2A**). The proposed future mine closure activities at Panel E, along with the removal actions being constructed at the Pole Canyon overburden fill, are expected to reduce the selenium load to South Fork Sage Creek from these two sources by approximately 80 percent within 5 to 10 years after closure of the Panel E operations (NewFields 2007b and **Appendix 2A**).

Smoky Canyon Tailings Pond Studies

A number of baseline studies, environmental analyses (EISs and EAs), wetland mitigation plans, and closure plans have been prepared in the past for Simplot's Smoky Canyon tailings ponds. These studies have been previously introduced in **Section 2.2.2**. In addition, Simplot has entered into a site-specific Administrative Order on Consent (AOC) for the Smoky Canyon Mine with the IDEQ, EPA, BLM, USFS, and USFWS to characterize sources, contaminant migration pathways, and potential environmental and human health effects associated with the operation of the Smoky Canyon Mine. The entire mine site has been divided into Areas A (the mineral extraction and mill area on federal land) and B (the tailings impoundments area located on Simplot-owned property).

Considerable data have been collected and interpreted in the following reports for Area B to describe the tailings ponds and the environmental conditions in their vicinity:

- Groundwater and Environmental Media Investigation Work Plan, November 2002.
- Baseline Ecological Risk Assessment Work Plan, Supplemental Information on Exposure Estimation and Risk Assessment Methods, December 2002.
- Baseline Ecological Risk Assessment Report, July 2003.
- Groundwater and Environmental Media Investigation Report, September 2003.
- Final Tailings Impoundment Recommendations Report, January 2004.

Extensive site sampling and surveying was conducted in 2002 and included water, sediment, vegetation, invertebrates, fish, mammals, and waterfowl. Additionally, the Idaho Department of Fish and Game (IDFG) conducted surveys for bald eagles, waterfowl, and shorebirds. Recommendations were made to minimize residual water in the ponds during final closure as well as amending the growth medium and selecting specific reclamation vegetation species to reduce selenium uptake by vegetation (MFG 2004a). More specifics on the proposed tailings pond closure are included in **Section 2.3.7**.

Monitoring of surface water in Tygee Creek downstream from the tailings impoundments has indicated that there was not evidence of adverse effects from the impoundments to surface water quality. No water quality standards were exceeded, and overall water quality in the stream has improved over the historic baseline since a second tailings pond was constructed (MFG 2004a). Groundwater studies indicated there was no evidence of adverse effects from the impoundments to the groundwater with little potential for migration of tailings pond water into the subsurface. Concentrations of metals and metalloids were at or near detection levels in shallow groundwater immediately down gradient of the tailings impoundments (MFG 2004a).

Exposure modeling suggested that individual waterfowl or subpopulations that reside at the tailings impoundments may be exposed to concentrations that exceed toxicity benchmarks for chromium and selenium. Migratory or transient waterfowl exposure was below levels of potential concern (MFG 2004a). Reduction and control of shoreline nesting habitat at the tailings ponds was requested by the IDEQ, BLM, EPA, and USFWS to protect waterfowl from excessive exposure to COPCs. Overall, mammalian populations were determined not at risk of adverse effects, but individual omnivores and predators that spend most of their lives at the ponds could be at risk from exposure to COPCs (MFG 2004a). Risk to individual bald eagles was shown to be below a level of potential concern unless they obtained over 50 percent of their prey from the tailings ponds.

3.1.7 Mineral Resources

Phosphate rock minerals are the only significant global source of phosphorus. The main economic use of phosphate rock is production of phosphate fertilizers, primarily diammonium phosphate (DAP). Fertilizers are increasingly important to feed the growing world population because, although demand for food will increase, the area of cultivated land is not expected to increase significantly. For this reason, commercial fertilizers will become increasingly important to meet the nutritional requirements of the world's population (USGS 1999). The United States is the world's largest producer and consumer of phosphate rock. More detailed information on U.S. and international phosphate markets is presented in **Section 3.16**.

Phosphate rock and fertilizer production is expected to remain steady or increase slightly in Idaho and Utah for the foreseeable future because this output is primarily used domestically (USGS 2003a). Simplot began construction operations at Smoky Canyon Mine in 1982 and is the largest phosphate rock producer in Idaho. Over 50 million tons of phosphate ore reserves were projected to exist at the Smoky Canyon site before mining began (USFS 1981).

Phosphate Leasing Program and Description of Existing Rights

Domestic phosphate ore mining rights are granted under a federal leasing program, in accordance with the Mineral Leasing Act of 1920 (as amended) and applicable regulations. Mineral leases are administered by the BLM. These leases, purchased by mining companies, convey the right to mine and develop phosphate resources within the lease, in accordance with applicable federal, state, and local requirements.

Mineral Economics

Costs associated with mining include removal of overburden as well as mining and processing costs of the ore. Because deeper ores require excavation of a larger pit, the ratio of overburden to ore, or stripping ratio, increases with pit depth. As ore depths increase, economic return decreases, and at a certain depth, mining of the phosphate ore becomes uneconomic. The depth at which ore recovery becomes uneconomic is also affected by ore grade, weathering, and other factors including capital costs and operational costs specific to the operation. Economics are also affected by supply and demand, foreign producers, and by proximity of deposits to processing facilities.

Proximity to existing mining and processing facilities affects mine economics due to capital expenditures and uncertainty of reserves. A large capital expense is necessary to build and staff new mining and processing facilities, so the use of existing facilities allows new deposits to be mined more economically. The Proposed Action and Alternatives would use the existing facilities at the Smoky Canyon Mine to mine the phosphate ore in Panels F and G, concentrate the ore, and pipe the concentrate slurry out from the mine to the Simplot fertilizer plant in Pocatello.

3.1.8 Topographic Resources

The Project Area is located within two of the large-scale ecological units called subsections discussed in the EIS for the CNF RFP (USFS 2003b). The western portion of the Study Area is in the Webster Ridges & Valleys subsection while the rest of the Study Area is in the Pruess Ridges & Hills subsection (USFS 2003b). The Webster Ridges & Valleys subsection occurs at low-to-high elevations with slopes ranging from 10 to 65 percent. The Pruess Ridges & Hills subsection occurs on mid-to-high elevation sites with slopes ranging from 15 to 60 percent. These landscapes include mountainsides, canyons, ridges, and valleys eroded from sedimentary rocks that are folded in generally north-south trending patterns.

The Smoky Canyon Mine existing mine panels are located on the eastern flank of the Webster Range, which is the dominant topographic feature in the Study Area. The Webster Range is a generally north-south trending mountain range that extends for about 33 miles from Lanes Creek on the north to the Pruess Range on the south. Freeman Ridge and Snowdrift Mountain are prominent ridges on the west limb of the Webster Range in the Study Area. Elevations in the Study Area range from about 6,500 feet in the lower end of the South Fork Sage Creek, Manning Creek, and Deer Creek drainages, to about 8,500 feet along Freeman Ridge west of Panels F and G.

The Boulder Creek Anticline is located on the east flank of the Webster Range. The surface topography of the Boulder Creek anticline mimics the orientation of its sedimentary units, forming a gentle ridge parallel to the Webster Range from Deer Creek on the south to Smoky Canyon on the north. The west side of this Boulder Creek Anticline ridge is a topographic swale in the overall east-facing slope of the Webster Range. Along this swale, part of the Phosphoria formation has been eroded. The Smoky Canyon Mine panels follow this exposure of the Phosphoria. South of Deer Creek, the Boulder Creek Anticline ridge is not present along the east slope of the Webster Range, but the phosphate deposits still occupy the topographic swale that parallels Freeman Ridge and Snowdrift Mountain along their east side.

Numerous east-trending drainages flow down the east side of the Webster Range and feed Tygee, Sage, and Crow Creeks. The more prominent of these drainages from north to south are Smoky Creek, Pole Creek, Sage Creek, and South Fork Sage Creek. Further south there are Deer Creek and Wells Canyon, which are tributary to Crow Creek. Crow Creek flows north and northeast out of the Study Area in a flat-bottomed alluvial valley bounded on the south by the Gannet Hills and on the north by Tygee Ridge.

3.1.9 Paleontological Resources

Sedimentary rocks of southeastern Idaho have paleontological resources consisting of vertebrate, invertebrate, and paleobotanical fossils including fish and shark remains. Fossils found in the Smoky Canyon Mine area are not unique to the Study Area or Southeastern Idaho. They are found throughout the region wherever similar formations exist (JBR 2001b).

The Paleozoic and Triassic-age bedrock units are generally fossiliferous. Fossils in the Wells formation were described by G.H. Girty (Mansfield 1927) as predominantly consisting of bryozoa and brachiopods with wide distribution (BLM and USFS 2000).

The Meade Peak member of the Phosphoria formation contains abundant pelecypods, gastropods, and brachiopods, as well as ammonites, nautiloids, crinoids, bryozoa, and sponge spicules. The base of the Meade Peak member contains a thin marker bed identified as the fishscale bed, which contains disarticulated fish fossils including Heliocoprion fossils (BLM and USFS 1992). The Rex Chert member of the Phosphoria formation contains brachiopods, crinoid fragments, and sponge spicules (Mansfield 1927).

3.2 Air Resources and Noise

The Study Area for air resources, relative to the Smoky Canyon Mine Panels F and G Expansion Project, consists of the immediate Study Area, the surrounding airshed (designated as Airshed 20), and out from the Study Area to a radius of 100 kilometers (60 miles) based on the Class I National Ambient Air Quality Standards (NAAQS). The NAAQS are defined in the federal Clean Air Act as levels of pollutants above which detrimental effects on human health and welfare may occur. Class I areas have the highest air quality protection standards while Class II areas have a moderate level of protection. All lands within the Project Area have been designated Class II. The nearest Class I area to the Project Area is the Bridger Wilderness, approximately 70 miles east of the CNF. Grand Teton and Yellowstone National Parks, also Class I areas, are both more than 75 miles away. These are all further away than the 60-mile NAAQS radius.

In general, the climate is typical of Rocky Mountain areas influenced by major topographic features. Nearby mountain ranges (e.g. Snowdrift Mountain and Freeman Ridge) trend primarily north to south and have an impact on local winds, as well as temperature and precipitation patterns in the immediate area. Based on the Smoky Canyon Mine's SWPPP, the annual precipitation in the vicinity of the Smoky Canyon Mine is 30-35 inches (Simplot Agribusiness 2004).

The valleys in the immediate Project Area have elevations that range from approximately 6,200 feet AMSL to 6,700 feet AMSL. These valleys have a middle-latitude steppe climate. The summers tend to be warm to hot and are typically dry. Winters are typically cold and the ground cover is snow packed.

Afton, Wyoming has a mean monthly average temperature of 61.7 degrees Fahrenheit (F) in July and a mean monthly average temperature of 16.4 degrees F in January (WRCC 2004).

3.2.1 Air Resources

The State of Idaho regulates and controls air pollution through Title 39 of the Idaho Code. The USFS, which administers much of the Study Area land, protects air quality through compliance with these rules, regulations, and procedures under the IDEQ. The Smoky Canyon Mine has an air quality permit issued by the IDEQ. This air permit was issued in the early 1980s and applies to the control of haul road fugitive dust by limiting speed and applying water sprays and to the identification of the mill's boiler as a point source of emissions.

The State of Idaho has adopted EPA's NAAQS for criteria air pollutants. The criteria pollutants are ozone, carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter with aerodynamic diameter less than or equal to 10 microns and 2.5 microns (PM_{10} and $PM_{2.5}$), and lead (Pb). The NAAQS are shown in **Table 3.2-1**.

TABLE 3.2-1 STATE OF IDAHO AND NATIONAL AMBIENT AIR QUALITY STANDARDS

POLLUTANT	AVERAGING TIME	CONCENTRATION
Ozone	1 hour	235 µg/m^3 (0.12 ppm)
	8 hours	157 µg/m^3 (0.08 ppm)
Carbon Monoxide (CO)	1 hour	40,000 µg/m^3 (35 ppm)
	8 hours	10,000 µg/m^3 (9.0 ppm)
Nitrogen Oxides (NO$_x$)	Annual Arithmetic Mean	100 µg/m^3 (0.05 ppm)
Sulfur Dioxide (SO$_2$)	3 hours	1,300 µg/m^3 (0.5 ppm)
	24 hours	365 µg/m^3 (0.14 ppm)
	Annual Arithmetic Mean	80 µg/m^3 (0.03 ppm)
Particulate Matter as PM$_{10}$ (Aerodynamic diameter ≤ 10 microns)	24 hours	150 µg/m^3
	Annual Arithmetic Mean	50 µg/m^3
Particulate Matter as PM$_{2.5}$ (Aerodynamic diameter ≤ 2.5 microns)	24 hours	65 µg/m^3
	Annual Arithmetic Mean	15 µg/m^3
Lead (Pb)	Quarterly Arithmetic Mean	1.5 µg/m^3

Note: µg/m^3 = micrograms per cubic meter; ppm = parts per million
Source: Code of Federal Regulations, 40 CFR Part 50, National Primary and Secondary Air Quality Standards

Ambient air quality standards for NO$_x$, SO$_2$, and PM$_{10}$ must not be exceeded at any time during the year in areas with general public access. Short-term standards for CO, NO$_x$, and SO$_2$ can be exceeded only once annually. Compliance with the 24-hour PM$_{10}$ and PM$_{2.5}$ standards is based on the 98th percentile of 24-hour concentrations averaged over three years. Fugitive dust and particulate control is regulated under Idaho Administrative Code (IDAPA) 58.01.01 for nonmetallic processing operations, haul roads, crushers, screens, material transfers, and stockpiles and must be controlled in accordance to IDAPA 808.01. Indian Reservations have similar regulations for man-generated fugitive dust and is stated in 40 CFR 49 Section 126. The ozone standard, which pertains to an area that meets the standard when the 3-year average of the annual 4th-highest daily maximum, 8-hour concentration is less than or equal to 0.08 ppm. The 1-hour standard applies only to airsheds that were in non-attainment status when the ozone rules changed in 2002.

According to EPA (1998, as cited in USFS 2003b), air quality on National Forest System lands is typically excellent. However, on occasion, pollutants from communities, industries, and agricultural activities outside of the Forest can adversely affect air quality within the Forest. Management activities within the Forest, such as prescribed burning and use of unpaved forest roads, can produce particulate matter and carbon monoxide emissions.

The air quality in the vicinity of the Smoky Canyon Mine is good to excellent because of the site's remote location and relatively limited industrial activity in the area. The Air Quality Index (AQI) is a daily EPA rating system, evaluating the mix of air pollutants one is likely to breathe. If an airshed receives an AQI rating of 100, there are health-based concerns. Lincoln County, Wyoming had only 1 day with an AQI over 100 in the last 4 years. This was reported from the FMC Skull Point Mine near Kemmerer. Caribou County experienced 12 days with an AQI over

100 in 2001. According to IDEQ, these exceedances were all recorded at the fence line of Monsanto's elemental phosphorous plant in Soda Springs. No other monitors showed AQI values over 100 in the Caribou County monitoring network (EPA 2003a).

Air quality in the Study Area is designated as in attainment or unclassifiable for all NAAQS and Idaho Ambient Air Quality Standards. No violations of the national or state air quality standards have been documented in the region since the 2001 episode. There is no record of Simplot's Smoky Canyon Mine ever receiving a Notice of Violation or having caused an NAAQS exceedance episode in regard to air quality.

The closest non-attainment area is located in the Portneuf Valley airshed in the area of Pocatello and Chubbuck, Idaho, which has exceeded NAAQS for PM_{10}. While there were three exceedances of the 24-hour PM_{10} standard in 1999, this episode did not register as a violation of the standard since no other exceedance occurred prior to December 31, 2001. The area's 24-hour PM_{10} standard has not been violated since 1993 (IDEQ 2004a). IDEQ has requested the EPA redesignate this airshed as "attainment".

The main emissions that are generated by mining operations include particulate matter generated from in-pit operations and haul truck traffic. These sources are both considered fugitive sources and are regulated by opacity standards and controlled by fugitive dust mitigation measures. Fugitive dust mitigation measures are usually stated in the sources air permit, as in Smoky Canyon's permit, or in a separate fugitive dust control plan.

Air Quality Monitoring Data

The IDEQ has conducted ambient air sampling and data collection in the region. The majority of the sampling and data collection sites within the airshed are located to the north and west of the Smoky Canyon Mine. These sites typically monitor background levels for criteria pollutants near and around Pocatello and Soda Springs, Idaho. The closest monitoring locations in Lincoln County, Wyoming are more than 50 miles south of the Project Area near industrial facilities around Kemmerer, Wyoming.

Twelve years (1990 through 2002) of PM_{10} ambient air quality data has been collected at the Caribou County monitoring locations, with monitors located in Soda Springs recording higher values than those located throughout other portions of the county (EPA 2003a). The annual average ambient concentration of PM_{10} throughout this period has been approximately one-half of the NAAQS limit. In 2003, the second high, 24-hour average PM_{10} concentration exceeded the NAAQS in the Caribou County. The state of Idaho ended PM_{10} monitoring in Caribou County in 2002. $PM_{2.5}$ monitoring began in 2002. There were no exceedances of PM_{10} or $PM_{2.5}$ in 2002 or 2003. The previous exceedance for PM_{10} for this county was in 1992. However, in each of the other years within the monitoring period, average annual 24-hour PM_{10} concentrations were recorded at approximately one-third of the standard.

Air Quality Source Classification

The area surrounding the Smoky Canyon Mine Project Area is designated as Class II, as defined in the federal Prevention of Significant Deterioration (PSD) program (IDEQ 2002a). Moderate degradation of air quality is allowed to occur within certain prescribed limits above baseline levels within a Class II designated area. Industrial sources desiring to locate or expand within a Class II area must demonstrate that the increased emissions will not cause significant degradation of air quality in all classified areas and will not cause visibility degradation in Class I areas.

Within designated Class I PSD areas, the level of deterioration allowed, and therefore the standards prescribed, are much more stringent. Class I areas typically include wilderness areas and National Parks. Within 125 miles of the Smoky Canyon Mine Project, the Federal Mandatory Class I areas include: Yellowstone National Park, Grand Teton National Park, the Bridger Wilderness Area in Wyoming, and Craters of the Moon National Monument in Idaho. A general distance guideline in evaluating Class I area impacts is 60 miles. The Federal Clean Air Act legally mandates that Class I areas be evaluated for haze and visibility impacts if a new or major-modification facility is planned within 60 miles of a Class I area. A major action, (i.e., construction) or event (wildfires) are also subject to visibility and haze impacts analyses. **Table 3.2-2** presents the distances and directions to the nearest Class I areas. The Smoky Canyon Mine is located more than 70 miles away from the nearest Class I areas, thus an evaluation for impacts to these areas was deemed unnecessary for **Chapter 4**.

TABLE 3.2-2 FEDERAL MANDATORY CLASS I AIRSHEDS NEAREST THE SMOKY CANYON MINE PROJECT

AREA	DIRECTION FROM PROJECT	DISTANCE FROM PROJECT (MILES)
Grand Teton National Park	Northeast	77
Bridger Wilderness Area	East	75
Yellowstone National Park	North	102
Craters of the Moon National Monument	Northwest	120

Existing Sources

Within the designated airshed (Airshed 20) of the Smoky Canyon Mine, there are four active mine sites. Mining operations emit primarily fugitive particulate matter from mining, truck hauling, and ore crushing. Heavy equipment internal combustion engines used in the mining process (loading, hauling, electrical generation, etc.) generate primarily gaseous (NO_x, SO_2, CO, and VOC) emissions and measurable quantities of fine particulate matter.

Table 3.2-3 identifies those stationary industrial air emission sources within Caribou, Bingham, and Bear Lake Counties, Idaho and Sublette and Lincoln Counties, Wyoming that have air quality permits issued by the states of Idaho or Wyoming. Operating by the regulations stated in their permits and by the regulations in the Idaho Code and Wyoming Air Quality Control Regulations, these facilities are permitted to emit PM_{10}, as well as products of combustion (NO_x, SO_2, CO, and VOC) from engines, kilns, boilers, crushing, and other processes. The majority of the sources are located more than 20 miles away from the Smoky Canyon Mine. The Soda Springs area has four major sources, but based on the winds and meteorological factors, these sources have little impact on the Smoky Canyon Mine area.

Unpermitted and mobile sources of air pollutants are common in rural settings. Agricultural operations, agricultural burns, forest prescribed burns, open burning/wildfires, road traffic, off-road vehicle use, and construction in the immediate area are all sources of fugitive particulate matter in the Study Area. The EPA estimates that these types of air pollution sources contribute up to 52 percent of the particulate matter emissions in adjacent Lincoln County (EPA 2003a).

TABLE 3.2-3 PERMITTED INDUSTRIAL EMISSION SOURCES - (WITHIN 60 MILES)

SOURCE	COUNTY, STATE
NW Pipeline Compressor Station, Peagram	Bear Lake, ID
NW Pipeline Compressor Station, Soda Springs	Bear Lake, ID
Professional Manufacturing, Inc.	Bear Lake, ID
Montpelier School District	Bear Lake, ID
Cargoll, Inc.	Bear Lake, ID
Basic American Foods Dehydrator	Bingham, ID
Smoky Canyon Mine	Caribou, ID
Kerr McGee Vanadium Chemicals	Caribou, ID
P4 Production L.L.C. (Monsanto)	Caribou, ID
Nu West Phosphates Fertilizers	Caribou, ID
FMC Dry Valley Mine (Not active)	Caribou, ID
Saddle Ridge Compressor Station	Sublette, WY
Big Piney Compressor Station	Sublette, WY
Exxon - Labarge Dehydration Facility	Sublette, WY
Amoco Pipeline - Labarge Station	Sublette, WY
Exxon Shute Creek Natural Gas Processing Plant	Lincoln, WY
PacifiCorp Naughton Power Plant	Lincoln, WY
Pittsburg & Midway Bituminous Coal & Lignite Mine	Lincoln, WY
Johnson Ready Mix	Caribou, ID
Brancroft Grain	Caribou, ID

In addition to IDEQ regulations on air quality, the CNF is subject to the Montana/Idaho State Airshed Group Smoke Management Plan, and the EPA Interim Air Quality Policy on Wildland and Prescribed Fires (USFS 2003b). The objective of compliance with these requirements is to reduce impacts from smoke and protect public health. Smoke from fire management activities and wildfire has potential to affect air quality and visibility on the CNF and surrounding areas. Fires produce carbon monoxide, nitrogen oxides, volatile organic compounds, and particulate matter.

3.2.2 Noise

To properly assess the noise resources for any area, an explanation of noise effects, consideration of the topography, climate, flora, and current ambient noise is required. The affected environment for noise impacts is usually limited to a distance of 880 yards (2,640 feet) from the source based on current wildlife studies (Fletcher 1980). However, if residential housing has the potential to be impacted, the affected environment includes the distance from the source of the noise to the residence. The basic equations for determining noise attenuation are based on the ISO 9613-2 Acoustics- Attenuation of Sound During Propagation Outdoors (ISO 1996). The equivalent continuous downwind octave-band sound pressure level at a receiver location, L_{fT}(DW), can be calculated for each point source using the following equation:

$$L_{fT}(DW) = L_w + D_c - A$$

Where L_w is the octave-band sound power level in decibels, produced by the point sound source; D_c is the directivity correction, in decibels; and A is the octave-band attenuation, in decibels. Since the sound source is radiating into free space $D_c = 0$ for these calculations. Attenuation (A) is quantified by the summation of the following factors:

$$A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}$$

With these factors representing attenuation due to:

A_{div} = geometrical divergence
A_{atm} = atmospheric absorption
A_{gr} = ground effect
A_{bar} = topography and man-made barriers
A_{misc} = miscellaneous factors, including vegetation

Noise Attributes

Noise is an unwanted sound occurrence. A noise's attributes (pitch, loudness, repetitiveness, vibration, variation, duration, and the inability to control the source) determine how it affects a receptor. The study of noise involves three important characterizing parameters: pressure, power, and intensity. The power of an oscillating sound wave is composed of kinetic and potential energies. The intensity of a sound wave is defined as the average rate at which power is transmitted per cross-sectional area in the direction of travel. Noise versus sound is a subjective measurement, thus a receptor's reaction to sound is a poor measurement of noise.

Noise Measurements

The unit of sound level measurement (i.e., volume) is the decibel (dB), expressed as dBA (decibel-A weighted). The A-weighted decibel measure is used to evaluate ambient noise levels and common noise sources. Sound measurements in dBA give greater emphasis to sound at the mid- and high- frequency levels, which are more discernible to humans. The decibel is a logarithmic measurement; thus, the sound energy increases by a factor of 10 for every 10 dBA increase.

Generally, natural noise levels will be around 35 dBA in rural areas away from communities and roads. Within a rural community, the man-made noise level ranges from 45 dBA to 52 dBA (EPA 1981). The day-night sound level of residential areas should not exceed 55 dBA to protect against activity interference and annoyance (EPA 1981). **Table 3.2-4** presents typical sound levels in dBA and subjective descriptions associated with various noise sources.

TABLE 3.2-4 SOUND LEVELS ASSOCIATED WITH ORDINARY NOISE SOURCES

NOISE SOURCE	NOISE LEVEL	SUBJECTIVE DESCRIPTION
Commercial Jet Take-Off	120 dBA	Deafening
Road Construction Jackhammer	100 dBA	Deafening
Busy Urban Street	90 dBA	Very loud
Standard For Hearing Protection 8-Hour Exposure Permissible Exposure Limit (PEL) (MSHA) Action Level within Active Mining Facilities	90 dBA 85 dBA	Very loud Loud - to very loud
Construction Equipment at 50 feet	80-75 dBA	Loud
Freeway Traffic at 50 feet	70 dBA	Loud
Noise Mitigation Level for Residential Areas Federal Housing Administration (FHA)	67 dBA	Loud
Normal Conversation at 6 feet	60 dBA	Moderate
Noise Mitigation Level for Undisturbed Lands (FHA)	57 dBA	Moderate
Typical Office (interior)	50 dBA	Moderate
Typical Residential (interior)	30 dBA	Faint

Figure 3.2-1 Noise

Noise Regulations

The Federal Noise Control Act of 1972 established a requirement that all federal agencies administer their programs to promote an environment free of noise that jeopardizes public health or welfare. Although the Occupational Safety and Health Administration (OSHA) has the most extensive regulations in regard to noise pollution, these standards are only for noise levels within the workplace.

EPA identifies outdoor noise limits to protect against effects on public health and welfare by an equivalent sound level (Leq), which is an A-weighted average measure over a given time. Outdoor limits of 55 dBA Leq have been identified as desirable to protect against speech interference and sleep disturbance for residential areas and areas with educational and healthcare facilities. Sites are generally acceptable to most people if they are exposed to outdoor noise levels of 65 dBA Leq or less, potentially unacceptable if they are exposed to levels of 65 – 75 dBA Leq, and unacceptable if exposed to levels of 75 dBA Leq or greater (EPA 1981).

Noise Issues

Loud noise can interfere with communications, cause fatigue and tiredness, reduce efficiency, affect attitudes, and distract and disrupt human activities. Noise concerns related to residential areas are mostly 'quality of life' impacts where moderate to low intensity noise can be an annoyance. An evaluation of baseline noise conditions was accessed in order to determine the potential changes from current levels.

3.2.3 Methodology and Results

The objective for this study was to assess noise-generating activities under typical operating conditions at the Smoky Canyon Mine and to measure current, typical, noise levels at various locations within the Study Area currently unaffected by the existing Smoky Canyon Mine. At the Smoky Canyon Mine area, noise measurements were taken for existing access road traffic, haul road traffic, in-pit activities, and blasting. Haul road noise levels were further segregated into flat terrain, steep grade terrain, haul and dump traffic, and haul and access road traffic. Measurements of noise were taken at different distances. Terrain and vegetation characteristics were also considered when determining the location for sound level measurements. **Table 3.2-5** shows the Leq measurements taken at the active mining areas, under typical operating conditions. **Figure 3.2-1** displays the locations where the measurements were taken.

Background noise measurements were also collected south of the existing Smoky Canyon Mine operations within the Study Area in May 2004. **Table 3.2-6** presents the background noise measurements at various locations. No unnatural sounds were heard during the background noise measurements (i.e., road traffic, car horns, etc.). **Figure 3.2-1** displays the location where the measurements were taken. These sites were selected for comparisons to be made with future noise impacts.

TABLE 3.2-5 SOUND LEVELS ASSOCIATED WITH EXISTING SMOKY CANYON MINE ACTIVITIES

NOISE SOURCE TYPE (SITE LOCATION)	LEQ* (DBA)	MAXIMUM MEASURED (DBA)
Smoky Canyon Access Road during morning "rush hour" commute. Measurements were taken at a distance of 120 feet from edge of road (A-6).	47.4	66.6
Panel C Haul Traffic where it crosses the Smoky Canyon Road. Measurements were taken at a distance of 300 feet from edge of haul road (B-2).	60.6	73.0
Panel C Haul Traffic and Overburden Filling Measurements were taken at a distance of 20 feet from edge of haul road (C-2).	70.4	87.5
In-Pit Loading of Haul Trucks. Measurements were taken at a distance of 125 feet from loader (D-2).	74.4	87.9
In-Pit Drilling. Measurements were taken at a distance of 130 feet from drill (D-5).	81.7	85.9
Panel C Blasting. Measurements were taken at a distance of 3,170 feet from location of blast (BL-1).	Not Applicable	74.4

* Measurements were averaged over a 5-10 minute timeframe.

TABLE 3.2-6 BACKGROUND NOISE MEASUREMENTS COLLECTED SOUTH OF MINING OPERATIONS

NOISE SOURCE TYPE (SITE LOCATION)	LEQ* (DBA)	MAXIMUM (DBA)	MINIMUM (DBA)
Manning Creek Road near Crow Creek Road (E-1)	34.6	54.4	27.9
Crow Creek Road near Deer Creek w/15 mph wind (E-2)	55.7	80.8**	27.8
Crow Creek Road near Deer Creek no wind (E-3)	38.6	55.4	28.3
Crow Creek Road near Residence (E-4)	35.7	47.5	27.7
Diamond Creek Road near Stream (BG-1)	41.1	52.3	37.1
Diamond Creek Road near Summit (BG-2)	38.4	45.1	37.4
Diamond Creek Road near South Fork Drainage (BG-3)	31.5	51.7	26.8

* Measurements were averaged over a 5-10 minute timeframe

** 80.8 dBA measurement was atypical and not used for comparison in this impact evaluation.

3.3 Water Resources

3.3.1 Surface Water Resources

Simplot's current mining activities are located in several watersheds that drain the east slopes of the north/south trending Webster Range (**Figure 3.3-1**), and ultimately into the Salt River drainage in Wyoming. The northernmost part of the existing Smoky Canyon Mine operations is within the Tygee Creek basin and several of its small tributaries. The southern part of the existing operations is within Sage Creek basin. The Panels F and G include lands in the South Fork Sage Creek, Manning Creek, Deer Creek, Nate Canyon, and Wells Canyon basins. These drainages are in the Crow Creek watershed (5^{th} Level Hydrologic Unit Code (HUC) 1704010507) (**Figure 3.3-1**). In addition, one of the proposed transportation corridors is located alongside Crow Creek. Crow Creek flows into the Salt River (HUC 17040105) approximately five miles downstream (northeast) of the Study Area boundary (**Figure 3.3-1)**.

A very small (17 acres) part of a proposed West Haul/Access Road drains toward the 34,000-acre Diamond Creek watershed (5th Level HUC 1704020712). All other transportation and mining alternatives lie entirely within the Crow Creek watershed.

Snow melt, rainfall, springs, and diffuse groundwater discharge all contribute to streamflow in the Project Area and its surroundings. In general, most runoff is attributed to snow melt; surface runoff from rainfall is typically low (USGS et al. 1975). The USFS notes, however, that flood flow events in this area of the Forest seem to represent an unresolved statistically mixed population of events due to various combinations of snow melt, local summer convective thunderstorms, and larger late summer tropical (monsoon) moisture from more southerly latitudes (Jim Laprevote, USFS Hydrologist, personal communication Sept 10, 2004). Maxim (2004c) reports that area streams normally peak in April, May, and June, with declining flows in late summer, fall, and winter. This temporal variability is reflected in the flow data described later in this section.

For most of the Project Area streams, where segments cross the Wells formation, all or most of the streamflow is lost to the permeable sandstone/limestone bedrock. This contributes to the spatial variability of reported streamflows in the area.

None of the streams within the Project Area have been designated by the State of Idaho as Outstanding Resource Waters or as Special Resource Waters (Idaho Administrative Code IDAPA 58.01.02). Neither are any of the streams in the Project Area designated under the Wild and Scenic Rivers System, or listed in the Nationwide Rivers Inventory as potentially possessing “outstandingly remarkable values” that may make them eligible for designation in the system (National Park Service 2004). Further, the USFS has determined that none of the streams in the area are eligible for inclusion in the Wild and Scenic Rivers System (USFS 1998). The USFS (2003b) recently rated CNF lands in regard to geomorphic integrity, water quality integrity, and watershed vulnerability. The Project Area has a moderate geomorphic integrity rating, low water quality integrity, and moderate watershed vulnerability.

The RFP for the CNF (USFS 2003a) contains goals, standards, and guidelines specific to managing surface water resources under various types of activities that may occur on the CNF. In regard to mining and road construction, forest-wide guidance that applies directly to surface water resources will be reviewed and evaluated as related to impacts analysis in **Chapter 4**.

Further, on a watershed basis, the RFP (USFS 2003a) includes guidelines for analyzing proposed projects in regard to non-point pollutant sources, beneficial use impairments, and percent of watershed that would be in a hydrologically disturbed condition at any one time.

In addition to forest-wide guidance, Prescription 2.8.3 applies within defined aquatic influence zones (AIZs), the delineation of which depends upon water source type (perennial, intermittent, wetland, etc.). AIZs in the Project Area are shown on **Figure 3.3-2**. Numerous goals are associated with AIZs in regard to protection of surface water resources; these are not outlined specifically here, but can be found in the RFP (USFS 2003a). Similarly, standards and guidelines associated with AIZs are not repeated here, but they generally focus on avoidance of AIZs. Relevant to this Project are guidelines for culverts and other road drainage features (USFS 2003a).

General watershed characteristics - including flow patterns - for each of the area streams are described below. Where data are available, stream flow measurements are summarized and discussed in regard to spatial and temporal variability. Most of these data are included in **Appendix 3A**. **Figure 3.3-2** designates perennial and non-perennial reaches as determined by baseline studies (Maxim 2004c). **Figure 3.3-3** shows stream (SW) and spring (SP) monitoring sites that are described in the following narrative. The sections (**3.3.2**, **3.3.3**, and **3.3.4**) following the watershed and streamflow descriptions contain information on surface water quality, channel morphology/streambed sediment, and surface water uses, respectively.

Salt River

As the Salt River flows through Star Valley, Wyoming, east of the Project Area, it collects flow from Crow Creek and Stump Creek, both of which collect flow from smaller drainages related to Simplot's existing and proposed operations. A USGS stream gauging station (#13027500) has been recording flow data on the lower Salt River since 1954 (USGS 2004b). The station is located above the Palisades Reservoir approximately 30 miles north of the Study Area. The maximum flow documented between 1954 and September 2002 was 5,090 cubic feet per second (cfs), recorded in early June 1986. Typically, snow melt runoff influences flows at the gage site between early April and late July; flows the remainder of the year are relatively uniform, averaging between 500 and 600 cfs (Miller and Mason 2000).

The Salt River watershed drains about 925 square miles. The watershed has been rated as being in good overall condition, with low vulnerability to pollutant loadings and other stressors (USFS 2003a).

Crow Creek

With a drainage area of a little more than 100 square miles, Crow Creek originates on CNF lands to the south of the Project Area. As it flows northeast toward Wyoming, it collects flow from Wells Canyon drainage, Deer Creek, Manning Creek, and Sage Creek in the Project Area, as well as other tributaries entering from the east (**Figure 3.3-1** and **Figure 3.3-2**). Crow Creek would ultimately receive all drainage from the proposed Panels F and G lease areas.

Historic flow monitoring data for the perennial Crow Creek is sparse. The 1981 Smoky Canyon DEIS (USFS 1981) showed a range of flow in Crow Creek just below Sage Creek in the last six months of 1979 from 35 to 68 cfs. Maxim (2004c, 2004d, and 2005a) obtained more recent flow data at various sites in Crow Creek to document spatial and temporal variability, at least within the narrow time frame and drought conditions experienced during that period (**Figure 3.3-3)**. According to their 2003 and 2004 records, flow increases downstream from the upstream station SW-CC-50 (0.8 cfs to 1.57 cfs) to SW-CC-800 (25 to 55 cfs), located approximately eight miles downstream of the Sage Creek confluence. While Maxim did not monitor these sites in 2005, their fall 2005 measurements at other sites along Crow Creek also showed flows increasing in a downstream direction Maxim (2005a). Primary sources of baseflow to Crow Creek are from several major springs in or near the Study Area: Stewart Springs in Stewart Canyon (SP-ST-100 and -200); Books Spring (SP-Books) between the mouth of Deer Creek and Nate Canyon; discharge from lower Deer Creek (between SW-DC-500 and -800); South Fork Sage Creek Springs (SP-SFSC-750); and Hoopes Spring (SP-Hoopes) in lower Sage Creek Valley. Combined baseflow discharge of these sources is about 15 cfs (Maxim 2004c). In addition, Crow Creek gains a measurable amount of flow between SW-CC-50 and SW-CC-300 due to discharge from the Wells formation into the valley alluvium (Maxim 2004c).

Figure 3.3-1 Location Map – Water Resources

Figure 3.3-2 Aquatic Influence Zones

Figure 3.3-3 Surface Water Monitoring Stations in Study Area

In May 2003, flows were measured in Crow Creek at two monitoring sites, one just upstream of the confluence with Sage Creek and one just downstream of that confluence (NewFields 2005b). The flow was about 23 cfs at the upper site, and about 42 cfs at the lower site; during that same monitoring event, flow was also measured at 16 cfs near the mouth of Sage Creek. On May 23, 2006, flows were up considerably in Crow Creek, with a reported 84 cfs upstream of the Sage Creek confluence and 140 cfs downstream of it (NewFields 2006b). By fall 2006, flows had decreased to 25 cfs below the confluence with Deer Creek and to 44 cfs below the confluence with Sage Creek, according to measurements made by NewFields (2007a) on October 18, 2006 (**Appendix 3A**).

Seasonality of Crow Creek flows is affected by irrigation withdrawals during the summer months; for example, at SW-CC-100, flows reported during the growing season in August 2003 and August 2004 (1.8 and 2.1 cfs, respectively) are much lower than the 10-11 cfs reported in October 2003, February 2004, May 2004, October 2005, and October 2006 outside the growing season (Maxim 2004c, 2004d, and 2005a; NewFields 2007a, **Appendix 3A**). Peak snowmelt flows would be substantially greater than this. For example, in the spring of 2005, Maxim (2005a) reported a flow of 76 cfs at SW-CC-300.

Sage Creek

The lowermost reaches of Sage Creek, from where South Fork Sage Creek enters it to where it enters Crow Creek, are included within the Study Area. The perennially flowing Sage Creek drains Sage Valley and collects flow from the eastern slopes of the Webster Range; its watershed area is approximately 25 square miles. The reach through Sage Valley upstream of where Sage Creek exits the Webster Range has been designated as North Fork Sage Creek.

Pole Canyon and South Fork Sage Creek are two of the larger subwatersheds within the Sage Creek basin. Pole Canyon flows apparently only rarely reach North Fork Sage Creek via surface flow. This occurred in the spring of 2006 (NewFields 2006b). NewFields (2007a) reports that there was no direct surface connection between Pole Canyon and Sage Creek in October 2006.

Tetra Tech EM Inc. (TtEMI), as part of a selenium investigation for IDEQ (IDEQ 2004b), reported flow in Sage Creek below its confluence with Pole Canyon in May 2002, and May 2003, and at the mouth of Sage Creek in May 2001, May 2002, and May 2003. For the upstream site, flow was about 1 cfs in 2002 and 4 cfs in 2003. Increasing greatly downstream, flows at the mouth of Sage Creek ranged between about 9 and 13 cfs. Flows were up in 2006: measurements by NewFields (2006b and 2007a) immediately below the confluence with South Fork Sage Creek indicated a flow in May of 52 cfs and a flow in October of about 21 cfs.

Simplot also measured base flows at these sites in October of 2002 and 2003 (NewFields 2005b). At the mouth of Sage Creek, the two October records - as well as one measurement in February 2004 - showed Sage Creek to have a base flow of between about 10 and 15 cfs. In October 2005, Maxim (2005a) measured a flow rate of 15 cfs at the mouth of Sage Creek. An October 2006 flow measurement at this location indicated a flow of about 18 cfs (NewFields 2007a).

South Fork Sage Creek

South Fork Sage Creek is one of the main tributaries of Sage Creek, with a watershed area of about six square miles. The entire length of an unnamed tributary entering South Fork Sage Creek from the south would be within the footprint of the proposed operations at Panel F.

Unnamed springs contribute flow to the upper reaches of South Fork Sage Creek (USFS 1981; Maxim 2004c). Maxim characterizes South Fork Sage Creek upstream of South Fork Sage Creek Spring (SP-SFSC-750) as intermittent with channel reaches where the stream flows subsurface for distances between perennial pools. The unnamed tributary in Panel F is described as flowing ephemerally, with an alluvial fan at its mouth. South Fork Sage Creek loses flow where it crosses the Wells formation outcrop (BLM and USFS 2002). After exiting the Webster Range, South Fork Sage Creek joins with the mainstem of Sage Creek and drains generally south through Sage Valley before entering Crow Creek.

Streamflows in South Fork Sage Creek have been periodically measured since 1992. Most of these measurements were obtained for Simplot by TRC Mariah Associates, Inc. as part of their ongoing surface water monitoring (TRC Mariah 2004). Flow measurements have typically been obtained twice yearly at two stations – one in upper South Fork Sage Creek about one mile upstream from the canyon mouth (USS), and the other about 1.5 miles upstream from its confluence with Sage Creek (LSS). In addition, in both the spring and fall of 1998, flows were measured at nearby sites as part of the ongoing IMA Selenium Subcommittee studies (MW 1999 and 2001). NewFields (2005b) measured flows at USS, LSS, and other locations on South Fork Sage Creek a number of times between October 2002 and July 2004. Lastly, streamflow measurements were obtained in the same general vicinities as part of the baseline studies (Maxim 2001) for the Smoky Canyon Mine B & C Panels SEIS (BLM and USFS 2002). **Appendix 3A, Historic Stream Flow Measurement Summary**, includes a summary table of surface water flow measurements; at the upper site, flows ranged from 0 to about 17 cfs, and at the lower site, flows ranged from about 4 to about 40 cfs. Higher reported flows were measured in the spring than in the fall season. The large spring complex near the mouth of the canyon provides much of the flow reporting to the downstream site and generally fluctuates much less seasonally.

More recently, streamflows were measured on South Fork Sage Creek and an unnamed tributary to it as part of the baseline data gathering efforts for the Project (Maxim 2004c, 2004d, and Maxim 2005a). Site locations SW-SFSC-200 and SW-SFSC-500 are located upstream of the aforementioned historic South Fork Sage Creek monitoring locations, while SW-SFSC-800 is located at the same approximate location as the downstream historic monitoring site. NewFields (2006 and 2007a) measured flows in lower South Fork Sage Creek at the downstream location in May 2006, and at upper and lower sites in October 2006. These recent flow measurements are within the range of historic flow measurements, but generally lower, presumably due to several years of drought in the area. One exception, noted by NewFields (2007a) is that October 2006 flow in lower South Fork Sage Creek was higher than normal for the baseflow season (**Appendix 3A**). The unnamed tributary is generally dry, except for a short reach in the upper part of the channel where two small springs discharge.

As reported in the TtEMI (2004) study mentioned above, flows were also measured in South Fork Sage Creek below Simplot's current mining activity in May 2001, May 2002, and May 2003, and ranged between 4 and 5 cfs.

Manning Creek

Manning Creek drains an area of about 2.3 square miles. Maxim (2004c) indicates that the reach of Manning Creek that coincides with the Panel F lease flows ephemerally, with a spring noted to discharge seasonally to the channel within the studied reach. Three streamflow monitoring events in 2003 indicated that this spring discharged in May but only saturated the ground, with no flow in August and September. The creek itself was dry during all seven monitoring visits between May 2002 and August 2004 (Maxim 2004d). About 0.5 miles below the studied reach, USGS mapping indicates that another spring contributes flow to Manning Creek but apparently does not sustain it for any distance downstream.

Deer Creek

Deer Creek drains an area of about 11.5 square miles. Flow in Deer Creek and its north and south forks, as with other streams draining the east side of the Webster Range, varies spatially along its alignment. Flow measurements (Maxim 2004c, 2004d, and 2005a) illustrate this variation, as shown in **Appendix 3A, 2003 - 2005 Streamflow Measurement Data**. Groundwater discharged from distinct springs, or from diffuse sources, can contribute to streamflow. Conversely, in-channel surface flow can be lost to the substrate but continue to flow down-canyon in a subsurface manner, either dispersing to recharge a groundwater system or reappearing as surface flow at some point downstream. Springs contribute flow to the various forks and unnamed tributaries of Deer Creek, as identified by recent baseline studies (Maxim 2004c and 2004d). According to these studies, Deer Creek is perennial below its confluence with North Fork Deer Creek, which itself becomes perennial about midway in its length. From this confluence upstream to the vicinity of SW-DC-300, Deer Creek flow is intermittent with flow occurring primarily during spring runoff. The upper reaches of Deer Creek (above SW-DC-300) and the tributaries in the vicinity of SW-DC-200 have typically exhibited perennial flow. Tributaries between SW-DC-200 and SW-DC-300 are primarily intermittent spring runoff channels. The South Fork of Deer Creek is mostly intermittent with localized reaches of perennial flow upstream of SW-SFDC-200. Similar to the South Fork of Sage Creek, Deer Creek contains isolated perennial pools between reaches of subsurface flow (Maxim 2003a).

As baseline flow data in **Appendix 3A, 2003 and 2004 Streamflow Measurement Data** and Maxim (2004c and 2005a) shows, streamflow in Deer Creek and its forks not only varies spatially but also temporally. Within the drought conditions reflected in the baseline dataset, baseflow in lower Deer Creek (SW-DC-800) was measured at about 1.2 to 1.9 cfs, while spring season flows increased to almost 10 cfs in May 2003. In May 2004, measured flow at SW-DC-800 was 5.4 cfs and increased to 6.8 cfs in June 2004 (Maxim 2004d). Flow at this location was reported as 34 cfs in May 2005 (Maxim 2005a). At SW-DC-600, which is upstream of SW-DC-800, flow was reported as 31 cfs in May 2006 (NewFields 2006b). It was not documented when - relative to snowmelt runoff peaks – any of these May and June measurements were made. In mid-October 2006, flows at SW-DC-600 were 2.8 cfs (NewFields 2007a, **Appendix 3A**).

A comparison between flows contributed to Crow Creek from Deer Creek and flows contributed from South Fork Sage Creek, based upon 2003 data from May, August, and October (Maxim 2004c), indicates a much greater seasonal variability in Deer Creek. Those same data also show that, while Deer Creek drains almost twice the surface area that South Fork Sage Creek does, during base flow conditions it supplies only about one-third as much water to Crow Creek.

Wells Canyon
Wells Canyon is a 3.3 square-mile watershed that feeds into an irrigation ditch near its mouth. Baseline studies (Maxim 2003a, 2004c, and 2004d) of the stream indicate that above SP-WC-750 the stream is non-perennial, and downstream of this point it is perennial. Monitoring in two tributaries to upper Wells Canyon recorded dry conditions during all sampling events (Maxim 2004d), with the exception of May 2006, when NewFields (2006b) measured a flow rate of 0.5 cfs at SW-WC-800. In mid-October 2006, a flow of 0.28 cfs was measured at this site (NewFields 2007a).

Nate Canyon
Nate Canyon flows ephemerally, with no flow observed during baseline studies (Maxim 2004c and 2004d).

Diamond Creek
A short reach of a proposed haul road would be located on the west side of the Webster Range, off of Freeman Ridge, and would thus be in the upper Diamond Creek watershed. Diamond Creek is tributary to the Blackfoot River. In the vicinity of the proposed haul road, Diamond Creek flows ephemerally, but becomes perennial within a short distance downstream (Maxim 2004c). Baseline studies measured flows at SW-DMC-200 in the spring, summer, and fall of 2003; the greatest reported flow was about 0.5 cfs, reported in the spring, decreasing to a negligible amount (<0.001 cfs) in the fall. In June 2004, flow was measured at 0.08 cfs (Maxim 2004d).

3.3.2 Surface Water Quality

Regulatory Information
In Idaho, surface water quality is protected by implementing Idaho State Water Quality Standards at IDAPA 58.01.02. Within that code, the State classifies streams according to their designated beneficial uses, and applies numeric and narrative criteria based upon those uses. For undesignated surface waters (including Crow Creek within Idaho, Sage Creek, Deer Creek, Diamond Creek, and their perennial or intermittent tributaries), cold-water aquatic life and contact recreation beneficial uses are presumed by default according to the Idaho Code, and the relevant criteria for those uses are applied to such waters by the Idaho Department of Environmental Quality. For cold water aquatic life, the lowest of the three relevant metals values for comparison purposes were used by Maxim (2004c): Criteria Maximum Concentration (CMC) for aquatic life; Criteria Continuous Concentration (CCC) for aquatic life; and Criteria Human Consumption (CHC) for organisms. That convention is followed in this document as well. For Idaho, surface water standards for metals are based on the dissolved fraction, except for the chronic aquatic life standards (CCC) for selenium, which is based on total recoverable analysis. Further, some aquatic life metals standards are hardness dependent; Maxim (2004c) derived those numbers individually for drainages in the Study Area using the average hardness and a water-effect ratio of 1.0. **Appendix 3A, Summary of Surface Water Data**, gives the appropriate standards as derived in the baseline study report (Maxim 2004c and 2004d). Later in this section, available water quality data for surface streams are described in regard to how they meet relevant water quality criteria.

Water that originates within or flows through the Study Area eventually flows to the Salt River and crosses the Idaho border into Wyoming. Wyoming considers the Salt River to be a Class 2 water. Class 2 waters are, according to *Quality Standards for Wyoming Surface Waters*, "Those surface waters, other than those classified as Class 1, which are determined to: (i) Be presently supporting game fish; or (ii) Have the hydrologic and natural water quality potential to support game fish; or (iii) Include nursery areas or food sources for game fish." The Wyoming reach of the Salt River, as a Class 2 water, has therefore been designated as a cold water game fishery, and water quality criteria are set similar to those in Idaho.

The States of Idaho and Wyoming are both required by the Clean Water Act to regularly assess streams to determine whether or not they support their designated beneficial uses. Streams not meeting beneficial uses are recommended by the states to EPA for listing as impaired under CWA section 303(d). They are then scheduled for total maximum daily load (TMDL) analysis, whereby loading quantities for specific pollutants are set such that listed streams will support their identified beneficial uses in the future (i.e., following implementation of the TMDL). These recommendations are revised and updated every two years; stream segments may be added, removed, or retained during this revision process.

For the DEIS the most current 303(d) list was from the 1998 recommendation. In the DEIS there were no streams in the Study Area with impaired regulatory status; however that status changed after the release of the DEIS. The most recent EPA approved 303(d) list for Idaho is the 2002 recommendation, which is contained as Section 5 of the 2002/2003 Integrated (303(d)/305(b)) Report (IDEQ 2005b). Several Salt River Basin assessment units are listed in the Integrated Report for impairment. These assessment units include some Project Area streams.

According to the 2002 list, 24 miles of stream within the "Sage Creek Source to Mouth" assessment unit are listed as impaired by selenium. These 24 miles include South Fork Sage Creek, Pole Canyon Creek, and several other tributaries to mainstem Sage Creek. However, IDEQ has revised their recommendation for this assessment unit based upon more recent data and analysis. They now consider Pole Canyon Creek as a separate assessment unit, which will remain listed for selenium. Sage Creek from its confluence with Pole Canyon Creek will remain listed for selenium as well. South Fork Sage Creek will be considered as a separate assessment unit. Further, 11.69 miles of the "South Fork Deer Creek" assessment unit, and 3.18 miles of the "North Fork Deer Creek" assessment unit are listed in both Sections 5 and 4c of the 2002/2003 Integrated Report. The South Fork Deer Creek assessment unit includes upper Deer Creek above its confluence with the South Fork.

Section 4c lists waters impaired by habitat alteration, which is not considered a pollutant, while the Section 5 list equates to the 303(d) list of impaired waters. Both the North and South Forks Deer Creek assessment units are categorized as not fully supporting aquatic life beneficial uses due to sediments. These reaches were initially proposed for listing based upon 1998 data collected under IDEQ's Water Body Assessment Guidance monitoring. The impairments were based upon biological indicator data obtained by IDEQ using the Stream Macroinvertebrate Index (SMI) and the Stream Habitat Index (SHI). Upper Diamond Creek also does not meet aquatic life beneficial uses due to sediments, but is included in Section 4a rather than Section 5 of the report because it has an EPA-approved TMDL. The data used to determine impairment are reported on an IDEQ website (IDEQ 2005a); that website gives the activities affecting these reaches as beaver, grazing, mining, other, and/or roads.

Sediment impairment is based upon an assessment that a given stream reach does not meet the narrative criteria in the Idaho State Water Quality Standards at IDAPA 58.01.02, which simply says that "sediment shall not exceed…quantities which impair designated beneficial uses", in this case, aquatic life. In addition to being narrative -- rather than numeric -- in nature, the standard encompasses both physical and biological aspects of sediment such as water column sediments (TSS, suspended sediment, turbidity), bed sediments (stream stability, surface sediments, subsurface fines), aquatic life (macroinvertebrates, fisheries), and habitat characteristics (proper functioning condition) (IDEQ 2005b). In determining impairment of a given stream in regard to sediment, an assessor's "substantiated best professional judgment" is relied upon (IDEQ 2002b). Once a stream segment is listed on the 303(d) list, the goal is to reduce loads of the pollutant(s) causing impairment. Until a TMDL or equivalent process is completed and needed load reductions are developed and allocated to various sources of a pollutant, permitted discharges and other activities contributing loads of the causative pollutants are limited by sections 054.04 and 054.05 (IDAPA 58.01.02) to prevent increased loading or further impairment of the designated or existing beneficial uses.

For Diamond Creek, where its sediment impairment was the subject of a TMDL study (IDEQ 2001), load targets were established for two indicators representing sediment: (1) depth of riffle fines of 25 percent less than 6.25 mm and 10 percent less than 0.85 mm, based upon maximum volumes of subsurface sediments on a five-year average; and (2) streambank stability of 80 percent or higher. At times, though not done for Diamond Creek, a TSS concentration limit can be included for clean sediments, and in these cases is often in the range of 50-80 mg/L (Marti Bridges, IDEQ, personal communication, September 1, 2004).

Crow Creek downstream of the Wyoming border is not listed on either the most recent approved (2004) or proposed (2006) Wyoming 303(d) lists.

Chemical Characteristics of Surface Water

From 1979 to the present, Simplot has been monitoring water quality at sites upstream and downstream of mining activity at the existing Smoky Canyon Mine (TRC Mariah 2004). Where this program overlaps with the Study Area for the Proposed Panel F and G mining, these data records include monthly or bi-annual sampling results from 1992 to the present for South Fork Sage Creek at the two locations where flow measurements were made, both upstream from Maxim's recent monitoring. These data represent background data as far as the Project is concerned, but data from 1998 forward at the downstream site represent a potentially mining impacted condition due to the existing Smoky Canyon Mine activities in Panel E. The data, along with a few samples taken by others (MW 2001; Maxim 2000), generally showed good water quality, with total dissolved solids typically 100-200 mg/L, with calcium, magnesium, and bicarbonate representing the major ions up until fall 2006. While the major ionic content has not markedly changed, selenium has increased in South Fork Sage Creek downstream of mining activities (NewFields 2007a), as described further below.

Samples were collected on South Fork Sage Creek, North and South Forks Deer Creek, mainstem Deer Creek, Manning Creek, Wells Canyon Creek, Diamond Creek, and some unnamed tributaries to those streams as part of the baseline studies for Panels F and G (Maxim 2004c and 2004d). Site locations are shown on **Figure 3.3-3** and water quality data are given in **Appendix 3A, Summary of Surface Water Data**. A review of these data does not identify any clear indications of spatial or temporal variability of water quality in the stream channels. Data from separate stream channels are quite similar in regard to major constituents, as are data from different locations along a given stream channel and data from different seasons at the same monitoring site. Sampling conducted for water quality from area streams was sporadic, with several stations being sampled once or twice, and some only sampled in a single season or only once in a given year. At least one value, the ORP=-39mv value taken from surface water station SW-SFSC-500, cannot be easily explained, as it generally signifies an oxygen deficit in a carbonate-dominated, shallow, surface stream. As dissolved oxygen for this sample was also given at 6.43 mg/l, this condition is unlikely, so this reading is likely to be erroneous. The lack of identifiable temporal variability may be due to the short-term nature of the monitoring period combined with the sparse frequency of sampling.

Streams in the Project Area and vicinity show calcium and bicarbonate as the predominant ions, with magnesium being the second-most predominant cation. Biannual operational monitoring (NewFields 2005b) in May and October of 2002, 2003, and February of 2004 showed similar ionic content for sites in lower Sage Creek, however it appears that sulfate content was higher in lower Sage Creek than in South Fork Sage Creek. In both Maxim's and Simplot's data, lower Crow Creek was noted as having a higher sodium and chloride concentration than other stream sites, perhaps due to the Books Spring contributions. As a whole, nutrient concentrations (nitrate, nitrite, ammonia, and phosphorus) in area streams were near or less than reporting levels (Maxim 2004c and 2004d).

Data obtained by Maxim (2004c, 2004d, and 2005a) from the Project Area streams did not always meet aquatic water quality numeric criteria that were applicable at the time of the baseline studies, and exceedances are shown in highlights in **Appendix 3A.** The noted exceedances were primarily metals, and were attributed to natural geologic sources (Maxim 2004c).

Selenium is the COPC with perhaps the greatest level of concern in regard to phosphate mining in Southeastern Idaho. Therefore, though none of the surface water (stream) baseline samples in the Study Area (Maxim 2004c, 2004d, and 2005a) showed selenium exceedances, data from the nearby area streams, which are affected by the existing Smoky Canyon Mine, are presented here. Outside of, but adjacent to, the Study Area, high selenium values are reported in storm water runoff crossing waste rock dumps and seepage through overburden fills, both associated with Simplot's Smoky Canyon Mine (Simplot Agribusiness 2004; MFG 2003a; NewFields 2005b). Baseline data collection efforts in the Study Area focused on areas not yet subjected to mining influences, but mining has occurred in the nearby areas draining to lower South Fork Sage Creek, Sage Creek, North Fork Sage Creek, and Pole Creek. A few studies have looked at selenium in these areas during the same general time frame as Maxim was collecting water quality data in the Panels F and G Project Area. Selenium data from these studies are summarized in **Table 3.3-1** and discussed further below.

TABLE 3.3-1 RECENT SELENIUM SAMPLING RESULTS – LOWER SOUTH FORK SAGE CREEK AND SAGE CREEK – REACHES CURRENTLY IMPACTED BY MINING

DATA SOURCE *	LOCATION (SITE NO.)	DATE	FLOW RATE (CFS)	SELENIUM (MG/L)
TtEMI	Mouth of Sage Creek (SCMTT026)	May 2001	9	0.003
		June 2001	8	0.002
		Sept 2001	14	0.0051
		May 2002	12.5	0.004
		May 2003	13	0.004
Simplot	Mouth of Sage Creek (LSV-4)	May 2002	14.5	0.004
		October 2002	14.3	0.005
		May 2003	16.3	0.004

DATA SOURCE *	LOCATION (SITE NO.)	DATE	FLOW RATE (CFS)	SELENIUM (MG/L)
		October 2003	10.3	0.0053
		February 2004	10.9	0.0061
		May 2004	13.4	0.0031
		July 2004	11.6	0.0049
		May 2006	---	0.0138 (avg. of two samples)
		June 2006	---	0.0065
		October 2006	17.9	0.0078
Maxim	Mouth of Sage Creek (LSV-4)	October 2005	15	0.0062
Greater Yellowstone Coalition	Mouth of Sage Creek	April 2005	---	0.00458
		July 2005	---	0.00768
		May 2006	---	0.0149
IDEQ	Mouth of Sage Creek	May 2006	---	0.014 (avg. of 3 samples
Simplot	Sage Creek downstream of South Fork Sage Creek (LSV-3)	May 2002	13.5	0.005
		October 2002	10.5	0.003
		May 2003	17.3	0.004
		October 2003	12.4	0.006
		May 2004	13.1	0.0033
		July 2004	11.6	0.0068
		September 2005	---	0.007
		May 2006	52.3	0.0232
		June 2006	---	0.0067
		October 2006	20.6	0.0074
Simplot	Sage Creek downstream of Hoopes Spring (LSV-2)	May 2002	12.5	0.007
		October 2002	5.6	0.007
		May 2003	7.7	0.008
		October 2003	7.6	0.0088
		May 2004	8.1	0.0052
		July 2004	7.5	0.0088`
		May 2006	---	0.0252
		June 2006	---	0.0084
		October 2006	13.7	0.01
TtEMI	North Fork Sage Creek downstream of Pole Creek (SCPTT027)	June 2001	1	<0.001
		Sept 2001	0.5	0.001
		May 2002	1	0.001
		May 2003	4	<0.001
Simplot	Sage Creek downstream of North Fork Sage Creek (LSV-1)	May 2002	1.9	0.001
		October 2002	0.3	0.001
		May 2003	0.8	0.001
		October 2003	0.6	0.0013
		May 2004	1.6	0.002
		July 2004	1.4	0.0036
		May 2006	---	0.0336
		May 2006	---	0.0089
		October 2006	2.6	0.0012
TtEMI	South Fork Sage Creek downstream of Mining (SSBTT022)	May 2001	4	<0.001
		June 2001	5	0.001
		Sept 2001	4	0.002
		May 2002	4	0.002
		May 2003	4	<0.001

DATA SOURCE *	LOCATION (SITE NO.)	DATE	FLOW RATE (CFS)	SELENIUM (MG/L)
Simplot	South Fork Sage Creek downstream of Mining (LSS)	May 2002	7.0	0.004
		October 2002	6.5	0.002
		October 2003	4.44	0.0023
		February 2004	4.72	0.002
		July 2004	5.37	0.003
		September 2005	8.2	0.0042
		May 2006	23.6	0.0019
		October 2006	11.8	0.0056
		January 2007	---	0.0081

*TtEMI 2002a; TtEMI 2002b; IDEQ 2004b; Simplot operational monitoring including from NewFields 2005b, 2006, and 2007a, and Tegtmeyer 2006; Maxim 2005a; GYC 2006; GYC and NRDC 2006; Greg Mladenka, IDEQ personal communication August 3, 2006

TtEMI reported data collected in Sage Creek at its mouth, in North Fork Sage Creek below the confluence with Pole Creek, and South Fork Sage Creek (downstream of Smoky Canyon Mine activity) as part of an investigation for IDEQ (IDEQ 2004b). During three monitoring events in 2001, they found that a sample taken in September near the mouth of Sage Creek exceeded chronic aquatic life criterion for selenium; other metals did not exceed numeric criteria at the three sites. Monitoring was repeated in May 2002 and 2003, but there were no reports of selenium or other metal exceedances at the Sage Creek sites. However, Hoopes Spring, which was sampled in 2003 did exceed the 0.005 mg/L selenium chronic criterion with a 4-day average of 0.0103 mg/L. An analysis by TtEMI suggested that Hoopes Spring was the source of selenium loading reported at the mouth of Sage Creek.

In addition, operational monitoring (K. Tegtmeyer, NewFields, personal communication July 14, 2004; NewFields 2005b; NewFields 2006b; NewFields 2007a) in 2001, in May and October of 2002, 2003, February of 2004, and May, June, and October of 2006 showed that the selenium criterion was consistently exceeded in Sage Creek downstream of flows from Hoopes Spring. Samples taken in Sage Creek above the confluence with Hoopes Spring did not show selenium exceedances, except during the two May 2006 monitoring events. At two sample sites further downstream (one below the confluence with South Fork Sage Creek and one near the mouth of Sage Creek), most (but not all) of the selenium concentrations in this several year time period were at or greater than the 0.005 mg/L criterion. However, samples taken by Simplot in Crow Creek in May 2003 downstream of the confluence with Sage Creek did not show selenium exceedances. Samples collected from Crow Creek on May 23, 2006 showed selenium exceedances (NewFields 2006b), which were attributed to Pole Canyon flows reaching Sage Creek for the first time in several years (NewFields 2006b). Samples taken in October 2006 and January 2007 showed selenium concentrations in Crow Creek downstream of Sage Creek were less than the criterion (NewFields 2007a). These data are included in **Appendix 3A**.

In 2003, TRC Mariah (2004) added a site on Sage Creek below the confluence with South Fork Sage Creek to its biannual sampling program. Those data showed similar water quality at this site as reported at their lower Sage Creek site, except that higher selenium concentrations were reported (0.004 mg/L in the spring and 0.006 mg/L in the fall) in Sage Creek than in South Fork Sage Creek.

Greater Yellowstone Coalition (GYC) sampled various locations in the area, including lower Deer Creek, mouth of Sage Creek, and Crow Creek above and below Sage Creek in spring and summer 2005 and spring 2006 (GYC and NRDC 2006; GYC 2006). Their data showed selenium concentrations lower than 0.005 mg/l in Deer Creek and Crow Creek upstream of Sage Creek. At the mouth of Sage Creek, as shown in the above table, selenium was slightly below 0.005 mg/l in April of 2005, but above that standard in July 2005 and May 2006. The addition of selenium from Sage Creek resulted in elevated selenium levels in Crow Creek downstream of Sage Creek, though the 0.005 standard was not exceeded in Crow Creek, even with the exceptionally high Sage Creek selenium concentrations in May 2006. In May 2006, IDEQ data showed similar results (Greg Mladenka, IDEQ, personal communication, August 3, 2006.) GYC and IDEQ data are provided in **Appendix 3A**. In sum, data collected by IDEQ, Simplot, and GYC during snowmelt runoff seasons in 2005 and 2006 showed similar and consistent results regarding selenium concentrations.

The source of the elevated selenium in lower Sage Creek is largely due to Hoopes Spring. Beginning in 2006, additional factors apparently began coming into play. First, as noted above, in the 2006 spring runoff, Pole Canyon flows reached Sage Creek and contributed additional selenium loads; this is reflected in the May and June 2006 data. Data from October 2006 showed this surface flow contribution had ceased. October 2006 data (NewFields 2007a) also indicates increasing selenium concentrations in lower South Fork Sage Creek. These data, reported on **Table 3.3-1**, indicate selenium concentrations above 0.005 mg/L in South Fork Sage Creek below the springs and downstream of existing mining at Panel E. NewFields (2007a) indicates that the most likely explanation is that the Panel E began contributing additional selenium through infiltration of greater-than-normal precipitation through mining disturbances (primarily exposed pit bottoms), which then moved subsurface southward to South Fork Sage Creek. Simplot and the Agencies recognize that this unanticipated contamination warrants further investigation, and plans are underway to gain a better understanding of surface, groundwater, and mining interactions in Lower South Fork Sage Creek under CERCLA authority. Existing information suggests that this selenium contamination of South Fork Sage Creek is a temporary effect, and proposed actions for the Panel E mining and reclamation are expected to reduce selenium concentrations in South Fork Sage Creek (NewFields 2007b and **Appendix 2A**).

Some of the general conclusions by TtEMI (2004) regarding seasonally variable selenium loading could be relevant to the other Study Area streams as well as to Sage Creek and the other streams they studied. Looking at previous studies, along with their 3-year study, they conclude that selenium and other metals tend to be greater during years of higher peak snowmelt runoff than during lower flow years. However, a correlation of selenium concentrations with snow water equivalent (SWEQ) was not statistically significant, possibly due to an insufficient data set; other factors including mobilization and uptake processes are also thought to contribute to selenium variability. A study by Presser et al. (2004) using data collected during the drought years of 2001 and 2002 indicates that selenium concentration and load in the nearby Blackfoot River downstream of numerous phosphate mines cycles seasonally with streamflows, with peak selenium concentrations following the hydrograph peak by 2-3 weeks, and most (approximately 70-80 percent) of the selenium load occurring during the 3-month high flow season of April – June when about 40-55 percent of the total annual flow occurs. The seasonality of selenium concentrations and load suggest that there is a regional reservoir of selenium that functions as a longer term supply, rather than simply reflecting a short-duration flush after a dry season (USGS 2004b).

Unlike what was observed by Presser et al. (2004), Sage Creek, where the existing Smoky Canyon Mine causes selenium loading, typically shows lower selenium concentrations in the spring than in other seasons, based upon the available data. This is likely due to the year-round selenium load in Hoopes Spring, which is tributary to lower Sage Creek. South Fork Sage Creek is also a tributary to lower Sage Creek downstream of Hoopes Spring and the clean water from upper Sage Creek and South Fork Sage Creek dilutes the selenium concentration caused by Hoopes Spring in lower Sage Creek. The selenium load in Hoopes Spring is continuous throughout the year whereas the flow rate in upper Sage Creek and South Fork Sage Creek increases during spring runoff and typically provides more dilution effect at that time of year. Data (GYC 2006; Greg Mladenka, IDEQ, personal communication, August 3, 2006; NewFields 2006b) collected during snowmelt runoff in 2006 (a year of more normal precipitation levels) did show higher selenium concentrations in lower Sage Creek than previous data showed. This is attributed to surface flow from Pole Canyon Creek carrying selenium load from the Pole Canyon Overburden Fill into Sage Creek during the few weeks of high spring runoff. While Pole Canyon Creek was contributing surface flow, selenium concentration in Sage Creek went from non-detectable near the Smoky Canyon Haul Road to 0.014 mg/L in lower Sage Creek on May 19, 2006 (Greg Mladenka, IDEQ, personal communication, August 3, 2006.)

The State of Idaho also has a monitoring program that includes several of the Project Area streams. The Beneficial Use Reconnaissance Program (BURP) focuses more on biological and habitat data rather than chemical data; thus, no selenium or other COPC data are available from this source. The available BURP data are discussed below in **Section 3.3.3**.

Water Column Sediments

This subsection describes available information on sediment-related water quality data; sediment data related to streambeds are described in **Section 3.3.3**. As noted above, the Idaho water quality narrative criteria for sediments encompasses both water column and streambed characteristics. While the terms ‘suspended sediments’ and ‘total suspended solids’ (TSS) are often used interchangeably, there are differences in their definitions and in how they are analyzed. All data discussed herein are thought to refer to TSS. Further, turbidity is often related to sediments in the water column, though there can be other contributing factors. Turbidity does have a numeric standard under the Idaho water quality standards, which is related to an allowable increase over background (50 Nephelometric Turbidity Units (NTU) increase instantaneous or 25 NTU for more than 10 consecutive days).

Though both TSS and turbidity data exist for streams within the Study Area, neither parameter lends itself to a direct comparison with water quality standards. Further, considering the spatial and temporal variability of natural sediment loads (easily varying over orders of magnitude) and turbidity in streams, the available data set is small and not likely representative. Effects of TSS and turbidity on aquatic life are dependent upon concentration (for TSS), levels (for turbidity), the duration of exposure, and the species considered; bed sediments are important as well.

In regard to suspended solids concentrations in area streams, recent data from Maxim (2004c and 2004d), TtEMi (2004), TRC Mariah (2004), and Simplot indicate TSS levels that are commonly less than detection levels (5 mg/L), and in no cases are reported levels greater than 25 mg/L. Turbidity values ranged from less than 1.0 to 52 NTUs in Maxim’s 2002 and 2003 baseline data (2004c); consistently high turbidity readings in 2004 were attributed by Maxim to an inaccurate meter (Maxim 2004d). These data are not sufficient to establish statistically significant regression relationships on a stream-by-stream basis between turbidity and TSS. While, as mentioned above, there is not a numeric water quality criterion for sediment, available information implies that these values would not impair beneficial uses (IDEQ 2003). Simplot’s

Storm Water Pollution Prevention Plan (Simplot AgriBusiness 2004) indicates that the monitoring benchmark for TSS in their storm water permit is 100 mg/L. Regarding the 303(d) listings for the upstream reaches of Deer Creek and its forks, the available data are not sufficient to either support or dispute the sediment impairment.

The data collection efforts mentioned above relied upon grab samples as opposed to width/depth integrated samples and did not attempt to specifically catch sediment-laden runoff. In addition, they represent a short time frame, which may not be representative. Depth-integrated sampling for sediment is the generally approved methodology for obtaining representative values for discharge-weighted suspended fluvial sediment measurements from flowing streams. USGS protocols for sampling suspended sediments (USGS 1999b) use width/depth integrated sampling to insure that samples are representative and are "discharge-weighted". This is needful due to the high variability in sediment concentrations that can exist within the water column (USGS 1970:19). For these reasons, grab samples are in general not judged to be representative measures of fluvial sediments in flowing streams. Longer term data (TRC Mariah 2004) for streams in the vicinity of the Smoky Canyon Mine show greater ranges of sediment concentration, though probably still less than the true variability of a given stream.

In the Blackfoot River TMDL (IDEQ 2001), overall sediment yield from the forest land within the subbasin was estimated to be 0.006 tons/acre/year.

3.3.3 Channel Morphology and Streambed Sediment

Maxim generally described morphology and substrate for Project Area streams in their water resources baseline reports (Maxim 2003a, 2004c, 2004e, and 2004k). These descriptions are summarized below. In addition, the State of Idaho's BURP habitat data are discussed. The BURP data were obtained from IDEQ's website (IDEQ 2005a) and are primarily from 1998 and 2002 monitoring events.

Crow Creek's morphology from the Wells Canyon confluence to the valley constriction ("Narrows") immediately downstream of the Deer Creek confluence is described as a Rosgen (1996) type E4 channel with a consistently stable meander riffle-pool pattern. Maxim also notes that, while not classified, Crow Creek from the Narrows downstream to the Sage Creek confluence appears similar to the upper E4 reach. In 1998 and 2002, Idaho BURP monitoring listed Crow Creek just downstream from Manning Canyon as a Rosgen type C channel (IDEQ 2005a). With a high sinuosity and a low gradient, Crow Creek's floodplain is up to 0.5 miles wide. Some beaver dams are found along Crow Creek but are presumed to be limited by lack of woody vegetation (Maxim 2004e:24). Lateral migration occurs over much of the length of Crow Creek, as is typical of an alluvial valley bottom stream. The existing road alongside the stream does prevent lateral channel migration in some locations, but Crow Creek appears to be vertically stable with riparian areas dominated by herbaceous species. The road encroachment and other impacts from livestock and upstream land use has resulted in segments of Crow Creek being rated as functioning-at-risk, while other reaches were rated as in proper functioning condition (PFC) by CTNF (Maxim 2004e). In 1998, Idaho BURP monitoring listed Crow Creek just downstream from Manning Canyon as being affected by grazing, "other", and recreation but rated 100 percent of the stream bank in the measured reach as stable (IDEQ 2005a). In 2002, they added agriculture, mining (exploration), and roads to the affecting activities, and about 4.5 percent of the bank length was rated as unstable.

Baseline studies describe South Fork Sage Creek's channel bed as having shallow alluvium over cobble substrate along much of the studied reach. Although much of the reach apparently is comprised of these permeable materials, conditions are sufficient to support various streamside wetlands with predominantly deep-rooted willows. In spots, the bed is less permeable and forms isolated perennial pools. Studies further described South Fork Sage Creek near its confluence with the unnamed tributary as a Rosgen type G4 and about one mile upstream from its mouth as an A4 type (Maxim 2004a). Maxim (2004k) describes the upper channel reach as being in proper functioning condition, but at risk from concentrated sheep grazing and trampling. They report that the lower reach (apparently) is functioning-at-risk due to grazing and noxious weeds, and they note that the 1999 CTNF evaluation indicated that the stream was functioning-at-risk because of roads and planned mining activities in the drainage.

In 2001, Idaho BURP monitoring listed Sage Creek just downstream from the confluence with South Fork Sage Creek as a Rosgen C stream type, affected by grazing and recreation, with about 20 percent of the stream bank in the measured reach rated unstable (IDEQ 2005a).

The channel bed in Deer Creek has a predominantly cobble substrate, though wetland areas and riparian corridors have formed, often associated with beaver activity. Beaver dams were noted to be the primary factor in channel shaping along much of mainstem Deer Creek (Maxim 2004a). However, Deer Creek and its tributaries exhibit a wide variety of channel types, and stability ratings of either stable or degrading. As reported in Maxim (2004e), Deer Creek was rated by Maxim and in the 1999 CTNF PFC analyses, as functioning-at-risk due to noxious weeds, roads, intensive grazing, and/or mining activities. In the headwaters, a degrading meander riffle-pool classification (Rosgen type G6) was identified, while a degrading meander pool-run (type F4) was identified at the confluence with North Fork Deer Creek. In the vicinity of the South Fork Deer Creek confluence and lower Deer Creek, the channel has a meander riffle-pool or riffle-run pattern (type C3). A site on lower Deer Creek was typed as Rosgen C in 1998 (IDEQ 2005a) with 25 percent of the banks rated as unstable; in 2003 a site on lower Deer Creek about 0.75 miles downstream from the 1998 site was considered a B stream with about 9 percent of the banks in that reach unstable (IDEQ 2005a). Upper North Fork Deer Creek is identified as a degrading high-grade riffle (Rosgen type A4), while the lower reach exhibits a degrading riffle pool pattern (type G4). In 1998 and 2003, Idaho BURP monitoring listed North Fork Deer Creek near its mouth as a Rosgen B stream type, with about 30 percent of the stream bank in the measured reach rated unstable in 1998 and about 14 percent unstable in 2003 (IDEQ 2005a). South Fork Deer Creek is a stable riffle-pool-run pattern of Rosgen type E6 according to Maxim; its upper reaches were classed by IDEQ (2005) in 1998 as a stable Rosgen type C.

Baseline studies also report that "intensive" livestock use is evident along North Fork Deer Creek and along the intermittent reach of the South Fork Deer Creek, where grazing and trampling have affected stream bank conditions (Maxim 2004e). Further, the South Fork of Deer Creek has been impacted by an adjacent USFS road. The IDEQ (2005) BURP data indicates the various reaches of Deer Creek are affected by beaver, grazing, mining, recreation, "other", and/or roads, depending upon the reach and the year (1998 or 2003).

Maxim (2004c) notes that lower Wells Canyon, near its mouth, is a riffle-run channel of Rosgen type G6. Rosgen type G6 streams are unstable with grade control problems (Rosgen 1996, table 4-1). They are generally considered to be highly degradational (Rosgen 1996, pg 5-186), highly sensitive to disturbance, and have poor recovery potential (Rosgen 1996, table 8-1, pg 8-9). Idaho BURP data (IDEQ 2005a) indicates that this same area was a Rosgen type B stream in 1998 and mostly stable (98.5 percent of the banks). An unpaved road alongside the channel has confined the Wells Canyon drainage, filled portions of it, and contributed sediments. Campsites and livestock grazing are also noted as contributing to the stream's instability and at-risk condition. Maxim (2004e) reports their assessment of Wells Canyon Creek as non-functional and degraded by sedimentation and road influences; they note that the 1999 CTNF assessment was functioning-at-risk due to roads, grazing, and recreational activities. Additional Idaho BURP data were apparently collected on Wells Canyon in 2004; however, these data are not yet publicly available. Upper Diamond Creek is a moderately sinuous Rosgen B channel confined within a v-shaped valley (IDEQ 2001). Its overall stability was rated as fair (using the Phankuch methodology) 20 or more years ago, but in 1990, aquatic habitat was apparently in good condition above the forest boundary (IDEQ 2001). In 2002, Idaho BURP monitoring measured 96 percent of the banks in the reach as stable. Diamond Creek was rated as functioning-at-risk in 1999 and is on the EPA approved (1998) 303(d) list of impaired waters, with sediment listed as the pollutant. Diamond Creek is under the governance of a TMDL approved by the EPA in April of 2002. Monitoring of the percent of streambed fines is being conducted by the Forest Service at a location just above the Forest boundary.

Streambed sediment

Streambed sediment can be directly measured as surface or subsurface sediments. The measures are not directly comparable, nor are they directly linked to TSS or suspended sediments as measured in the water column. As mentioned under the regulatory information subsection above, the Diamond Creek TMDL established loads based upon subsurface (depth) fines as determined by core samples taken in bed substrate (IDEQ 2001). Higher percentages of depth fines are related to impacts to salmonid spawning, anadromous habitat, invertebrate habitat, and redd conditions (IDEQ 2005b).

At selected sites in the Study Area, Maxim (2004c) performed pebble counts to characterize in-situ stream bottom grain size distribution (surface sediments). Results of the pebble counts showed that most sites were comprised of predominately gravel-sized sediment, followed by sand and cobbles.

As an alternate means of characterizing substrate, TRC Mariah (2004) has been rating the streambed embeddedness at two South Fork Sage Creek sites on a biannual basis since 1992. Embeddedness is related to, but not directly comparable with, surface fines (IDEQ 2005b). The rating system describes the amount of gravel and larger particles that have their surfaces covered by fine sediment. By its nature, use of the measure of embeddedness indicates that the original streambed substrate is comprised of a matrix of coarse grained particles (gravel and larger); embeddedness ratings cannot be done on beds that are comprised predominately of fines. Values can range from 1 to 5. Implied in a lower embeddedness value is the assumption that fine sediments have been eroded from up-channel or in the watershed and deposited over the surface of "cleaner" substrate that is more suitable for aquatic habitat. A value of 5 would indicate particles that have not been covered over by fines and are therefore of potentially greater habitat value. Between 1992 and 2001, embeddedness values (taken only when flow occurred) ranged between 1 and 4 at the upstream South Fork Sage Creek site and between 3 and 5 at the downstream site, indicating somewhat better conditions downstream (TRC Mariah 2002). Embeddedness is of dubious relevance in intermittent or ephemeral stream reaches, so these data should be treated accordingly.

Subsurface fines data for the area streams are limited to core samples taken at four of the stream sites: South Fork Sage Creek, Deer Creek, South Fork Deer Creek, and Wells Canyon (Maxim 2004c). It is not known whether these samples were taken with the same protocol as would be used to assess impairment-related targets such as were developed for the Diamond Fork TMDL (IDEQ 2001) in regard to core diameter, depth, placement in the riffle, etc. These samples appear to be single unit samples, rather than a set of randomly collected samples within a larger grid, which better characterizes the inherent spatial variability of particle sizes in a small area. The available data are presented in **Table 3.3-2** in a manner that allows them to be compared with the Diamond Fork TMDL allocations. As seen in the table, based upon the single sample analysis at each site, three out of the four streams sampled would not meet the depth fines targets if they were applicable to these reaches.

TABLE 3.3-2 SUBSURFACE FINES DATA FOR AREA STREAMS (FROM MAXIM 2004C)

LOCATION (SITE NUMBER)	PERCENTAGE OF PARTICLES IN SAMPLE LESS THAN		DEPTH FINES – FIVE YEAR AVERAGE ALLOWABLE UNDER DIAMOND CREEK TMDL (FOR COMPARISON PURPOSES ONLY)	
	<6.25 MM	<0.85 MM	<6.25 MM	<0.85 MM
South Fork Sage Creek (SW-SFSC-800)	21	5	25%	10%
Deer Creek (SW-DC-800)	35	18		
South Fork Deer Creek (SW-SFDC-300)	26	11		
Wells Canyon (SW-WC-800)	66	55		

In addition to their physical characteristics, the chemical makeup of streambed sediments can also be important to aquatic and riparian resources. The Area Wide Human Health and Ecological Risk Assessment for the Southeast Idaho Phosphate Mining Resource Area (IDEQ 2002c) summarized conservative benchmarks for freshwater sediments for selected COPCs, as shown in **Table 3.3-3** below. Most of these benchmarks are based on a Threshold Effect Concentration (TEC). Subsequent to the risk assessment, IDEQ published a risk management plan (IDEQ 2004a), which established removal action levels for sediment (and other media) at phosphate mine-impacted sites under CERCLA consideration; these are also shown in the table. With the exception of selenium, the removal action levels are set at a higher concentration than the benchmark levels used in the 2002 report. In cases where the regional background levels exceeded what would otherwise be the removal action level, the maximum background level was substituted as the action level for a given constituent (IDEQ 2004a).

In August 2003, Maxim (2004c) sampled streambed sediment at ten Study Area sites to characterize baseline metals concentrations. These data are included in **Appendix 3A**. Concentrations of selenium in sediment ranged from less than 0.4 to 1.3 mg/Kg, which are less than both the 4.0 and 2.6 mg/Kg benchmark and removal action levels in **Table 3.3-3**. In most of the samples analyzed, concentrations of cadmium, chromium, nickel, and zinc were greater than the benchmark levels, and in some cases greater than the removal action levels; only copper and selenium concentrations remained below these levels. The reason for the apparently high concentration for some COPCs in these stream sediments is not clear; there has not yet been mining related disturbances in the watersheds that contribute flow to these sample sites. Further, while the background levels from the IDEQ (2004b) dataset were limited, they were obtained from areas with similar general geology as the watersheds contributing to these sample sites. In addition, the results generally echo streambed sediment samples taken by Montgomery Watson (1999) at the two established monitoring sites above and below mining disturbances in South Fork Sage Creek.

TABLE 3.3-3 SEDIMENT BENCHMARK LEVELS USED BY IDEQ (2002B)

PARAMETER	SEDIMENT BENCHMARK (MG/KG)*	REMOVAL ACTION LEVELS (MG/KG)*
Cadmium	0.99	5.1
Chromium	43.4	100
Copper	31.6	197
Nickel	22.7	44
Selenium	4.0	2.6
Vanadium	none	72
Zinc	123.1	315

* See above paragraphs and IDEQ (2002b) for derivation of these numbers and their source.

3.3.4 Surface Water Uses

Water use in the State of Idaho is managed through the adjudication of water rights, and the adjudication process is managed by the Idaho Department of Water Resources. Water rights information for the Study Area was obtained from their website online computer database (Idaho Department of Water Resources 2004). Water rights for the use of stream flow for various uses are summarized in **Appendix 3A, Summary of Water Rights Points of Diversion** and in Maxim (2004c). The majority of these rights are seasonal, for stockwatering and irrigation uses. In addition, there are surface water rights for stockwatering and irrigation in lower Crow Creek downstream of the reaches described in **Appendix 3A** and continuing into Wyoming.

3.3.5 Groundwater Resources

This section describes groundwater resources in the Study Area, including a description of hydrostratigraphy, recharge/discharge, hydraulic characteristics, and water quality, primarily utilizing information from the Water Resources Baseline Technical Reports for the Study Area (Maxim 2004c and 2004d). Other applicable information on groundwater includes memos and reports on the Study Area relating to water balance estimates of the Crow Creek area (JBR 2004b, 2004c), isotopic data from samples collected in the Study Area (Mayo 2004), groundwater modeling (JBR 2007), and similar work conducted previously at the Smoky Canyon Mine (MFG 2003a and 2004b, and JBR 2001c). In addition to the physical description of the groundwater resources in the Study Area, the connection between groundwater and surface water is described as well as the beneficial uses of groundwater in the Study Area.

Hydrostratigraphy

Groundwater in the Study Area occurs primarily in sedimentary rock units, although some areas of alluvium and colluvium contain local groundwater flow systems. The general geology, structure, and description of hydrostratigraphic units are described in the Geology, Minerals, and Topography section of this document (**Section 3.1**). The primary regional aquifer in the Study Area is the Wells formation, consisting of over 1,000 feet of sandstone and limestone.

The 100-foot thick Grandeur Limestone overlies the Wells formation and is mapped locally as part of the Wells formation. Underlying the Wells formation is the Brazer Limestone, which has similar hydrostratigraphic characteristics (i.e., limestone and interbedded sandstone). Therefore, the Grandeur Limestone, Wells formation, and Brazer Limestone are considered to function as a single hydrostratigraphic unit with respect to groundwater movement.

Immediately overlying the Wells formation is the Meade Peak member of the Phosphoria formation, which generally consists of 75 to 120 feet of shale and mudstone. These rocks have low permeability and do not transmit water, except where faulted and fractured. The Meade Peak member is considered to be a barrier (aquitard) to downward groundwater movement between units above (Rex Chert and Dinwoody) and below (Wells formation) (Ralston 1979, Mayo et al. 1985).

The Rex Chert member of the Phosphoria formation is water bearing in some locations and forms local groundwater flow systems.

The highest bedrock unit stratigraphically in the Study Area that contains groundwater is the Dinwoody formation, which is composed of interbedded siltstone, limestone, and shale. This unit is part of local groundwater flow systems. Presence and movement of groundwater in the Rex Chert member and Dinwoody formation are most predominant where these rocks are faulted and fractured.

The stratigraphy and structure for the Study Area is shown on **Figures 3.1-1** through **3.1-3** and is discussed in **Section 3.1**. The mine panels are located along the east limb of the Webster Syncline and the west limb of the Boulder Creek Anticline. These folds plunge slightly to the north. **Figures 3.3-4** through **3.3-7** focus on hydrostratigraphy and groundwater conditions in the immediate vicinity of Panels F and G and these are discussed later in this section. Locations of all cross-sections are shown on **Figure 3.1-1** in **Section 3.1**.

Groundwater Movement

Geologic cross-sections in **Section 3.1** (**Figures 3.1-2** and **3.1-3**) show areas of groundwater recharge and discharge in the Study Area. In general, groundwater recharge occurs to the Wells formation and Brazer Limestone along the high-elevation Freeman Ridge and Snowdrift Mountain on the west side of the Study Area and flows generally eastward downhill toward discharges located in Sage Valley and Crow Creek Valley. Additional recharge occurs along this flow path where outcrop of the Wells formation and Brazer Limestone occur between the eastward edge of the Phosphoria formation and the discharge locations. Evidence for this eastward flow includes the difference in ground surface elevation between the recharge and discharge areas that have been measured for the water table in the Wells formation. The Wells formation aquifer water table elevation was determined to be 6,902 feet at the monitoring well DC-MW-5 northwest of the Panel G, 6,780 feet at Stewart Ranch Spring, 6,590 feet at Books Spring, and 6,630 feet at South Fork Sage Creek Spring (**Figure 3.3-8**). In addition, water balance studies conducted in 2003 and 2004 in Crow Creek below its confluence with Lamb Canyon indicate that Crow Creek gains flow due to groundwater discharge from the Wells formation and Brazer Limestone between about Lamb Canyon to just downstream of Deer Creek (Maxim 2004a).

The Webster Range highland is located within the Webster Syncline and contains the Thaynes, Dinwoody, and Woodside formations in the upper elevations, which locally may be highly permeable. Ralston et al. (1977) estimated that the recharge rate of these formations is dependent on locally intense fracturing where snow accumulation occurs. These conditions were thought to result in net recharge rates of 2 to 4 inches in Little Long Valley. This is at a lower elevation than the Webster Range, and minimum recharge rates are expected to be higher in the Webster Range where precipitation amounts are greater. These are recharge areas for what Ralston et al. (1977) called the upper flow system that is contained on top of the Phosphoria formation. Groundwater moves along bedding and fractures within these upper flow system rocks, flowing down dip in the more permeable beds to locations where the beds outcrop in canyons and/or where geologic structure provides secondary permeability.

Ralston conducted a number of site-specific hydrogeology studies in the Smoky Canyon Mine area (Ralston 1979, 1980, 1981, 1983, and 1987). He concluded that there are two major zones of groundwater flow in the Smoky Canyon area, the Triassic beds above the Phosphoria shale and the carbonate rocks below it. He described the same pattern of stream gains and losses in the Triassic beds (Dinwoody and Thaynes formations) and Wells formation, respectively, which has been noted throughout the Southeastern Idaho area. Gaining perennial flows were noted for the upper reaches of Smoky, Pole, Sage, and South Fork Sage creeks where they flow over the Triassic beds. Flows were noted to be stable where these streams flow across the Phosphoria and then decrease dramatically where they flow over the Wells formation. Winter (1980) described similar patterns of stream channels gaining flow from groundwater discharges in the Dinwoody formation and then losing flow over the Wells formation in Wells Canyon and the Deer Creek drainage.

The Idaho Water Resources Research Institute (1980) studied the general hydrogeology of the region between the Aspen Range and the Smoky Canyon area. They summarized hydraulic conductivity data for the Meade Peak member of the Phosphoria from multiple test locations in the area and concluded that it was an aquitard that “virtually prevented” groundwater flow between the overlying Dinwoody and Thaynes formation aquifers and the underlying Wells formation aquifer. They also characterized the upper aquifers as being “intermediate flow systems” dominating local conditions, while the Wells formation was postulated to be a regional flow system.

Mayo et al. (1985) described the regional hydrogeology of the Meade Thrust Plate throughout southeastern Idaho. They determined that groundwater contained in the strata above the base of the Phosphoria formation did not circulate through that aquitard to strata below the Phosphoria, and groundwater below the Phosphoria in the Wells formation and Brazer Limestone did not circulate to rocks above the aquitard. They also determined that groundwater in the Webster Range did not pass through the Meade Thrust Fault zone to the Salt Lake formation and other rocks on the east side of the fault. Isotopic values for groundwater discharges along the Meade Thrust Fault suggested to them that groundwater discharging along the fault could be deeper (older) groundwater from the Brazer Limestone mixed with shallower groundwater in the Wells formation. Groundwater studies done in the Smoky Canyon Mine area within the last few years also indicated that mixed age groundwater was apparently discharging along the Meade Thrust Fault in that area (JBR 2001c).

The separation of the bedrock groundwater above and below the Meade Peak member is an important feature in the Study Area because groundwater in the Dinwoody formation is stratigraphically above the proposed pit backfills and external overburden fills. Therefore, the overburden fills from the proposed mining are downgradient of the Dinwoody aquifer. The Wells formation and Brazer Limestone are stratigraphically below the proposed mining operations and groundwater in these units is downgradient of the proposed mine pits, pit backfills, and external overburden fills. Groundwater in the Wells formation and Brazer Limestone west of the Meade Thrust Fault zone discharges upward to surface streams and springs located along the fault zone or locations west of it.

Figure 3.3-4 Panel F East-West Cross Section

Figure 3.3-5 Panel F North-South Cross Section

Figure 3.3-6 Panel G East-West Cross Section

Figure 3.3-7 Panel G North-South Cross Section

Figure 3.3-8 Monitoring Well Locations

In the Study Area, the major eastward groundwater flow component in the Wells formation and Brazer Limestone appears to discharge as major springs (e.g., Hoopes Spring, South Fork Sage Creek Springs, and Books Spring) at or near the surface expression of the thrust faults in Sage Valley and in the bottom of Crow Creek Valley (**Figure 3.3-8**). The thrust faults are considered to be barriers to eastward groundwater flow, resulting in the discharge of groundwater at the low elevations along this linear feature. Mayo et al. (1985) indicated that the thrust faults east of and below the Boulder Creek Anticline were barriers to groundwater flow transverse to the plane of the faults, while also providing potential flow pathways parallel to the faults in the shatter or damage zone of the faults. Ralston (1979) concluded that the flow from Hoopes Spring and South Fork Sage Creek Springs occurred from the Wells formation along the West Sage Valley Branch fault where the trace of the fault and adjacent Wells formation outcrop is at an elevation below the water table in the Wells formation, estimated at approximately 6,700 feet (Ralston 1979).

Flow monitoring of streams and springs in the Study Area during 2003 and 2004 baseline studies resulted in an understanding of the approximate amount of groundwater being discharged from the Wells formation and Brazer Limestone to the surface environment (Maxim 2004c). In addition to discrete springs, monitoring of stream flow in Crow Creek and lower Deer Creek indicate the approximate amount of groundwater that is thought to move from the ground into the stream channels within the Study Area (JBR 2007). **Table 3.3-4** shows the estimates of the discharges from the Wells formation and Brazer Limestone aquifers in the Study Area.

TABLE 3.3-4 GROUNDWATER DISCHARGE FROM WELLS FORMATION AND BRAZER LIMESTONE IN THE STUDY AREA

LOCATION	ANNUAL FLOW (CFS)
Stewart Ranch Springs	6.0
Wells Canyon Spring	0.2
Books Spring	2.9
Lower Deer Creek	0.9
Crow Creek Channel Gain	1.8
South Fork Sage Creek Spring	4.5
Total	16.3

Localized groundwater flow systems occur in the Dinwoody and Phosphoria formations. These rocks receive recharge locally from precipitation in the mountain areas where they outcrop. Smaller springs and seeps in and near the Panel F and G lease areas are likely from local, shallow groundwater systems in the Dinwoody and Phosphoria formations that are structurally and/or stratigraphically controlled. Relatively small flows from these springs discharge where these rocks outcrop due to topography, bedding, or faults/fractures.

A review of drill logs provided by Simplot (2003) for Panel F show that groundwater was encountered in the Rex Chert and Meade Peak members of the Phosphoria formation only in the vicinity of upper Manning Creek where several normal faults have been identified. Other exploration drill holes completed in Panel F to the top of the Wells formation encountered no groundwater. Drill holes in Panel G show that water was encountered in the Rex Chert and Meade Peak members, primarily on the west side of the proposed mine pit. **Figures 3.3-4** through **3.3-7** show locations of groundwater encountered in monitoring wells completed in the vicinity of Panels F and G. Locations of all cross sections are shown on **Figure 3.1-1**.

Figure 3.3-4 is a section across the southern portion of Panel F showing how the mine development would remove the Meade Peak and part of the overlying Rex Chert down dip to the economic stripping ratio. Standing groundwater was encountered in the Rex Chert and in fractured Meade Peak. Both of these groundwater observations are above the regional water table in the Wells Formation, which is more than 800 feet below the bottom of the Panel F pit at this location.

Figure 3.3-5 is a section roughly running along the axis of Panel F and also shows the elevation of the groundwater in the monitoring wells installed within the Meade Peak and Rex Chert. The projection of the deepest portion of the Panel F pit is shown and portrays the fact that the proposed pit bottom throughout Panel F is estimated to be at least 200 feet higher than the regional water table in the Wells formation.

Figure 3.3-6 is a section roughly east-west through Panel G and shows the planned open pit removing the Meade Peak and the Rex Chert that is present on west side of the unnamed hill down dip to the economic stripping ratio. This also shows that a groundwater body exists in the Rex Chert in this location but the regional Wells formation water table is estimated to be approximately 100 feet below the deepest portion of the pit bottom. This is also shown in **Figure 3.3-7**, which is a section roughly parallel to the long dimension of Panel G, which shows groundwater in the Rex Chert and that the bottom of Panel G is estimated to be from 100 to 200 feet above the Wells formation aquifer.

Influence of the Deer Creek and Wells Canyon faults (**Figure 3.3-8**) on groundwater movement in the Study Area is uncertain. A small spring, Wells Canyon Spring, is located about a third of the way up Wells Canyon and may be influenced by the Wells Canyon Fault located in this canyon. Books Spring is located along the Deer Creek Fault and likely discharges from the Wells formation and/or Brazer Limestone. Downstream of where the Deer Creek Fault crosses Deer Creek (**Figure 3.3-8**), the stream gains flow from groundwater from the Wells formation and Brazer Limestone.

Groundwater flow in the Wells formation north of the Deer Creek Fault (under Panel F) flows primarily to the east toward the Meade Thrust Fault and then along the fault toward the north. South of the Wells Canyon Fault, groundwater in the Wells formation and Brazer Limestone appears to discharge at Stewart Spring (**Figure 3.3-8**). Additionally, some groundwater from these formations also appears to discharge into alluvium in the Crow Creek Valley in the general reach between Lambs Canyon and Deer Creek, as evidenced by water balance measurements made in this area in 2003 and 2004 (Maxim 2004c).

Unconsolidated Quaternary colluvium and alluvium deposits occur along the bottoms of South Fork Sage, Deer, and other creeks flowing east from the Webster Range in the Study Area. Alluvial deposits, consisting of well- to poorly-sorted gravel, sand, silt, and clay, are narrow and thin in the bottoms of these creeks where they flow through their respective canyons and become thicker at the mouths of the canyons (Cressman 1964). Permeability of the alluvium is high to moderate, depending on the amount of fines in the sediments.

Aquifer Hydraulic Characteristics

During summer 2003, several monitoring wells were constructed in the Project Area to evaluate groundwater conditions (**Figure 3.3-8**). Well completion information is summarized in **Table 3.3-5**. A total of 11 monitoring wells were drilled and completed in the following hydrostratigraphic units: alluvium, Rex Chert, Meade Peak, and Wells formation.

TABLE 3.3-5 MONITORING WELL COMPLETION DATA
SMOKY CANYON MINE - PANELS F & G

WELL NO.	DEPTH TO WATER (FEET)	WATER ELEVATION (FEET)	WELL DEPTH (FEET)	SCREEN INTERVAL (FEET)	MONITORED LITHOLOGY
MC-MW-1	148.1	6632	210	160 - 210	Upper Wells formation
MC-MW-2	60.0	7763	85	55 - 85	Rex Chert Member
MC-MW-3	dry	dry	25	5 - 25	Alluvium
MC-MW-4	45.5	7846	96	66 - 96	Rex Chert Member
MC-MW-5	88.4	7786	121	81 - 121	Meade Peak Member
DC-MW-1	7.5	7381	7.5	2.5 – 7.5	Alluvium
DC-MW-2	62.6	7203	117	87 - 117	Meade Peak & Upper Grandeur Fm.
DC-MW-3	94.9	7300	193	163 - 193	Rex Chert Member
DC-MW-4	105.0	7314	136	106 - 136	Meade Peak Member
DC-MW-5	303.0	6902	494	380 – 483	Upper Wells formation
DC-MW-6	4.3	7260	7.5	2.5 – 7.5	Alluvium

Note: Elevations surveyed October 29, 2003 as feet above mean sea level. Based on NAD 83 datum.

Regional aquifer test data show the following mean, horizontal hydraulic conductivity values for the various hydrostratigraphic units over a wide geographic area: Rex Chert (unfractured) = 2.8 feet/day; Rex Chert (fractured) = 52 feet/day; Meade Peak (unfractured) = 2.4 feet/day; Meade Peak (fractured) = 25 feet/day; and Wells formation = 1.8 feet/day (Whetstone Associates 2003). Hydraulic conductivity of the Wells formation where locally fractured would be expected to be higher.

Aquifer testing conducted in the bedrock monitoring wells indicated hydraulic conductivities that were lower than the ranges of regional values (Maxim 2004c). Tests of three monitoring wells in the Rex Chert yielded hydraulic conductivities ranging from 0.05 to 0.57 feet/day. A test of the Meade Peak Member away from known faulting yielded a hydraulic conductivity of 0.4 to 0.6 feet/day. Where the Meade Peak was faulted in two monitoring wells, the hydraulic conductivity ranged from 0.4 to 2.9 feet/day. The one test of the Wells formation (DC-MW-5) produced a hydraulic conductivity of less than 0.04 feet/day, which is much lower than expected, but this well was difficult to develop, so the measured hydraulic conductivity is suspect. A recent pump test conducted in the Smoky Canyon Industrial Well by NewFields (2004) indicated a hydraulic conductivity for the Wells formation of 3.7 feet/day.

3.3.6 Groundwater Model

To better understand the flow of groundwater in the Wells formation and Brazer Limestone, a numerical groundwater model using the USGS computer code MODFLOW 2000, was developed for the Study Area (JBR 2007). The boundaries of the modeled area were South Fork Sage Creek on the north, Freeman Ridge/Snowdrift Mountain on the west, Lamb Canyon on the South, and Crow Creek or the Meade Thrust Fault on the east (**Figure 3.3-9**).

An estimate of the groundwater recharge to the Wells formation and Brazer Limestone was made for the model area using empirical data from previous hydrogeology studies (JBR 2005). The recharge to these units comes from: 1) distributed infiltration of precipitation directly into the outcrop areas of the units within the Study Area, 2) percolation from stream channels where they cross the units and lose flow, and 3) underflow from adjacent portions of these units outside the model area. The estimate of these recharge amounts is shown in **Table 3.3-6**.

TABLE 3.3-6 RECHARGE INTO THE WELLS FORMATION AND BRAZER LIMESTONE IN THE STUDY AREA

TYPE OF RECHARGE	ANNUAL AMOUNT (ACRE-FEET/YEAR)
Distributed Precipitation Infiltration	4,800
Percolation from Stream Losses	1,900
Groundwater Underflow from Adjacent Areas	4,400

Distributed recharge occurs from infiltration of rain and snowmelt over the recharge area of the Wells formation and Brazer Limestone within the model area boundary. It was assumed there would be no such recharge in the area underlain by the Meade Peak member aquitard. Streams that cross the outcrop areas of the Wells formation and Brazer Limestone are known to lose flow through percolation into the units under the stream channels (Ralston 1979, Winter 1980). Estimates of the annual recharge to these formations through stream losses were made using gain/loss survey data measured on the streams in the Smoky Canyon Mine area (JBR 2007). Groundwater that flows into the model area originates from recharge of precipitation and snowmelt in outcrop areas of the Wells formation to the south and west of the model area. A large, high-elevation recharge area is in the area of Meade Peak immediately south and southwest of the model area boundary.

The groundwater model used a water budget consisting of the measured groundwater discharges listed in **Table 3.3-4** and the groundwater recharge estimates listed in **Table 3.3-6**. The hydraulic conductivity within the model area was adjusted until the model discharges calibrated with the measured flows listed in **Table 3.3-4**, and the elevation of the water table at the discharge points calibrated with the known elevations at these points and the measured water table elevations at monitoring wells DC-MW-5 and MC-MW-1. Based on previous studies in the area, the hydraulic conductivity along the Meade Thrust Fault plane was set at a high level (Mayo et al. 1985). Outside of the thrust fault and the immediate vicinities of Stewart Ranch and Books springs, the majority of the calculated hydraulic conductivities within the model area ranged from about 1.4 to 3.8 feet/day, which is consistent with the measured hydraulic conductivity at the Smoky Canyon Mine Industrial Well.

The model was then used to generate the water table contours shown in **Figure 3.3-9**. These show a general pattern of eastward groundwater flow for the Wells formation /Brazer Limestone regional aquifer within the model area. They also show the influence of the large amount of groundwater recharge that occurs in the high-elevation area south and southwest of the model area. Finally, hypothetical particles were placed in the top of the modeled aquifer at specified locations along the east margin of the Meade Peak member and allowed to move downgradient under the influence of groundwater flow. These “particle tracks” are shown in **Figure 3.3-9**.

The particle tracks indicate that groundwater in the Wells formation and Brazer Limestone generally moves toward the east boundary of the model area. They also indicate that the groundwater under Panel F moves toward the trace of the Meade Thrust Fault and then northward along the fault toward South Fork Sage Creek Spring. Groundwater under Panel G appears to flow eastward toward discharge locations along lower Deer Creek or at Books Spring.

Figure 3.3-9 Modeled Potentiometric Surface and Groundwater Flow Direction

3.3.7 Chemical Characteristics of Groundwater

Water samples were collected in 2003 and 2004 from all monitoring wells in the Study Area, with the exception of alluvial well MC-MW-3 (Panel F) because it was dry. Samples were analyzed for the water quality parameters listed in **Appendix 3A, Summary of Groundwater Data**. Some parameters were also measured in the field during sample collection including: temperature, pH, conductivity (SC), dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity. Metals were analyzed as both total and dissolved. Tables including complete groundwater quality data are contained in the baseline technical reports (Maxim 2004c and 2004d) and are reproduced in **Appendix 3A, Summary of Groundwater Data**. The groundwater quality standards listed in this same table are obtained from IDAPA 58.01.11.200. For Idaho, groundwater standards for metals are based on the total fraction. Groundwater samples were obtained and analyzed for both total and dissolved metals to identify the potential effect of turbidity on the reported water chemistry. Some groundwater standards (e.g., pH, TDS, chloride, sulfate, aluminum, iron, manganese, silver, and zinc) are “secondary”, which are generally based on aesthetic qualities (IDAPA 58.01.11.200.01.b). If the natural background level of a constituent in groundwater exceeds its standard, the natural background level shall be used as the standard (IDAPA 58.01.11.200.03).

Comparison of the baseline monitoring results from the monitoring wells to applicable standards show that, in general, groundwater in the Study Area meets the groundwater quality standards with some exceptions that exceeded the standards. These exceedances are highlighted in **Appendix 3A, Summary of Groundwater Data** with shading. Many of the exceedances of the metals standards were measured in total metals samples with fewer exceedances noted in dissolved metals samples. The total metal samples are not filtered in the field and represent water quality in the well itself, including any suspended sediment in the well. The dissolved metals samples are filtered in the field to exclude any suspended sediment and represent water quality in the aquifer outside the well casing. However, for Idaho, groundwater standards for metals are based on the total fraction.

The pH was typically in a range of about 7 to 8.5. Values in the lower range from 5.4 to 6 were measured in the field in four samples from monitoring wells completed in Rex Chert, Meade Peak shale, and alluvium (MC-MW-2, MC-MW-5, and DC-MW-1). Laboratory pH measurements for all four samples were about 7 or above. One well (DC-MW-3) had field and lab pH values over 8 and 10, respectively for the 2003 and 2004 samples. This water was obtained from the Rex Chert west of Panel G.

One groundwater sample (DC-MW-1) had a nitrate value (25 mg/L) over the standard (10 mg/L). This was from a shallow (7.5-foot deep) well developed in alluvium west of Panel G.

The manganese standard (0.05 mg/L) was exceeded in four groundwater samples from the Rex Chert (MC-MW-2, MC-MW-4, and DC-MW-3), two samples from alluvium (DC-MW-1 and DC-MW-6), and three samples from the Meade Peak member (MC-MW-5, DC-MW-2, and DC-MAW-4). The manganese standard is a secondary one intended to reduce discoloration of materials that come in contact with the water.

The dissolved selenium concentration (0.507 mg/L) in the 2003 sample from the Meade Peak member in MC-MW-5 exceeded the selenium standard (0.05 mg/L) by an order of magnitude. The selenium concentration in this well dropped to half the groundwater standard in June 2004 but then increased to 0.325 mg/L in October 2004. The selenium concentration in a June 2006 sample from this well was 0.0171 mg/L (NewFields 2007a, **Appendix 3A**). Other monitoring well samples collected from the Meade Peak (DC-MW-2 and DC-MW-4) had dissolved selenium values that were below the groundwater standard.

Well DC-MW-5, completed in the upper Wells formation at Panel G, also had selenium concentrations that were anomalous. The dissolved selenium concentration was 0.0143 mg/L in 2003, 0.0105 mg/L in June 2004, 0.0079 mg/L in October 2004, and 0.0106 mg/L in June 2006. These concentrations are below the groundwater standard of 0.05 mg/L, but above the surface water standard of 0.005 mg/L. The significant drop in manganese and iron concentrations between 2003 and 2004 in the samples from this well, combined with the extreme depth (>300 feet) and low pumping rate (1.5 gpm), indicate that this well was not adequately developed to obtain representative groundwater samples, and the selenium concentrations are likely not indicative of baseline conditions. Concentrations of several metals are elevated for the total fraction (e.g., aluminum, cadmium, chromium, iron, and manganese). Dissolved metal concentrations, however, are lower and show the effect of insufficient development of this well on measured water chemistry, although the effects of the poor well development appear to be decreasing over time. The other baseline Wells formation monitoring well, MC-MW-1, had selenium concentrations well below the surface water selenium standard (0.005 mg/L), confirming that baseline selenium concentrations in the Wells formation aquifer are low. The selenium concentration in this MC-MW-1 in May 2006 was 0.00037 mg/L (NewFields 2007a and **Appendix 3A**)

Graphical plots (Piper and Stiff diagrams) of common ions for the surface water and groundwater samples are included in **Appendix 3A, Figures H-1 – H-9**. The Piper diagrams titled “Median Groundwater Quality” and “Median Spring Water Quality” (**Appendix 3A, Figures H-3 and H-6**) graphically show that ion concentrations are generally similar for all groundwater samples, and the water samples are of the calcium-magnesium bicarbonate type. Stiff diagrams graphically show the concentrations of the major cations and anions in a way that allows comparison of the water chemistries of the different samples. The Stiff diagrams for the median water quality for springs from the Wells formation (**Appendix 3A, Figure H-7**) show the close chemical similarity of these samples, consistent with them all discharging from the same aquifer.

The higher sodium and chloride concentrations in SP-Books (Books Spring) suggest the water in this spring discharge has contacted saline rocks in the Pruess formation, which is known to contain bedded salt deposits in the area. The Pruess formation is present to the east of the Meade Thrust Fault in this area, suggesting the water discharging from this spring has flowed along the fault zone and contacted salt bearing rock.

The major ion values of the water in the two Wells formation monitoring wells (DC-MW-5 and MC-MW-1) on **Figure H-4, Appendix 3A**, are similar to the Wells formation springs shown on **Figure H-7**, again demonstrating a common aquifer for these samples. Note that the concentration scales for **Figure H-4** are different than **Figure H-7**, which is the reason the shapes are different between these two figures even though the chemistries are similar. The stiff diagrams for the other monitoring wells on **Figures H-4 and H-5, Appendix 3A,** demonstrate different water chemistry than the samples from the Wells formation aquifer and show highly variable chemistries when compared to each other.

The stiff diagrams for the Rex Chert monitoring wells (**Figure H-5, Appendix 3A**) typically show low concentrations of all major ions. This pattern is similar to the spring waters shown on **Figure H-9, Appendix 3A,** that discharge on the Rex Chert outcrop (SP-UTNFDC-400, SP-DC-350, SP-UTDC-700, SP-WC-400).

The chemistries shown in **Figures H-5, H-8 and H-9 (Appendix 3A)** for waters sampled from monitoring wells and springs contained in shales (DC-MW-2, SP-SFSC-100, SP-UTSFSC-100, SP-MC-300, SP-UTNFDC-600, SP-NFDC-700, and SP-UTDC-800) all have higher concentrations of calcium and bicarbonate than the samples from the Rex Chert.

Comparisons of water chemistry data for springs in the Study Area to applicable water standards are shown in **Appendix 3A, Summary of Surface Water Data.**

The field pH of the springs was typically in a range of about 7 to 8.5 for the 2002 and 2003 samples. Lower pH values in the range from 6.2 to 6.5 were measured in the field in 2004 regardless of the spring location in the Study Area. Laboratory pHs for all samples in all years were in the range of 7.4 to 8.6. Questions related to field pH measurements in May 2004 resulted in them being declared invalid (Maxim 2004b). There are no obvious geographic or geologic trends in pH between the various springs in the Study Area.

Spring water in the Study Area is generally good quality with total dissolved solids (TDS) values ranging from 22 to 308 mg/L. The lowest TDS values were from SP-UTWC-300 (22 mg/L) and SP-UTSFDC-500 (54 mg/L), which discharge from colluvium west of Panel G. The higher TDS springs included Books Spring (264 mg/L) and Hoopes Spring (276 mg/L), which discharge Wells/Brazer groundwater, and two springs located on the south end of Panel F and the north end of Panel G, respectively (SP-UTNFDC-600 = 308 mg/L and SP-UTDC-800 = 285 mg/L), which likely discharge groundwater from the Rex Chert or alluvium/colluvium.

Electrical conductivity is an indirect measurement of the salinity of water and the readings from the springs in the Study Area ranged from 26 to 629 umhos/cm. The lowest conductivity reading was for SP-UTWC-300 (26 umhos/cm). The highest conductivity value for spring water was obtained from SP-CC-500, the small saline spring near the narrows along Crow Creek downstream of Deer Creek (629 umhos/cm). The other high values were from SP-UTNFDC-600 (573 umhos/cm), Books Spring (498 umhos/cm), SP-UTNFDC-540 (498 umhos/cm), and SP-UTDC-800 (488 umhos/cm).

Springs in the Study Area typically had dissolved cadmium concentrations that were below the surface water standard of 0.001 mg/L (dissolved basis, hardness adjusted). There were three dissolved cadmium concentration exceedances at SP-UTNFDC-540 (0.0019 mg/L in 2004, 0.0024 mg/L in May 2005, and 0.0024 mg/L in October 2005). This spring is located in an area downhill of Meade Peak Shale outcrop. In 2005, the cadmium standard was exceeded at SP-UTSC-850 (0.0052 mg/l).

The selenium concentrations in a number of springs exceeded the surface water standard of 0.005 mg/L (total basis) (**Table 3.3-7**). All of these springs except SP-UTSC-850 discharge water from the Rex Chert or Meade Peak members of the Phosphoria formation. SP-UTSC-850 is a small spring located approximately along the West Sage Valley Branch thrust fault and could potentially be discharging groundwater from the Wells/Brazer aquifer.

TABLE 3.3-7 SPRINGS EXCEEDING THE SELENIUM SURFACE WATER STANDARD

SPRING	DATE	CONCENTRATION (MG/L)
SP-DC-350	8/08/02	0.006 D & T
SP-UTDC-700	5/19/03	0.01 D*
SP-UTDC-700	10/28/03	0.0068 T
SP-UTDC-700	5/17/04	0.0073 D, 0.0075 T
SP-UTDC-800	5/19/03	0.015 D*
SP-UTDC-800	5/17/04	0.0065 D, 0.0069 T
SP-UTDC-800	5/24/05	0.0102 D & T
SP-UTNFDC-540	10/28/03	0.0054 D & T
SP-UTNFDC-540	5/17/04	0.0105 D, 0.0104 T
SP-UTNFDC-540	5/24/05	0.009 D, 0.0087 T
SP-UTNFDC-540	10/18/05	0.0051 D, 0.0056 T
SP-UTNFDC-600	10/29/03	0.0122 D*
SP-WC-400	8/08/02	0.006 D & T
SP-UTSC-850	5/18/04	0.008 D, 0.0084 T
SP-UTSC-850	5/25/05	0.0063 D, 0.014 T
SP-SFSC-750 (LSS)	10/16/06	0.0056 D, 0.0056 T
SP-SFSC-750 (LSS)	1/13/07	0.0081 D*

*There was no total metals sample for this date or quality assurance requires use of dissolved data.

South Fork Sage Creek Spring (SP-SFSC-750) is located at the mouth of South Fork Sage Creek and the combined flow and water quality of this spring has historically been measured in the creek just downstream from the spring at site LSS (Maxim 2004c and 2004d). During low flow season, the water monitored in the creek at LSS is typically comprised solely of groundwater discharged at the spring just upstream. The water quality at LSS has historically contained very low concentrations of selenium, below the surface water standard (**Table 3.3-1**). In October 2006, the selenium concentration of the stream at LSS was 0.0056 mg/L and a sample obtained in January 2007 contained 0.0081 mg/L selenium.

The only other metal that exceeded surface water standards in the springs water quality monitoring was zinc with a standard of 0.120 mg/L. The standard was exceeded in the samples from SP-UTDC-700 (0.225 mg/L) and SP-UTSFDC-500 (0.21 mg/L). Both these springs are located in the Phosphoria formation outcrop area. In 2005, a sample from SP-RIEDE had a reported dissolved zinc concentration of 0.256 mg/L, which also exceeded the standard.

In general the groundwater discharges to the surface at springs in the Study Area indicate good quality groundwater with the exception of certain springs that discharge within the outcrop area of the Phosphoria formation where groundwater flow can contact mineralized rock units. These springs are not hydrologically connected to the regional Wells/Brazer aquifer.

3.3.8 Environmental Isotopes

Analyses were conducted of isotopes (deuterium, oxygen-18, tritium, carbon-14) in selected water samples from the Study Area (Mayo 2004). The stable isotopes (deuterium and oxygen-18) were used to discriminate between different waters and to interpret their origins. All of the springs that appear to discharge from the Wells formation or Brazer Limestone (Hoopes, Wells Canyon, Books, South Fork Sage, Lower Deer Creek, Lower Clear Creek, and Stewart Ranch) had similar, depleted stable isotopic characteristics indicating they belong to a common aquifer. The more negative values of the stable isotopes for these samples indicate the water precipitated in relatively low temperature conditions, consistent with precipitation occurring at high elevations and as snow, or during colder climatic conditions (old water).

The sample from the deep Wells formation monitoring well upgradient (west) of Panel G, DC-MW-5 had the most depleted stable isotope ratios, indicating it formed at the coldest temperatures of any of the samples. This is consistent with the fact that only high elevation recharge areas are upgradient of this sample site. On the other hand, the sample from the shallower monitoring well in the mouth of South Fork Sage Creek Canyon, MC-MW-1, had a rather positive stable isotope value, indicating it is in the flow path of recharge from surface water flow in the adjacent South Fork Sage Creek (Mayo 2004).

The stable isotope results for the groundwater samples are consistent with water that was recharged at higher elevations and then flowed eastward to lower elevation discharge locations. The more negative isotope values are also consistent with mixed shallow and deeper origin groundwater along the Meade Thrust Fault where the deeper waters would be older and have more negative isotopic values.

Stable isotope characteristics for surface water samples obtained in the Study Area during summer 2003 tended to be similar to each other and were more positive in value than the groundwater samples, indicating the water precipitated at warmer temperatures (lower elevations) and possibly was affected by evaporation.

Stable isotope values for Crow Creek samples in the Study Area taken during summer and winter indicated that the winter base flow of the creek upstream from the area of the confluence with Deer Creek was supported by the same aquifer as the other Wells formation/Brazer Limestone springs. This is consistent with water balance studies conducted along Crow Creek during summer 2003 and winter 2004, which indicated that groundwater is discharged into the Crow Creek channel from somewhere below the mouth of Lamb Canyon to just downstream of Deer Creek Canyon (Maxim 2004c).

The radioisotopes (carbon-14 and tritium) were utilized to evaluate mean residence times (age) of the groundwater in the aquifers. Carbon-14 provides information regarding the number of years that have elapsed since the groundwater became isolated from soil-zone gases and near-surface waters. Tritium is a qualitative tool that indicates if groundwater was recharged since about 1954 when man-made tritium was released to the atmosphere through thermonuclear testing. Groundwater ages determined from carbon-14 and tritium were listed as modern, mixed old/modern, or old, depending on whether the samples contained anthropogenic carbon-14 and tritium.

The elevated tritium content of all samples, typically greater than 4 tritium units, indicated that all samples from the Wells formation and Brazer Limestone contained appreciable modern recharge. Most samples also contained carbon-14 concentrations greater than 50 percent modern carbon, indicating anthropogenic (human-induced) carbon associated with atmospheric nuclear weapons testing. Hoopes and Books springs had the lowest carbon-14 contents which, when combined with their lower tritium contents, indicate the flows discharging from these springs are mixtures of old and younger waters with mean residence times of 200 and 300 years, respectively. This is consistent with the mixed-age that was determined for Hoopes Spring water in 2000 (JBR 2001c) and in 1980 (Muller and Mayo 1983).

The modern tritium and radiocarbon ages determined for MC-MW-1 indicated that this well is located in recharge flow paths for modern surface waters in the adjacent South Fork Sage Creek.

Unlike Hoopes Spring and Books Spring, South Fork Sage Creek Spring and Stewart Spring both have appreciable carbon-14 contents indicating they have more modern mean residence times than either Hoopes or Books springs.

The mixed-age mean residence times for samples from Books and Hoopes springs indicate flows from these sources are likely mixtures of relatively young groundwater in the upper Wells formation and Brazer Limestone aquifer, with relatively old groundwater rising along the Meade Thrust Fault. This is consistent with the theory proposed by previous workers that the trace of the thrust fault acts as a barrier to flow perpendicular to it but also as a zone of preferential flow in the damage zone parallel to the fault trace (Mayo et al. 1985, JBR 2001c).

3.3.9 Groundwater – Surface Water Interconnection

Groundwater in the Dinwoody and Thaynes formations supports springs and seeps located in the map area for these units. Perennial and seasonal seeps, springs, and streams in the Study Area are supported by Dinwoody groundwater discharges in the following watersheds: Diamond Creek, Upper Deer Creek (above SW-DC-300), Upper South Fork Deer Creek (above SW-SFDC-200), North Fork Deer Creek (above SW-DC-500), Upper Manning Creek (SP-MC-300), Upper South Fork Sage Creek (SP-SFSC-100), and the upper portion of the unnamed tributary to South Fork Sage Creek that drains the northern portion of Panel F (SP-UTSFSC-100 and –200) (**Figure 3.3-3**).

Groundwater in the Rex Chert apparently does not support any of the major mapped streams in the Study Area, but does provide flow to isolated seeps and springs in the following areas: Upper Wells Canyon (SP-WC-400, SP-UTWC-300), Panel G (SP-UTDC-800, SP-UTDC-700, SP-UTSFDC-500 and -600), and Panel F (SP-UTNFDC-400 and –600) (**Figure 3.3-3**).

All of the groundwater supporting the seeps, springs, and streams in the Dinwoody and Rex Chert areas is stratigraphically isolated above the Meade Peak member and is not connected to the groundwater in the Wells formation and Brazer Limestone underlying the Meade Peak.

Groundwater contained in the Wells formation and Brazer Limestone supports the following springs and streams located along the eastern slope of the Webster Range: Hoopes Spring (SP-Hoopes), South Fork Sage Creek Spring (SP-SFSC-750), unnamed spring south of SF Sage Creek (SP-UTSC-850), Lower Deer Creek (above SW-DC-800), Books Spring (SP-Books), Wells Canyon (SP-WC-750), Stewart Ranch (SP-ST-100, -200, and –500), Crow Creek (above SW-CC-500), and Clear Creek (SW-CL-800) (**Figure 3.3-3**). All of the discharges described above that apparently flow from the Wells formation or Brazer Limestone combine for a total flow in the range of 15 to 20 cfs, which provide perennial base flow to Sage Creek, Crow Creek, and certain tributaries to these creeks including Lower South Fork Sage Creek, Lower Deer Creek, and lower Clear Creek.

Groundwater in the Rex Chert member and Dinwoody formation does not recharge the aquifer in the Wells formation to a significant degree. The exception to this is where perennial streams flowing across the Dinwoody are supported by Dinwoody groundwater, and these stream flows are lost to the Wells formation outcrop where the channels cross the outcrop.

Groundwater from the Wells formation and Brazer Limestone does not flow up through the Meade Peak member, so it does not connect with seeps, springs, and streams within the outcrop areas of the Rex Chert member or Dinwoody formation.

Based on the above, it is apparent that there are two separate groundwater systems in the Study Area: 1) the Rex Chert and Dinwoody groundwater system located stratigraphically above the Meade Peak member and 2) the Wells formation and Brazer Limestone groundwater system below the Meade Peak.

3.3.10 Beneficial Use of Groundwater

A listing of water rights associated with both surface water and springs (considered a groundwater right) in the Study Area obtained from IDWR (2004) is presented in **Appendix 3A, Summary of Water Rights Points of Diversion**. Also included in the appendix is a map showing locations of water rights (points of diversion) in the Study Area. According to this information, springs closest to Panels F and G that have water rights coincide with:

- SP-UTSFSC-100 and -200 along the west side of Panel F in a tributary to South Fork Sage Creek (No. 4054, USFS, stock water);
- SP-MC-300 on the west side of Panel F in upper Manning Creek (No. 4053, USFS, stock water); and,
- SP-WC-400 on the southwest side of Panel G in upper Wells Canyon (No. 4056 and 10505, USFS, stock water).

In addition to these springs closest to the Panels F and G, the following spring discharges in the Study Area also have water rights: Books Spring (SP-Books; No. 4069, Nate, irrigation-stock water); Stewart Springs (SP-ST-100 and -200; No. 2020 and 4010, Alleman and Stewart, domestic-irrigation-stock water); South Fork Sage Creek Springs (SP-SFSC-750; No. 10034, Hoopes, stock water); and Hoopes Spring (SP-Hoopes; No. 4081 and 10033, Peterson and Hoopes, domestic-irrigation-stock water). There are also springs with water rights that occur within or very near the proposed haul/access road corridors throughout the Study Area. The majority of these springs have been included in the baseline studies for this EIS and are shown on **Figure 3.3-3**.

There is one listed groundwater right for the Study Area: No. 10024; owner – Reide; domestic use. This matches the "SP-Reide" monitoring site shown on **Figure 3.3-3**, which is a spring that has been developed into a shallow well.

3.4 Soils

Regional Setting

The Project Area is located in the middle Rocky Mountain Physiographic Province of southeastern Idaho. Much of the province is made up of interior basins. Mountains rise steeply from the semiarid sagebrush-covered plains or agricultural valleys. The mountains are generally well covered with vegetation, and the higher elevations support conifer forests on the north and east facing slopes (USDA 1990).